ADOPTION OF GREEN BUILDINGS IN PAKISTAN

To achieve Pakistan's Nationally Determined Contribution

2024.09

Abstract

This report is a draft of the evaluation system and criteria development for the establishment of a green building certification system in Pakistan and is intended to facilitate the review with partner organizations. First, we summarize the current status, challenges, and implications of green building in Pakistan. Then, we examined the challenges and strategies to achieve energy efficiency in buildings considering the diversity of local climate zones, and proposed a green building certification system and detailed criteria for Pakistan.

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I. Executive Summary

An NDC report indicates that Pakistan has set an ambitious conditional target to reduce the country's projected total emissions by 50% by 2030. This reduction is to be achieved through a combination of 15% reduction in emissions from Pakistan's own resources and 35% reduction in emissions from the energy transition. The latter will require international financial assistance of approximately USD 101 billion. To achieve this target, Pakistan has established goals to switch 60% of its energy mix to renewables and 30% of vehicles on the road to electric vehicles. It also plans to introduce a complete ban on coal imports. However, there are still several challenges to overcome, including a lack of local expertise and skills in green buildings and the public's lack of awareness of the need for green buildings.

This study aims to enhance public awareness of green buildings and facilitate a low-carbon transition in Pakistan through the development of a green building rating system and detailed criteria.

To this end, we conducted a comparative analysis of green building policies and certification schemes in many Asia-Pacific countries to identify best practices applicable to Pakistan's context. The findings from this analysis formed the basis for establishing a green building assessment system for Pakistan. Based on this, we conducted a SWOT analysis and developed basic measures for green building applications in Pakistan.

Second, we conducted a review of prior local studies and materials from workshops, among others, with the objective of gaining insight into the country's current status. This included an analysis of policies, economics, and market conditions that may influence local green building practices and existing buildings. At the same time, we conducted an in-depth examination of the characteristics of the local climate and the local architectural practices with the aim of facilitating the development of a green building code tailored to Pakistan's context. The results of these local environmental surveys provided the basis for establishing a green building rating system for Pakistan. Based on these results, we conducted a SWOT analysis and developed a strategy for green building applications in the local context.

Third, we used the findings from the aforementioned analyses to develop a viable green building assessment model for Pakistan and outlined the implementation of the rating system. Finally, we proposed a draft evaluation mechanism and detailed criteria for green building evaluation. The development of a green building rating system and detailed criteria will facilitate Pakistan’s efforts to transition to a low-carbon economy and achieve the United Nations' Sustainable Development Goals (SDGs).

The findings of this study will provide Pakistan with insights on how to develop policies to promote green building practices, which will enhance the resilience of the construction sector and lay the foundation for the decarbonization of the economy.

II. Overview

1. Purpose and Rationale of the Project

■ Purpose and Background

- **Project Title**: Adoption of green building in Pakistan to achieve Pakistan's nationally determined contribution
- **Country**: Pakistan

The need for a response to the ever-accelerating climate crisis resulting from climate change and the rapid urbanization of developing countries has led to increasing interest in and expectations for building energy efficiency, as well as green building standards and regulations. Pakistan is facing challenges to introduce green buildings due to the lack of awareness and limited funding, despite the country's efforts to envision carbon emission reduction as a national goal. In Pakistan, several studies have already been conducted with the support of the EU and SWITCH-Asia[1] to develop a green building code. However, the absence of green building standards and regulations means that the sustainability aspects are still not considered in urban development projects pursued nationwide.

The Ministry of Climate Change of Pakistan has submitted a Technical Assistance Response Plan to the United Nations Climate Technology Centre and Network (UN CTCN). In response, the UN CTCN has requested the South Korean government (Korea Institute of Civil Engineering and Building Technology, KICT) to consider a partnership program with Pakistan. The KICT has executed this study as part of the partnership program, entitled "Adoption of Green Building in Pakistan to Achieve Pakistan's Nationally Determined Contribution."

The KICT and Korea Research Institute of Eco-Environmental Architecture (KRIEA) has developed a rating system based on a local fact-finding survey and international case

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[1] *SWITCH-Asia is a program funded by the European Union (EU). Launched in 2007, it supports Asian, Middle Eastern, and Pacific countries in their transition to a low-carbon, resource-efficient, and circular economy and promotes sustainable production and consumption, facilitating the creation of sustainable supply chains connecting these regions with Europe.*

studies to assist Pakistan in achieving carbon neutrality, responding to climate change, and promoting green building practices in the medium to long term.

■ Rationale

Many developing countries are working to reduce carbon emissions by promoting low-carbon, zero-energy architecture and green buildings. However, they still face significant challenges in implementing and adopting these practices, while they are seriously affected by the exposure to rapid climate change. In this context, it is crucial to develop effective and feasible green building evaluation criteria and a certification model.

Urgent need to establish effective measures for the promotion and development of green building

「Vulnerability of developing countries due to rapid climate change」

「Need for effective international cooperation and climate change's economic impacts」

「Lack of substantive criteria considering economic, institutional, and social aspects」

ENVIRONMENTAL CONTEXT	ECONOMIC CONTEXT	INSTITUTIONAL CONTEXT
Accelerating climate change crisis response and rapid urbanization	**Economic impacts due to climate change, international support**	**Lack and challenges of systems for establishing eco-friendly green buildings**
• Approximately 40 countries are accelerating the global response to the climate crisis by regulating greenhouse gas emissions to slow down global warming • The emergence of participation from developing countries: Many countries are setting international greenhouse gas reduction targets, leading to a demand for substantive greenhouse gas-related policies in buildings • Rapid population growth has led to increased energy consumption and instability in power systems	• Economic impacts due to natural disasters caused by climate change • Despite increased interest in eco-friendly technologies such as renewable energy and localism, challenges persist with energy shortages and difficulties in economic growth, including job creation • International support: Organizations like the UN-CTCN (Climate Technology Centre and Network) and cooperation programs from developed countries such as the EU's SWITCH-ASIA are established to actively assist developing countries in reducing greenhouse gas emissions. However, local application of these programs often presents challenges.	•Rapid population growth in developing countries has also led to increased demand for housing, necessitating national-level consideration of supply •Due to a lack of green building standards and regulations, urban development often proceeds without sustainability considerations •In developing countries, there is a lack of awareness about eco-friendly buildings and constraints in financing, which make the implementation of green buildings challenging

Figure 1. Project background

In Pakistan, international green building certification systems such as Leadership in Energy and Environmental Design (LEED) are used in practice. However, differences in perceptions of people who apply the certification systems to practices and the inherent limitations of LEED, which was developed primarily based on the climate and environmental conditions in North America, that are not in line with the various climate and environmental conditions of Pakistan[1] highlight the urgent need to develop a new certification system and criteria for green buildings. To this end, it is essential to explore the best practices of Asia-Pacific countries that have similar climatic conditions to Pakistan and develop an actionable green building certification model and evaluation criteria tailored to Pakistan. It is also necessary to identify the current laws and policies for green buildings in Pakistan and to establish a rating system that reflects the local market conditions and circumstances. In other words, the new green building certification system in Pakistan should have flexibility to respond to the country's economic and environmental contexts. This study will also contribute to the advancement of sustainable building practices and the achievement of the SDGs in Pakistan and numerous other developing countries.

2. Scope and Objectives of the Project and Key Tasks

■ Scope of the Project

The scope of this project is to conduct a comprehensive literature review and local fact-finding survey on green building practices in Pakistan, to develop an effective evaluation model and operational system, to analyze overseas trends and data, to develop an evaluation model and criteria, and to identify methods and mechanisms to apply the model to practice.

■ Objectives and Key Tasks

This study aims to contribute to Pakistan's transition to a low-carbon economy and achieve the UN SDGs by establishing a green building rating system, including evaluations of components thereof. It will also raise public awareness of sustainable architecture in Pakistan and facilitate the low-carbon transition. Figure 2 shows the key tasks performed in this study.

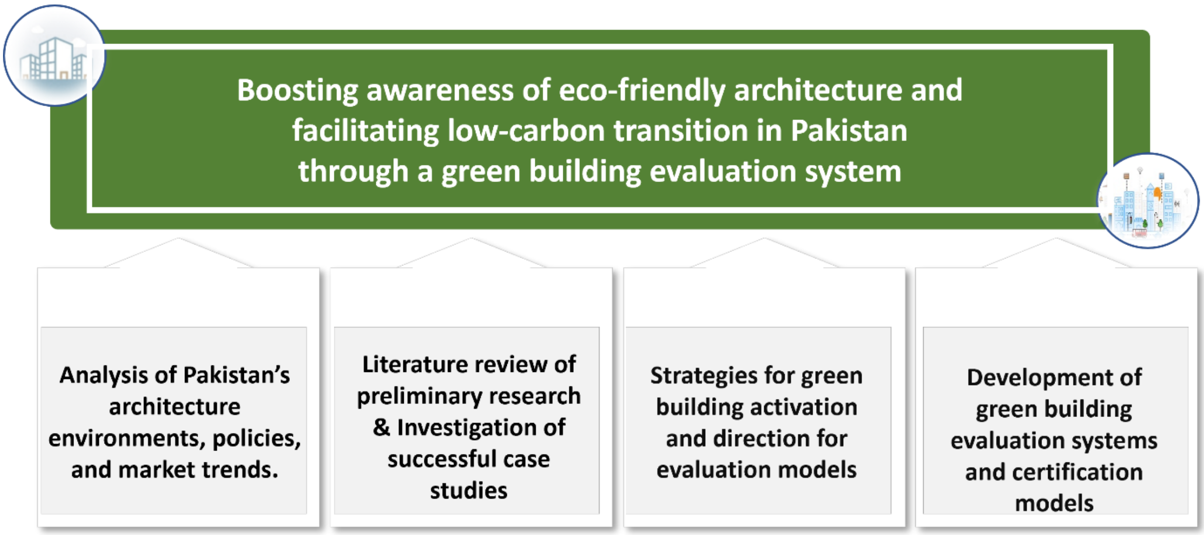


Figure 2. Major implementation tasks for this research

- Identify best practices applicable to developing countries by identifying successful cases of green building technology, policy, institutions, and support systems in Asia-Pacific.
- Conduct surveys on local building conditions, construction industries, building energy supply and demand, green building and energy plans, and policies and regulations in place or planned in developing countries to understand local contexts and issues.
- Analyze the results of these surveys to identify implications and improvement plans for the promotion of green building practices in developing countries.
- Develop a green building evaluation mechanism and detailed criteria.

3. Project Structure and Progress

■ Project Structure

The KICT spearheaded the development of the evaluation model and certification system for the Pakistani Green Building Code. Green Growth Consulting (GGC), a Pakistani expert group, prepared an expert report on the status of green building and architecture in Pakistan. The KRIEA, in collaboration with the two organizations, analyzed the status of

Pakistan and identified gaps in current policies and delivered the findings to GGC in six review opinions.

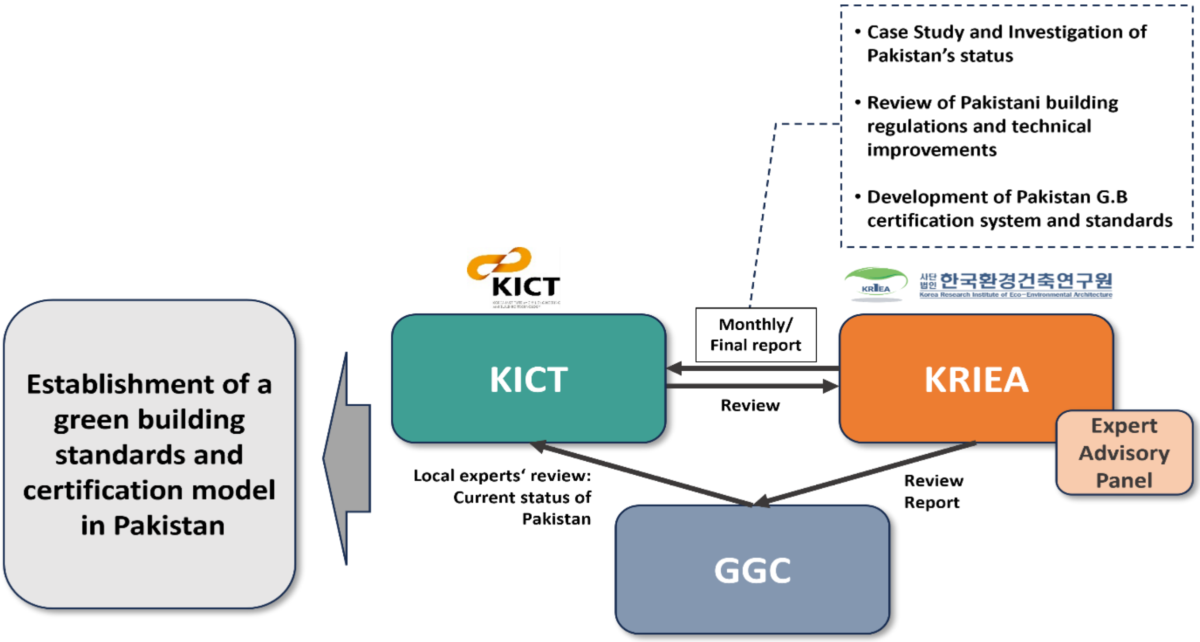
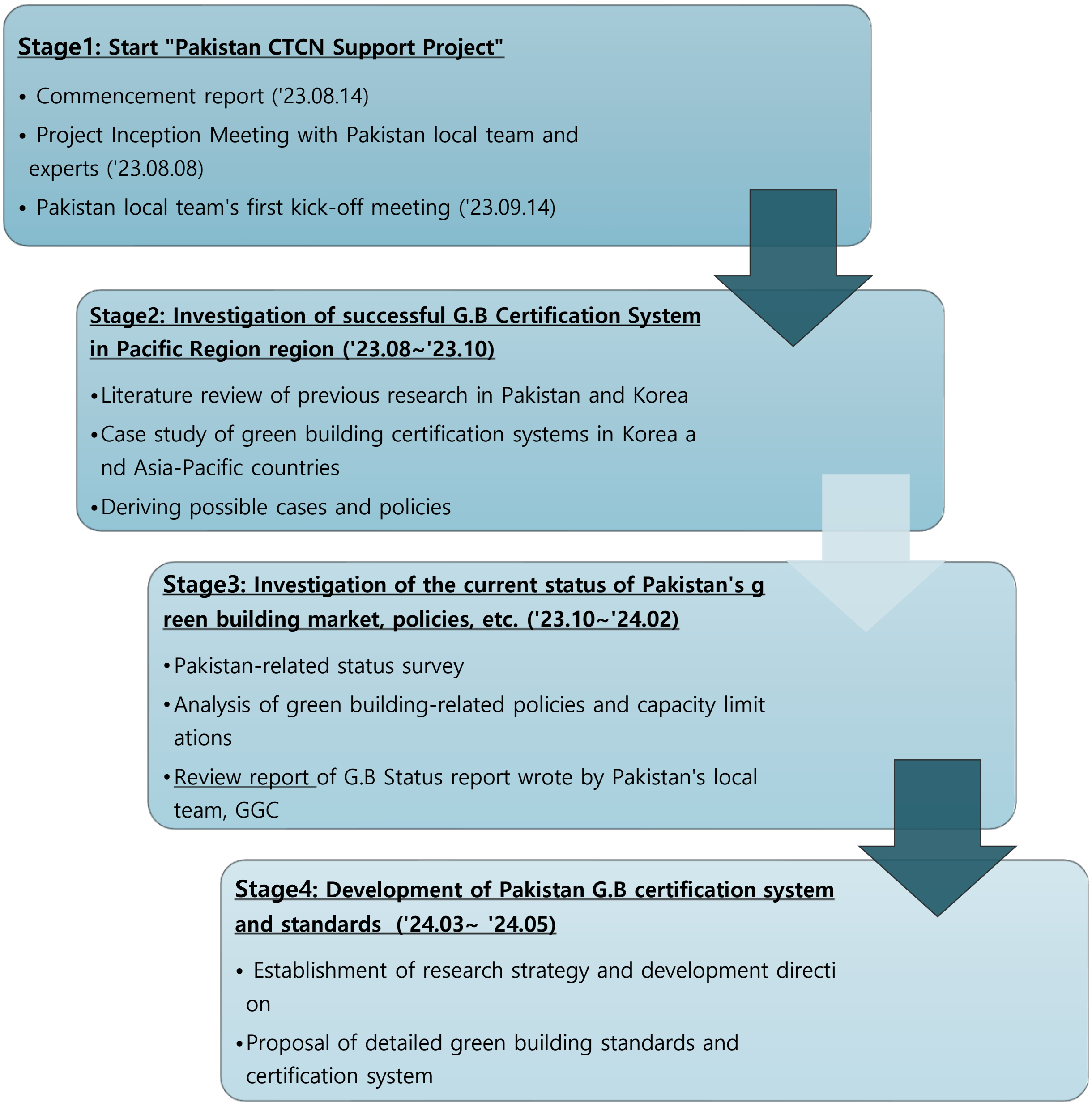


Figure 3. Strategic research development system with defined roles for establishing green building standards and a certification model in Pakistan

■ Project Progress

The international collaborative research framework established four stages of detailed tasks with the objective of developing actionable green building standards and an evaluation model (Figure 4). Following the project initiation stage, we conducted research on successful cases of green building certification systems and schemes in the Asia-Pacific region and identified cases and policies applicable to Pakistan's context. In the third stage, we analyzed green building technologies, policies, and markets in Pakistan and developed a strategy. In the final stage, we set the direction for the development of green building standards applicable to Pakistan and proposed a certification model system.



Stage1: Start "Pakistan CTCN Support Project"

- Commencement report ('23.08.14)
- Project Inception Meeting with Pakistan local team and experts ('23.08.08)
- Pakistan local team's first kick-off meeting ('23.09.14)

Stage2: Investigation of successful G.B Certification System in Pacific Region region ('23.08~'23.10)

- Literature review of previous research in Pakistan and Korea
- Case study of green building certification systems in Korea and Asia-Pacific countries
- Deriving possible cases and policies

Stage3: Investigation of the current status of Pakistan's green building market, policies, etc. ('23.10~'24.02)

- Pakistan-related status survey
- Analysis of green building-related policies and capacity limitations
- Review report of G.B Status report wrote by Pakistan's local team, GGC

Stage4: Development of Pakistan G.B certification system and standards ('24.03~ '24.05)

- Establishment of research strategy and development direction
- Proposal of detailed green building standards and certification system

Figure 4. Research process for developing a green building certification model and proposing standards for Pakistan

4. Expected Outcomes

The World Green Building Council (WGBC) conducted case studies in Australia, India, South Africa, and the United States, among other countries. The study categorized the benefits of green building into three categories: environmental, economic, and social [2].

- Environmental
  - Reduce greenhouse gas emissions from the building sector by up to 62%.

  - 40-50% energy savings and 20-30% water savings compared to conventional buildings.

- Economic
  - Lower utility bills for residents.
  - GB industry's contribution to GDP and full-time jobs.
  - 7% higher property value compared to conventional buildings.

- Social
  - Well-ventilated offices have been shown to contribute to increased cognitive abilities (brain function) and improved sleep quality.
  - Improved indoor environmental quality (lower CO2 and pollutant concentrations, better ventilation) can lead to productivity gains of up to 8%.

This study will also assist in developing a government-led green building rating system and serve as a driving force for building a green building industry ecosystem in developing countries. The expected outcomes of this study are as follows:

- Green building awareness: Raise awareness of the importance of green building, the market ecosystem, benefits and constructability in both the public and private sectors.
- Best practices and export markets: Provide best practices for the green building technology market in developing countries and facilitate overseas market penetration of relevant policies and technologies.
- Local workforce training: Use the results of the study to train local professionals, develop guidelines, and address negative perceptions of green building.
- Policy resource: Use as a valid policy reference for planning and implementing green building policies.

III. Investigation of International Best Practices for Green Buildings (with a Particular Focus on the Asia-Pacific Region)

1. Analysis of the status of Green Building System in Korea

- Overview of G-SEED

The「Green Standards for Energy and Environmental Design 」generally refers to a system that evaluates and certifies the environmental friendliness of a building in order to reduce environmental burdens such as use of energy and resources and pollutant emissions that may occur throughout the entire building process of the material production stage, design, construction, maintenance and disposal, and to create a pleasant environment.

At present, the Korea's Green Standards for Energy and Environmental Design (hereinafter G-SEED), which was introduced in 2002 for apartment houses, quantitatively evaluates the eco-friendliness of newly constructed buildings, including small houses and apartment houses as residential buildings, and commercial buildings, residential complexes, schools, retail facilities, accommodation facilities, and other buildings as non-residential buildings. It also evaluates existing buildings, including apartment houses and commercial buildings. In 2016, the G-SEED was completely reorganized and is divided into new buildings (residential, non-residential, single-family houses) and existing buildings (residential, non-residential, green remodeling).

The G-SEED is Korea's only evaluation system that comprehensively evaluates the eco-friendliness of buildings. The government and local governments require public buildings to obtain certification, and provide incentives by developing support policies for green buildings that have obtained certification.

The policy direction for green buildings aims to minimize damage to the environment throughout the life cycle from design, construction, operation and maintenance to disposal for the purpose of saving energy, saving and recycling resources, preserving the natural environment, and creating a pleasant indoor environment for all buildings in the future

- Operating system of G-SEED

The G-SEED is being operated by the Korea Institute of Construction Technology (KICT) under the overall management mandate from the Ministry of Land, Infrastructure and Transport and the Ministry of Environment, and the green building certification assessment is being carried out by 9 certification agencies, including the Korea Environmental Industry and Technology Institute. The Management Committee and Certification Review Committee are organized in relation to management and certification. The Management Committee is in charge of reviewing the establishment and revision of standards and making decisions on system improvement, while the Certification Review Committee conducts review and final evaluation decisions on the certification review reports evaluated by the certification agencies.

The role of the management agency is to carry out tasks such as operation of the certification management system, review of the results of the certification agency's examination, promotion of the certification system, education, consulting, research and development, and improvement and activation of the certification system.

The G-SEED institutions consist of five public institutions including the Korea Environmental Industry and Technology Institute and four private organizations including CreBizQM, and each certification agency is required to have at least five examiners. To apply for certification, the building owner (applicant) must write a self-evaluation report and submit it to the certification agency, and the certification agency must verify the evaluation report through document review and on-site inspection and issue a certificate.

- Specialized Fields of G-SEED

The G-SEED conducts an evaluation of the overall environment from the external environment to the internal environment of the building, as well as the entire process from the design stage to the post-construction stage. Thus, specialized fields are organized for each certification item and evaluated.

In the early stages of implementation in 2002, the evaluation was divided into four fields: land use and transportation, energy and resources, ecological environment, and indoor environment. However, as the certification fields were expanded to commercial buildings, school facilities, etc. other than apartment houses in 2006, the specialized fields were also expanded to 10 fields, including land use, transportation, and energy. And then, through the reorganization of the certification system, evaluations are currently conducted in seven fields, from land use and transportation to indoor environment, and in the case of apartment houses, the housing performance field is evaluated.

Specialized field	Evaluation details
Land use and transportation	Evaluate by considering the relationship with the external environment in terms of considering or restoring the ecological function of the land as much as possible
Energy and environmental pollution	Evaluate architectural measures and system-related measures for energy consumed for building operation
Materials and resources	Evaluate the use and input ratio of low-carbon materials and recycled materials that reduce environmental pollution and impacts based on the impact of materials in the entire life cycle of a building
Water circulation management	Evaluate methods for managing and using rainwater for promoting water conservation and efficient water circulation
Maintenance	Evaluate architectural methods that achieve minimization and maximization of environmental impact through appropriate maintenance systems
Ecological environment	Evaluate in terms of diversifying the composition of biodiversity within the habitat by minimizing direct impact on biodiversity during the development process
Indoor environment	Evaluate the thermal, sound, light, and air environments by reviewing the parts to minimize the harm to occupants and neighbors in terms of health and welfare
Housing performance	Evaluate the performance of the building, such as the residential, living environment, durability, and variability of the house

Innovative design	Evaluate original/creative ideas through innovative green building design of buildings

[Table] Evaluation details for each specialized field of G-SEED

The weighting for each specialized field is applied differently depending on the difficulty and importance of each field, and is also applied differently depending on new or existing buildings, residential or non-residential.

[Table] Weighting for each specialized field of G-SEED (2016 version)

Classification		Land use and transportation	Energy and environmental pollution	Materials and resource	Water circulation management	Maintenance	Ecological environment	Indoor environment
New	Residential	10%	25%	18%	10%	7%	10%	20%
	Single-family house	15%	25%	15%	10%	5%	10%	20%
	Non-residential	10%	30%	15%	10%	7%	10%	18%
Existing	Residential	10%	27%	15%	10%	15%	10%	13%
	Non-residential	10%	25%	15%	10%	15%	10%	15%
Green remodeling	Residential	-	60%	10%	10%	10%	-	10%

	Non-residential	-	60%	10%	10%	10%	-	10%

- History of G-SEED

The development of G-SEED can be divided into three stages from 1999 to the present.

☐ Introduction review stage: Research-centered

○ Based on the 'Study on the Introduction of the Building Environmental Performance Certification System' of the Ministry of Environment in 1999, G-SEED began as a pilot certification method for eco-friendly buildings by integrating the 'Pilot Certification for Excellent Residential Environment Housing' of the Ministry of Land, Infrastructure and Transport and the'Pilot Certification for Green Building' of the Ministry of Environment in 2000, and the institutionalization plan for the 'Eco-friendly Building Certification System' was reviewed in 2001.

☐ Introduction stage: Implementation of certification standards and preparation of detailed guidelines

○ And then, the 'Detailed Guidelines for the Eco-Friendly Building Certification System' were established in 2002, and the certification system was first carried out based on apartment houses, and the target buildings were expanded to apartment houses (2002) → commercial buildings and complex buildings (2003) → school facilities (2005) → sales and accommodation facilities (2006).

○ The initial certification levels were divided into two: Best and Excellent, and started with four certification agencies, and along with the expansion of certification to school facilities, the Korea Institute for Educational and Environmental Research was additionally designated in 2006

☐ Settlement stage: Revision of certification system and expansion of buildings subject to certification

○ In 2012, the 'Green Buildings Construction Support Act' was enacted to establish a legal basis for eco-friendly buildings, and the Korea Institute of Construction Technology (KICT) was designated as the management agency for smooth operation of the system, and six organizations including the Korea Infrastructure Safety and Technology Corporation were designated as additional certification agencies.

○ In 2013, the housing performance rating system, which is a certification system similar to the eco-friendly building certification system, was integrated and branded as 'G-SEED', and the reorganization of the specialized fields and rating system was carried out at the same time.

○ In 2016, the classification and criteria system were reorganized by unifying the existing classification by building use and separate certification items, and the naming G-SEED 2016 was established.

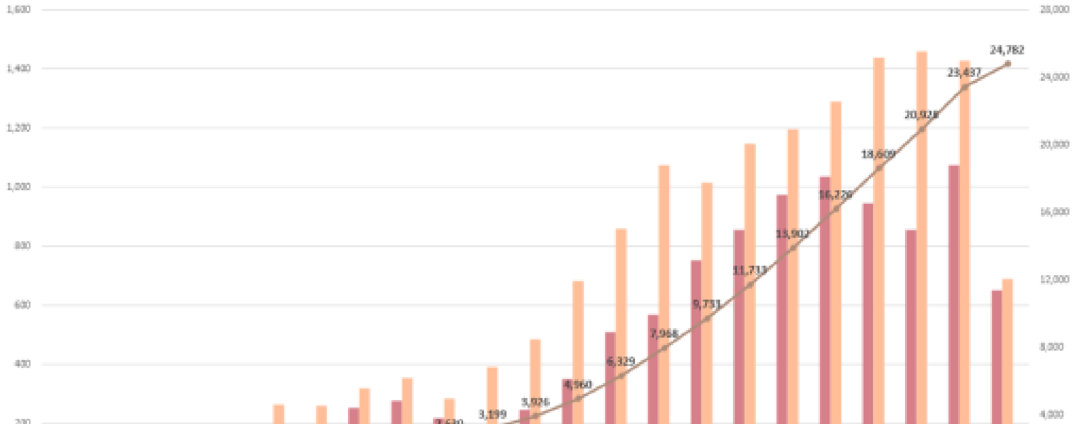
○ And then, based on G-SEED 2016, detailed criteria were revised in 2018, 2019, 2020, 2021, and 2023, and G-SEED 2016-7 version was operated in 2023

○ Also, beyond the application of G-SEED to the domestic market, standards were established for Vietnam in 2016 and Kenya in 2020, enabling acquisition of G-SEED for overseas ODA projects

○ In order to link green building for diplomatic offices managed by the Ministry of Foreign Affairs, such as overseas embassies and consulates, with the use of domestic technology and products, a version of G-SEED for diplomatic office was established and operated

- Examples - Best Practice of G-SEED certified buildings

□ Currently, there are over 24,000 G-SEED certified buildings in Korea, as shown in the figure below. Since 2006, the number of G-SEED certified buildings has been continuously increasing, and is expected to steadily increase in the future. This chapter covers examples of buildings that have recently obtained G-SEED certification with excellent levels.



(1) Private rental housing for urban development project in Yonghyeon Hanik Block 1

☐'Private rental housing for urban development project in Yonghyeon Hanik Block 1' is an example building that has recently received the highest level of G-SEED, 'Best (Green Level 1)' in July 2024, and is located in Michuhol-gu, Incheon Metropolitan City.

☐ This is a project to design approximately 13,000 households of private rental housing on a site area of approximately 1.54 million (㎡), which is a small new city that contains self-sufficient functions with commercial, residential, and business complex sites.

☐ Mainly four blocks form one city, creating a future-oriented residential complex that can be organically connected to each other through the Green Network, an economic complex for creating sustainable jobs, and a self-sufficient future city that combines housing, medical care, and education together

[Figure] Private rental housing for urban development project in Yonghyeon Hanik Block 1 (Green Level 1)

(2) Kunsan National University College of Engineering Integrated Education Center BTL

☐ The'Kunsan National University College of Engineering Integrated Education Center BTL'building located in Daehak-ro, Gunsan-si, Jeollabuk-do has recently obtained an 'Excellent (Green Level 2)' with 71.04 points out of 100

☐ This project, a G-SEED case certified by the Korea Real Estate Board, has implemented an eco-friendly building by applying various design techniques, and it is known that the power supply through renewable energy such as solar power and geothermal energy amounts to approximately 39.13%.

[Figure] Kunsan National University College of Engineering Integrated

Education Center BTL (Green Level 2)

(3) Hydrogen Energy Advanced Research Building

☐ The ‘Hydrogen Energy Advanced Research Building Construction Project Design Service’ is an education and research facility of the Korea Institute of Energy Technology located in Yuseong-gu, Daejeon, with 1 underground floor and 7 above-ground floors. As a G-SEED certified building certified by the Korea Green Building Council (KGBC), this building has obtained‘Excellent (Green Level 2)’

☐ The Korea Institute of Energy Technology established this research building to research hydrogen, a future eco-friendly energy source, and to create a technology development research institute that can develop infinitely. Realizing the value of this research building through three goals: 1) harmony with the surrounding environment, 2) establishment of research infrastructure, and 3) future-oriented experimental environment, this project strives to make the hydrogen industry the center of national innovation and growth.

[Figure] Hydrogen Energy Advanced Research Building (Green Level 2)

(4) Construction of Incheon Geomdan Police Station

☐ The 'Incheon Geomdan Police Station Construction Site' located in Majon-dong, Seo-gu, Incheon received G-SEED certification from the Korea Research Institute of Eco-Environmental Architecture, obtaining 'Excellent (Green Level 2)'

☐ In the western part of Incheon Metropolitan City, large-scale apartment complexes are actively being built in Geomdan New Town, and large-scale development projects such as Cheongna International City are underway, leading to active support for expansion of police personnel and construction of Geomdan Police Station to stabilize local security.

[Figure] Incheon Geomdan Police Station (Green Level 2)

2. Analysis of the status of Green Building System in other countries

This study aims to provide a foundation for the development of a rating system and detailed criteria for green building. In this chapter, we analyze the green building policies and certification/rating systems of Asia-Pacific countries in the vicinity of Pakistan and identify best practices applicable to the development of a rating system for Pakistan.

Figure 5. Case study countries: 7 ASEAN countries and India

Table 1 provides an overview of the green building codes, related energy standards, and rating tools developed in the aforementioned eight Asia-Pacific countries. These countries have their own mandatory or voluntary guidelines and rating tools for public and private buildings.

Country	Green Building Codes / Related Codes including Energy Standards	Rating Tools
Brunei Darussalam[3]	• PBD 12: 2017 Building Guidelines and Requirements • EEC Building Guidelines for Non-Residential Buildings – 2015 (Mandatory for public buildings)	• Green Unified Seal (BAGUS) (Voluntary)
Thailand[3]	• Ministerial Regulation for Energy Saving Building Design BE 2552 (Mandatory for public buildings) • Energy Conservation Promotion Act BE 2550 - 2007	• TEEAM (Thailand Energy and Environmental Assessment Methods) (Voluntary) • TREES (Thailand Energy & Environmental Sustainability Assessment) (Voluntary)
Singapore[3]	• Code for Environmental Sustainability of Buildings - SS530:2014	• GreenMark

	- SS531-1:2006 - SS CP 38 - SS CP 43 - Code of Envelope	- Mandatory of BCA (Building & Construction Authority) Green Mark certification - Mandatory & Required to achieve various - For all new and major renovations (over 200 m2 certification levels)
Indonesia[3]	• Bandung Green Building Code (Mandatory) • Jakarta Green Building Code (Mandatory for large buildings (e.g. Bandung, Jakarta: buildings with a total area between 10000-50000m2)) • Energy standard: (Mandatory) - SNI 03-6389-2011 - SNI 03-6390-2011 - SNI 03-6197-2011 - SNI 03-6196-2011 - Energy Efficiency Guidelines for Building Design (Unknown for Mandatory)	• GREENSHIP (Voluntary)
Malaysia[3]	(Mandatory status unknown) • PH JKR, • GreenPASS, • Green RE • Energy standard: - MS 1525: 2014 (Voluntary) - MS ISO 50001 (Mandatory)	• Green Building Index(GBI) (Voluntary) • Malaysian Carbon Reduction and Environment Sustainability Tool (MyCREST)
Philippines[3]	• Guidelines for Energy Energy Conserving Design of Buildings – 2008 (Mandatory) • Philippines Green Building Code – 2015 (Mandatory)	• Building for Ecologically Responsive Design Excellence (BERDE) (Voluntary)
Vietnam[3]	• QCVN 09: 2013/ BXD (Mandatory)	• LOTUS (Voluntary)
India	Energy Conservation Building Code (ECBC) (Partially Mandatory)	• GRIHA (Green Rating for Integrated Habitat Assessment) (Mandatory for public buildings • IGBC (Indian Green Building Council) provides rating systems for different building types (Voluntary)

Table 1. National green building codes, related energy codes and rating tools and incentives

Table 2 provides a comparative overview of the evaluation and rating systems of the eight countries. The key evaluation items include building envelope, air conditioning systems, natural and artificial lighting, and renewable energy.

Country	**Energy in Green Building Assessment Tool Efficiency Related Categories**	**Country**	**Energy in Green Building Assessment Tool Efficiency Related Categories**
Brunei Darussalam	• Building envelope • Air conditioning systems • Building envelope - design/thermal parameters • Natural ventilation (for parking lots) • Artificial lighting • Ventilation in the parking lot • Ventilation in common areas • Elevators and escalators • Energy-efficient practices and features	**Thailand (TREES)**	• Minimum energy efficiency • Energy Efficiency • Renewable energy • Refrigerants in air conditioning systems that do not destroy the ozone layer
Singapore **(Green Mark)**	• Building envelope – Envelope Thermal Transfer Value (ETTV) • Air conditioning systems • Building envelope - design/thermal parameters • Natural Ventilation/Mechanical Ventilation • Natural lighting • Artificial lighting • Ventilation in the parking lot • Ventilation in common areas • Elevators and escalators • Energy-efficient practices and features • Renewable energy	**Indonesia** **(GREENSHIP)**	• Electricity submetering • OTTV Calculation • Energy Efficiency Measures • Natural lighting • Ventilation • Climate change impacts • On-site renewable energy (bonus)
Malaysia **(GBI)**	• Minimum Energy Efficiency (EE) performance • Illuminated zones • Electricity submetering • Renewable energy • Advanced EE performance • Improved commissioning • Post-occupancy commissioning • EE Verification • Sustainable maintenance	**Philippines** **(BERDE)**	• Detailed metering of energy • Energy-efficient lighting • Natural ventilation • On-site renewable energy generation • Improved energy efficiency • Energy-efficient building envelope

Vietnam **(LOTUS)**	• Passive Design • Total building energy • Building envelope • Natural ventilation and air conditioning • Artificial lighting Energy monitoring and management	**India** **(GRIHA)**	• Sustainable Site & Planning • Energy Efficiency & Renewable • Energy • Water Efficiency • Material & Resources • Health & Well-being • Solid Waste Management

Table 2. Composition of the energy efficiency categories in the G.B. assessment tools of ASEAN countries

Table 3 lists the economic incentives offered by these countries to promote green building practices. These incentives include tax exemptions, low-interest loans, and funding programs for specific energy efficiency and renewable energy projects.

Country	Incentives program	Description
Brunei [3]	Feed-in Electricity Scheme	Low-cost loans to consumers to fund solar panel installation
Thailand [3]	Energy Efficiency Revolving Fund (EERF)	Fund loans to local bank at 0% interest rate with 7 years final maturity
Singapore [3]	Building Retrofit Energy Efficiency Financing (BREEF) Scheme	Financing program which provides credit facilities to carry out energy efficiency retrofits of existing commercial buildings
	BCA Green Mark Incentive Scheme for Exiting Buildings (GMIS-EB)	Funding program to encourage developers and building owner of existing building for its energy efficiency
	BCA Green Mark Incentive Scheme – Design Prototype (GMIS-DP)	Funding for the engagement of Environmentally Sustainable Design (ESD) consultants to conduct collaborative design workshops and assist in simulation studies
	BCA Green Mark Incentive Scheme for Existing Building and Premises (GMIS-EPB)	Cash incentive op up to 50% of the qualifying costs
	Wero Capital Partnership Scheme (ZCPS)	Offering one-stop solution for retrofits, including provision of financial options, application of grants of incentives
Indonesia [3]	Green Building Program	Cost estimation for EDGE software implementation in the frame of retrofitting buildings projects
	Green Building Code implementation – Tax Incentives	Provide Some tax benefits for green commercial buildings
	Renewable Energy Incentives	Tax facility for renewable energy in the form of Income

	EE revolving fund	Provide technical assistance to develop a concept and a program for a revolving fund, via the Project Implementation Plan (PIP) mechanism
Malaysia [3]	Fiscal Incentives for Energy Efficiency - 2001	Tax incentives for promoting EE projects and equipment
	Save Program - 2011	RM 100-200 rebates on refrigerators air-conditioners and chillers
	Green Technology Finance Scheme – 2013	2% subsidy to the interest rates offered by commercial banks and credit-guaranteed support for the loan capital
	Green Investment Tax Incentive – 2014	Green Investment Tax Allowances (GITA) for the purchase of green technology equipment/ assets and Green Income Tax Exemption (GITE) for green technology service providers
Philippines[3]	Feed-in tariff (FIT) program	- Pay companies for energy generated through non-generated through non-conventional measures - 7-year tax holiday for renewable energy developers and the ability to import technologies from abroad duty-free for 10 years
Vietnam [3]	Economic incentive	- Import duty exemption for clean technology products - Incentive tax rate of 10 % for 15 years - Tax reduction of 50% with tax exemption for 4 years on new projects
India	Government incentives to IGBC-rated Green Building Projects and GRIHA applicated projects	Offer different incentives by local government - Offering fast track environmental clearance for green building and township projects - Additional Floor Area Rate (FAR) - Enterprises of MSME sector a subsidy - Offering reimbursement/ reduction of 50% of IGBC Certification fee or consulting charges - and others

Table 3. Economic incentives in Asian countries and India (as of 2017)

The green building practices in these countries demonstrates a growing trend towards incorporating energy efficiency and sustainability aspects into national building standards and codes. These countries have combined mandatory regulations and evaluation tools for voluntary certification schemes to promote green building. In addition, they offer economic incentives to encourage the adoption of green technologies and practices. The following measures identified from the countries included in the case studies are applicable to Pakistan to address the constraints to the adoption of green building.

- **Economic constraints**: Need to support the development of low-cost green building technologies and materials
    - (India) Local governments develop and implement government incentive programs tailored to their own circumstances to promote green building practices.
    - (Brunei, Thailand, Singapore, Malaysia) Provide tax exemptions, low-interest loans, or funding/grants for businesses.
    - (Vietnam) Four-year tax exemptions and other tax incentives for new projects.
- **Government structure**: Federal and local governments
    - (Vietnam, India, Singapore) Expedited permits and financial support including fast-track, one-stop solutions.
    - (Indonesia, India) It would be beneficial to leverage decentralized government structures to encourage local governments to develop and implement their own green building codes. To this end, the central government can provide guidelines and technical assistance, while local governments can develop policies tailored to their own local conditions. It is recommended that green building mandates be introduced for buildings over a certain size in major cities, with the intention of gradually expanding the program to other cities.
- **Lack of human resources and skills, awareness building:** Need for a variety of support and programs (workshops/campaigns, etc.)
    - (Malaysia, Philippines, Vietnam) Tax exemptions or other incentives for foreign skills and experts.
    - (Singapore, Indonesia) Capacity and awareness building: Funding to support collaborative design workshops and simulation studies.
    - (All countries other than Singapore) Introduce their own voluntary green building certification systems to encourage building owners and developers to achieve higher levels of sustainability.

- **Monitoring and verification systems**: Build a robust monitoring and verification system to ensure compliance with green building standards and measure the effectiveness of the measures taken.

To promote green building in Pakistan, it is essential to benchmark successful cases of other countries and develop policies tailored to the country's circumstances and resources. This will require introducing energy efficiency regulations and incentive programs, developing low-cost technologies, strengthening cooperation with local governments, promoting public-private partnerships, and conducting education and awareness campaigns. These measures will help create a favorable environment for sustainable green building in Pakistan.

IV. Context and Strategic Directions for Green Buildings in Pakistan

This chapter examines literature related to green building in Pakistan and considers the directions envisaged in previous studies. Based on these findings, we conduct a SWOT analysis to identify strengths, weaknesses, opportunities, and threats and set a strategic direction to move forward.

1. Fact-finding Survey in Pakistan

1) Pakistan: Country Overview

Name	 Islamic Republic of Pakistan	Capital	Islamabad
Area	796,000 ㎢	Population	230 million (2020, World Bank)
Ethnicity	Punjabi (44.7%), Pashtun (15.4%), Sindhi (14.1%), etc.	Religion	Islam (state religion) 96.4%, (85-90% Sunnis, 10-15% Shias), Hinduism, Christianity, etc.
Languages	Official languages (English, Urdu), Punjabi (39%), Pashtun (18%), Sindhi (15%), Balochi (3%), etc.	Government	Cabinet government (bicameral) – 100 Senate members and 342 Lower House members
Major industries	Textile, sewing, agriculture, food processing, etc.	Economy	Gross Domestic Product (GDP): $376.5 billion (2022, EIU) Per capita GDP: $1,596 (2022, EIU) Growth rate: 6.2% (2022, EIU)

Table 4. Pakistan: country overview

With a population of 235 million in 2022, Pakistan is the fifth largest country in the world and the 41st largest economy with a GDP of $346.3 billion. The country's growing population is impacting power demand, presenting a challenge for the energy sector. While 60% of the population lives in rural areas and 40% in urban areas[4], more than 60% of electricity is consumed in the capital region, which presents challenges related to grid instability and limited access in rural areas. This situation is reflected in the country’s per capita energy consumption, which is one of the lowest in the world[5]. To address the energy shortage, the Pakistani government has announced the 2013 National Power Policy, the 2015 Power Policy, and the 2019 Alternative and Renewable Energy Policy[6].

Pakistan's economy encompasses a diverse range of industries. As of 2022, the primary industries, including agriculture, accounted for 22.35% of the nation’s GDP. The secondary industries, including manufacturing, accounted for 20.42%, and the tertiary industries, including services, accounted for 52.19% [7]. Pakistan's major industries include textiles, apparel, food processing, dairy products, fertilizers, pharmaceuticals, building materials, and paper. In terms of total electricity consumption, residential demand outweighs industrial demand.

Population growth and the lack of sustainable, eco-friendly technologies, coupled with ever-increasing materials consumption, have caused waste disposal and housing issues. In particular, water scarcity and water quality-related health and sanitation are considered serious issues in Pakistan. Pakistan's per capita water availability is approximately 1,071 m3 per year, and the country is rapidly moving from a water-stressed country to a water-scarce country. A 2020 survey revealed that only 36% of the population has access to safely managed drinking water, with almost 70% of households using contaminated water as potable water[8]. Approximately 60% of the groundwater, which is a source of water for more than 90% of the population, is exposed to E. coli. Furthermore, the estimated safe water supply rate, which is a target under the SDGs, is approximately 20%[4]. Moreover, Pakistan's Building Energy Code (EP-2011) mandates indoor design temperatures of 21°C in summer and 26°C in winter. However, many local residential buildings lack the capacity to provide these comfortable temperatures for residents[9].

2) Climate and Building Characteristics and Energy Consumption by Region/Major City

■ Climate and Building Characteristics and Energy Efficiency Measures

The establishment of green building standards for Pakistan and the achievement of energy efficiency in sustainable green buildings necessitates an understanding of the climate conditions of different parts of the country. In general, Pakistan is situated within the hot and dry subtropical climate zone. Its summer weather is characterized by high temperatures and frequent rainfall. From December to January, the temperature drops to 0-1℃.

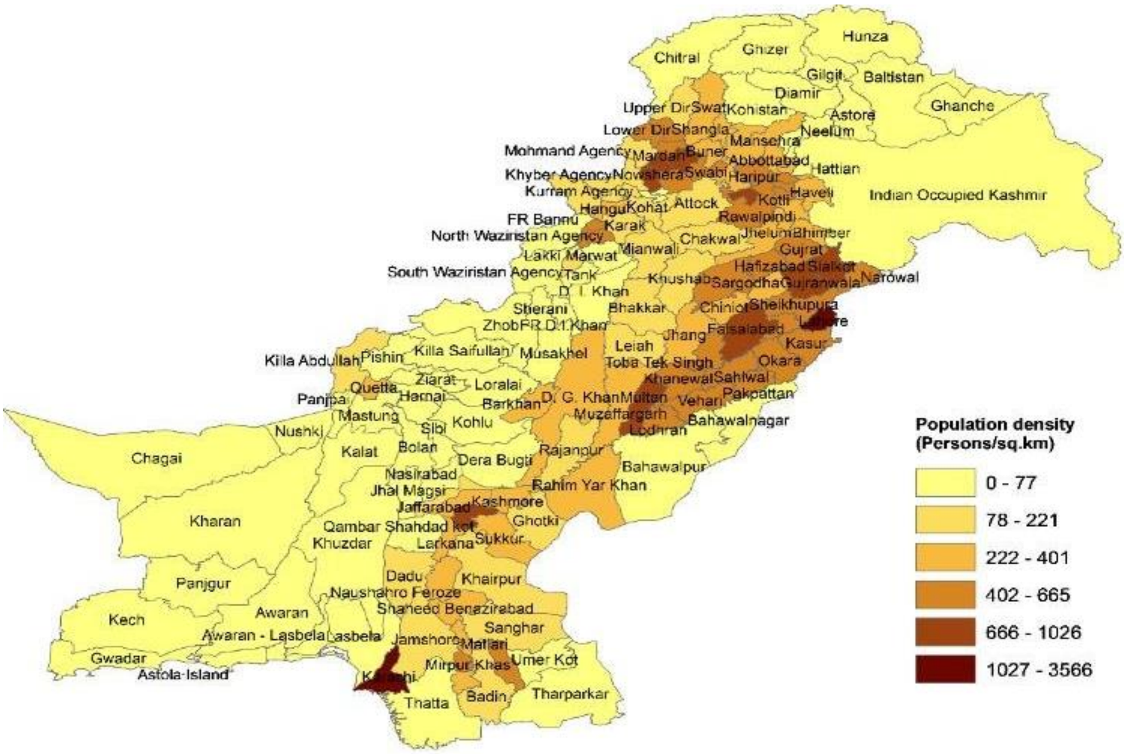
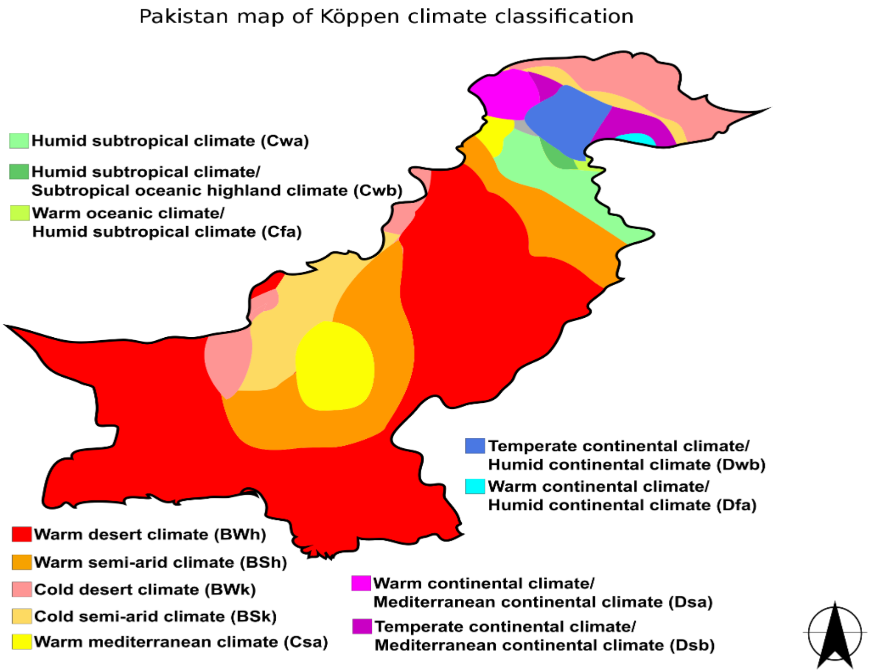


Figure 6. Population density by region in Pakistan: The population density of cities is as follows: Karachi > Lahore > Faisalabad > Rawalpindi > Gujranwala. Most major cities, except for the southern coastal city of Karachi, are located in the eastern part of Pakistan. Islamabad, the capital, is the 9th largest city.

Table 5 illustrates the diverse climatic conditions observed across various municipalities in Pakistan. The mountainous northern region is characterized by an alpine climate, while the central Punjab region features a subhumid temperate climate with high temperatures and torrential rains during the summer monsoon, and cool winters. The climate in the southern, southeastern, and southwestern regions is a combination of subhumid temperature and dry desert climate conditions[10]. This indicates that buildings in southern Pakistan would require more cooling, while those in northern Pakistan would need more heating. In addition, cities that experience greater seasonal fluctuations and temperature extremes, such as Quetta and Balochistan, would require both cooling and heating[9]. However, more than 60% of Pakistan's electricity is consumed in the capital region and the population is primarily concentrated in other major cities (Figure 6). Given that 70% of the country's land falls under a climate zone where it is sunny and hot all year round, the primary purpose of building energy consumption is for cooling, and this should be considered in building energy design. Currently, 55% of the country's energy resources are consumed for cooling, yet buildings still do not provide a comfortable living environment [11]. Table 5 provides an overview of building energy efficiency measures that can be applied in different regional climate contexts.

(Image source: [12])



Region	Climate conditions	Energy efficiency measures
Central (Lahore and Islamabad)	Subtropical climate with hot summers and mild winters	• The relatively high power consumption in major cities provides a rationale for energy efficiency plans to minimize the use of artificial lighting and cooling systems, which can be achieved by focusing on natural ventilation, shading, and insulation.

West (Balochistan)	Desert climate with hot summers and cold winters	• The southwest features one of the world's highest Global Horizontal Irradiance (GHI) [8] → Justification for the use of solar panels. • Designing buildings with passive cooling and heating systems, such as using natural light, helps reduce energy consumption and promote sustainability. • Insulation plans are essential for energy efficiency.
Mountainous northern region	Cold winters with heavy snowfall	• There is a strong need for proper insulation and energy-efficient, sustainable heating systems. • Building designs that maximize natural light help reduce energy consumption.
Coastal region (Karachi and southern coasts)	Hot and humid summers	• Building arrangements that takes into account the amount of sunlight, shading, natural ventilation, and passive cooling systems are required to maintain a comfortable indoor environment.

Table 5. Pakistan's regional climate conditions and energy efficiency measures

Pakistan is also being severely impacted by the recent rapid climate change. The most frequent and complicated extremes are heat waves and droughts in the Balochistan and Sindh areas. In 2022, the highest summer temperature recorded in Sindh's Jacobabad was 51℃. While precipitation has increased globally by an average of 0.08 inches per decade since 1901, some of Pakistan's arid areas have become drier with below-average precipitation. In the central region, the lowest temperature in summer is ever rising, and variability in precipitation continues to increase in Sindh and Gilgit Baltistan (GB)[13]. In addition, increases in effluent of glacial water from Pakistan's glacial lakes pose risks for major floods, as in the disasterous cases in 2010 and 2022[14]. These all highlight the need for considering energy efficiency, buildings' disaster resilience, and water storage capacity in the green building legislation. It is recommended that Pakistan introduce green building institutions and policies that take into account different geographic and climate conditions to encourage provincial governments to develop green building master plans tailored to their own conditions. This will ensure the construction of energy-efficient buildings optimized for each region.

■ Infrastructure in Major Cities and Regions

Islamabad, the capital of Pakistan, is a relatively small city with a population of 20 million, making it the ninth largest city in the country by population. It is known for its high standard of living and infrastructure, as it is home to many government officials and is the political center of the country[15]. Lahore and Faisalabad are known for their strong industries, and Karachi for its financial sector, being home to the stock exchange and the headquarters of many banks. The characteristics of Pakistan's five largest cities are summarized in Appendix 1.

Karachi, in Sindh Province, is the largest city in Pakistan with the highest number of skyscrapers. However, the city slipped in the livability rankings in 2016, mainly due to rapid population growth, inadequate housing infrastructure, and poor urban planning and transportation policies[16]. Four of the top-ranked major cities are located in Punjab Province. The cities of Lahore, Faisalabad, Rawalpindi, and Gujranwala have economic advantages and are socially stable, either because of their strong textile, manufacturing, and agricultural industries, which each play an important role in the country's GDP, or because of direct support from the provincial and federal governments to develop them as industrial hubs. In other words, local governments in Sindh and Punjab are in a better position than other municipalities to develop policies and pursue pilot projects related to zero energy and green buildings.

■ Energy Consumption in the Building Sector

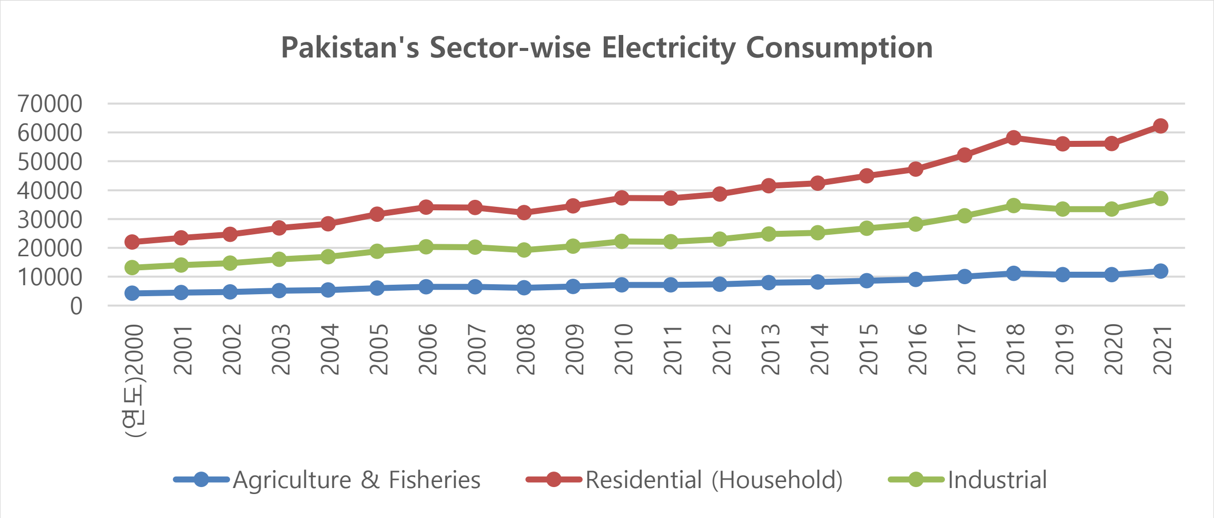


Figure 7. Electricity consumption by building use in Pakistan

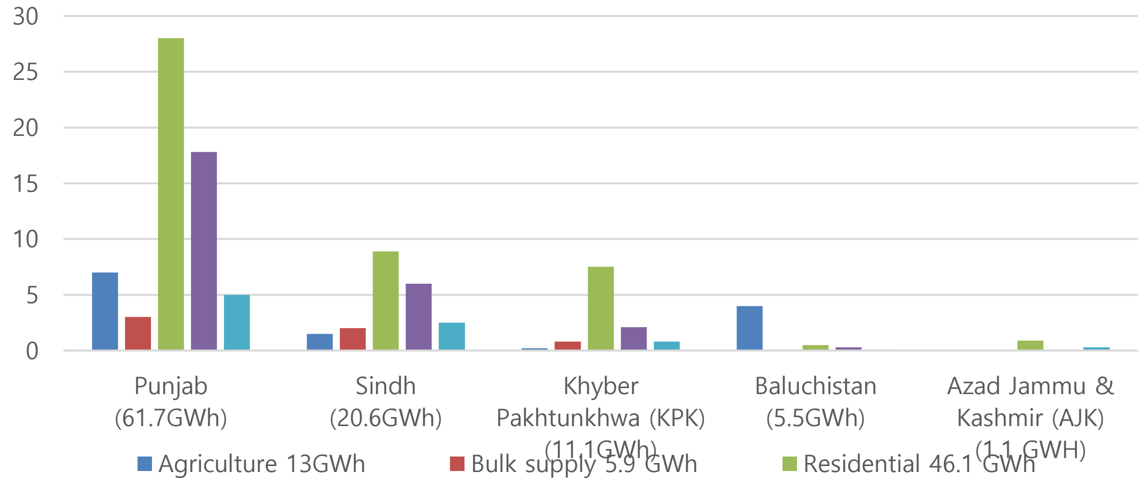


Figure 8. The population distribution by industry and energy consumption in each region (Original Data: [17])

In Pakistan, the residential sector consumes more electricity than any other sector, including industry. It has been growing steadily since 2000 (Figure 7). This may be related to population growth as well as increased use of appliances.

Previous statistical data indicates that more than 40 million people would be living in urban areas in Pakistan by 2023[13]. The pace of this urbanization is predicted to accelerate, leading to a 5.3% annual growth in demand for new buildings [18]. This rapid population growth and changing lifestyles are associated with increased energy consumption and supply challenges. In addition, the global challenge to drastically reduce carbon emissions and the insufficiency of green energy and existing electrical energy supply chains also affect the country's economy. Figure 8 shows the distribution of population and energy consumption by region. In four provinces, except Baluchistan, the residential sector consumes more energy than other sectors.

The Building Energy Code has evolved since the 1990s. It forms the framework for Pakistan's energy management policy, along with the Energy Provisions 2011. However, it primarily covers commercial buildings and does not focus on single or multi-household homes[9]. In Pakistan, the overall building market for 2018-2025 is estimated to be 79% residential and 21% commercial, with the number of multi-household dwellings far outnumbering single-household dwellings due to the high level of urbanization[19]. It is estimated that approximately 35% of Pakistan's total electricity is consumed by the building sector, of which 85% is consumed by residential buildings[20], [21]. This highlights the need for the Building Energy Code to include measures to address carbon emissions, which are estimated to be 2,487 tons[18], in the building sector. In addition, it is essential to develop a green building code and standards to create an institutional framework that complements or integrates with the BEC.

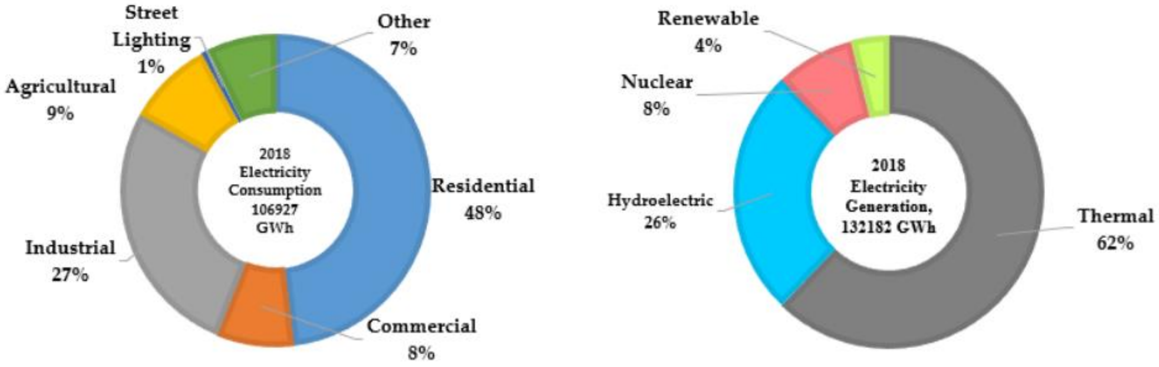


Figure 9. Example of electricity generation and consumption of Pakistan in 2018 [22]

■ Energy Consumption by Building Area

Floor area has a positive linear relationship with the energy consumption of a building, which should be examined in the local context. Typical urban buildings in Pakistan are measured in units called "Marles[2]" or "Kanal", and the electricity consumption of residential buildings in Pakistan depends on the floor area and the number of households (Table 6). A typical household in Pakistan consists of 4 to 10 people, although there are exceptions of large families of 15 people or more[23].

No	Plot area		Covered area	Conditioned space	Minimum	Maximum	No. of people
	Marla	m2	m2	m2	(Electricity consumption KWhj)		
1	5	105	95	12-24	100	684	6-12
2	10	211	167	16-54	250	1000	
3	20	418	367	48-85	450	3000	

Table 6. Typical Energy Usage by Building Area (Source of Original Data: [23])

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[2] 1 Marla is approximately 30 m^2. 1 Kanal is 20 Marla, which is equivalent to 400 m^2 of covered area.

In all three types of urban residential buildings in Pakistan, monthly electricity consumption peaks during the winter and summer seasons(Figure 10). In particular, the peak energy load is observed on weekends and in the evenings during the summer months of May to October, due to the use of air conditioning systems for residential spaces. Residential energy consumption in Pakistan is dominated by electricity for air conditioning, and natural gas is used for cooking, heating, and hot water. The majority of urban dwellings in Pakistan are one- or two-story houses. According to the Pakistan Bureau of Statistics, more than 90% of these houses are owner-occupied[23].

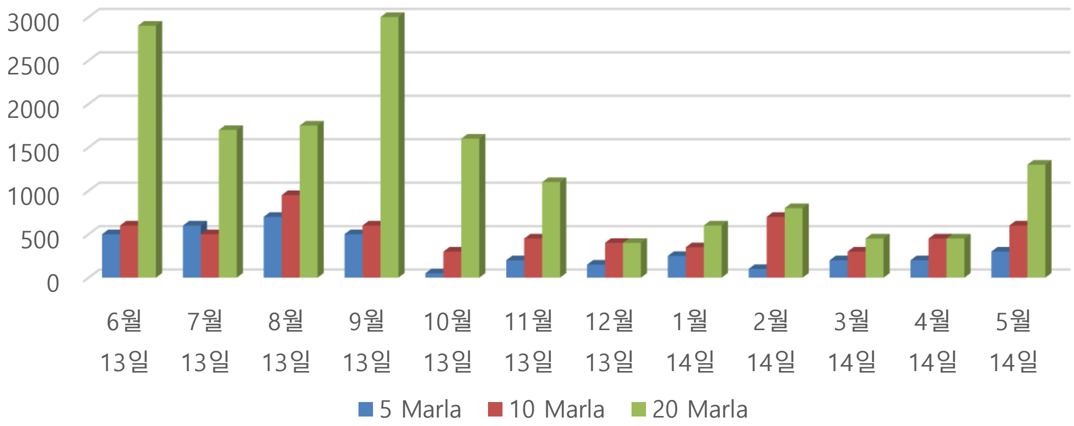
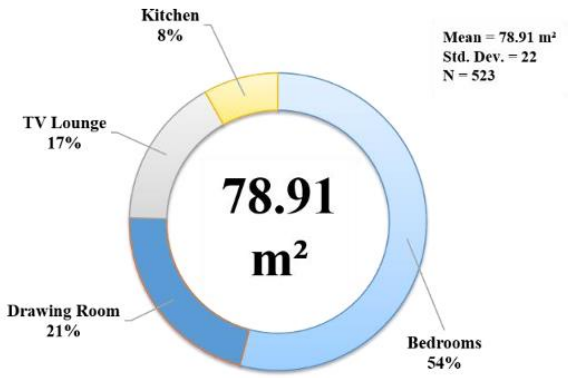


Figure 10. Monthly Electricity Usage in Urban Homes in Pakistan by Area (Source of Original Data: [23])

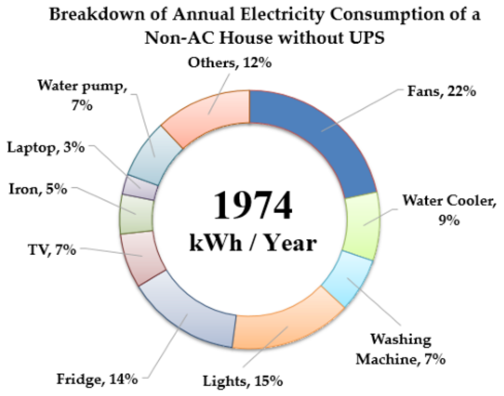
Understanding the various aspects of energy consumption and conducting research, with particular emphasis on comprehensive data collection, is a prerequisite for improving the energy efficiency of residential buildings in different climatic zones of Pakistan and establishing appropriate sectoral standards.

For instance, a study aimed to collect data from 523 households in the city of Mirpur in Pakistan. Monthly electricity bill data, surveys, and interviews were used to profile the monthly electricity consumption of these households. The results showed that 61% of the respondents in Mirpur lived in single-story houses and 36% in multi-story houses. Only 2.29% of the respondents lived in apartments or residential plazas. The average floor area of the multi-story houses was 89 m² and they consumed an average of 33 kWh/m² of electricity per year, 27% more than the single-story houses. This is because multi-story houses have a larger floor area and use more electrical appliances. On the other hand, the average annual electricity consumption of apartments was 44 kWh/m², which is probably due to the fact that appliances in common areas of apartment buildings run longer and their operation is not properly monitored. It may also be due to the fact that apartment buildings are taller than surrounding buildings and therefore exposed to sunlight for longer hours[22].

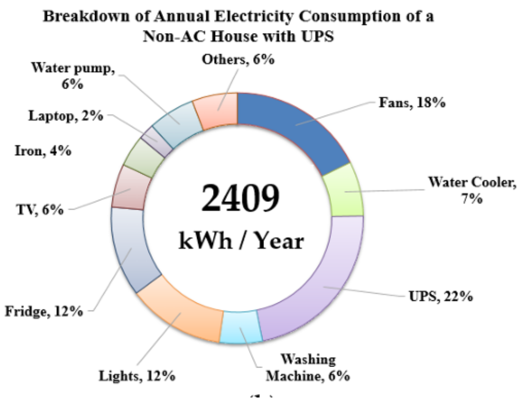
The average floor area of a typical single-story house in Mirpur surveyed in this study was 78.91 m², and as shown in (a) of Table 7, the bedroom occupied the largest portion of the total floor area at 54%, followed by the living room at 21%, the TV lounge at 17%, and the kitchen at 8%. The figures in (b) and (c) of Table 7 show the breakdown of annual electricity consumption, with fans, lights and refrigerators consuming the largest amounts of electricity. This is partly due to the use of inefficient appliances.



(a)



(b)



(c)

Room	Average Number	Dimensions and Frequency	Average Floor Area/ Room (Each)
Bedroom	3.2	12′ x 14′ (51%) 10′ x 12′ (45%)	13.47m^2

Drawing Room	0.96	12′ x 14′ (48%) 14′ x 16′ (43%)	18.30 m^2
TV Lounge	0.72	14′ x 16′ (51%) 12′ x 14′ (42%)	17.90m^2
Kitchen	1	8′ x 10′ (60%)	6.27m^2

Table 7. Percentage distribution of average floor area of a typical house in Mirpur city, Breakdown of Annual Electricity Consumption of a Non-AC house with / without UPS, Average floor area of a typical house in Mirpur city (down)[22]

Figure 11. Typical house and residential flats in Mirpur city. (a) Double-story house and (b) Flats. Figure 4. Typical house and residential flats in Mirpur city. (a) Double-story house and (b) Flats (출처: Unlocking household electricity consumption in Pakistan[22])

Understanding these regional characteristics of residential buildings and their electricity consumption profiles should be a priority in the development of effective energy policies, rating systems, and detailed criteria. It will also contribute to the forecasting of future energy demand and the design of measures to address the use of inefficient electrical appliances.

■ The Use of Local Building Materials and the Need for the Reinterpretation of Passive Design

The predominant materials used in Pakistan's vernacular architecture were mud and clay. Clay regulates temperature by absorbing and releasing moisture during precipitation. Given the lowest heat transmission coefficient, clay also is a highly energy efficient material (Shah, 2020). However, driven by rapid urbanization, clay is increasingly replaced by cement concrete block walls, kiln-fired bricks, and reinforced cement concrete roofs. Table 8 shows the most commonly used building materials.

Envelope component	Structural component	Insulation materials [24])

Wall	1. Brick 2. Mud 3. Cement	1. Glass wool 2. Expanded polystyrene (25m, 40m, 50mm) - Molded beads - Extruded 3. Expanded polyurethane (25m, 40m, 50mm) - Molded beads - extruded 4. Vacuum insulation panel (VIP)
Roof	1. T-iron guarder (girder) 2. Wood 3. Sarkanda/ Sirkiyan 4. Concrete	
Floor	1. Mud 2. Cement 3.Tiles 4.Chips 5. Brick 6. Marble	
Fenestration	Single pane with frame (wood, vinyl, fiberglass, metal like aluminium frames)	Double glazed with… 1. Low thermal conductivity gas fill 2. Electro chromic glazing 3. Holographic optical elements 4. Aerogel glazing 5. Spectrally selective glass coatings (lowE)

Table 8. Common Building Facade Materials Used in Pakistan [23], [25]

Inefficient design resulting from urban sprawl and high population density is a major contributor to the deterioration of the quality of living environments and the increase in energy consumption for heating and cooling. The high cost of materials, the prevalent use of sub-standard materials, and the lack of specialists in functional window systems result in the predominance of single-glazed windows, which negatively affect the thermal efficiency of buildings and increase energy consumption. Other challenges include difficulties with natural cross-ventilation, poor space design, inadequate storage ventilation systems, lack of consideration for dust storms and ventilation, orientation and thermal comfort issues, and low material and construction quality[23].

According to a report by ENERCON in Pakistan, improved building design can reduce residential energy costs by 20%, or coupled with the use of energy-efficient appliances, by 50%[20]. Pakistan is located in a temperate climate zone, and according to the Energy Conservation Building Code 2023, a significant reduction in energy consumption can be achieved by using appropriate building materials with insulating properties in the temperate climate region.

Data on the use of building materials for roofs and walls in Pakistan (Table 9, Table 10) show that concrete and brick are the predominant roofing materials in urban areas, while bamboo and truss roofs are the predominant roofing materials in rural areas. The brick walls of Pakistani vernacular buildings provide good thermal regulation in hot climates, but there are problems that need to be addressed, such as poor performance due to the use of low-quality materials, inadequate seismic and flood resistance, and lack of relevant building codes and legislation.

The use of brick and concrete is expected to increase in urban areas as urbanization progresses, which in turn will exacerbate the heat island effect caused by the use of concrete. This underscores the need to develop measures using sustainable materials. Following the urbanization trend, bamboo, while still a dominant choice in rural areas, is becoming less preferred in urban construction. The use of this and other sustainable materials should be promoted in both urban and rural areas. It is also a challenge to meet the resilience and aesthetic requirements using modern technology[26].

Province & District	**Materials Used for Walls**				
	Burnt Brick/Block	**Mud Brick/Mud**	**Wood**	**Others**	**Total**
Pakistan	79.84	15.32	1.62	3.21	100.00
Urban	95.95	2.94	0.46	0.65	100.00
Rural	69.68	23.13	2.35	4.83	100.00

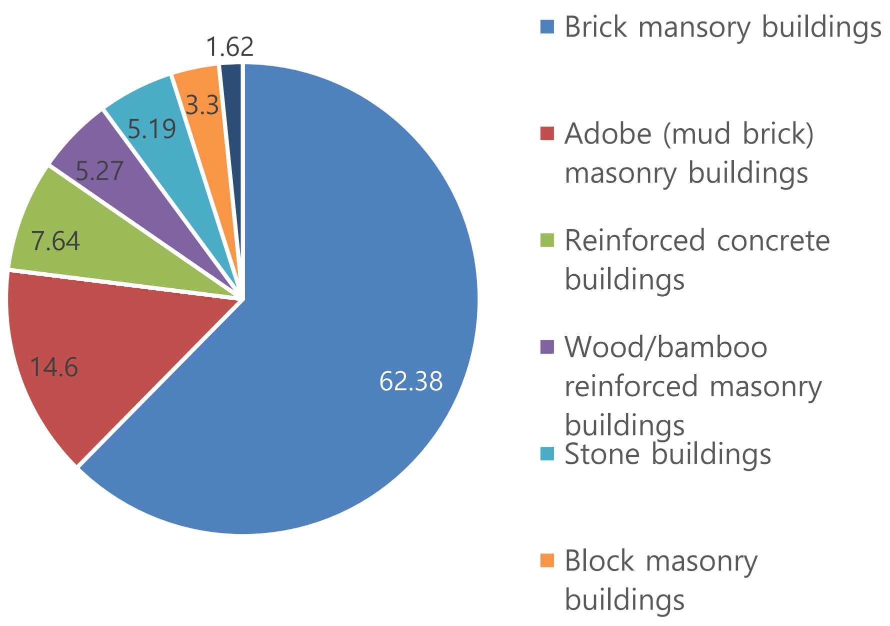
Table 9. Housing Units in Pakistan by Construction Material (Source: Pakistan BUREAU of Statistics 2019-20[26])

Province & District	**Materials Used for Roofs**					
	RCC (Reinforced Cement Concrete) /RBC (Reinforced Brick Concrete)	**Wood/Bamboo**	**Sheet/Iron/Cement**	**TR Girder Roof**	**Others**	**Total**
Pakistan	33.31	22.86	4.05	39.19	0.59	100.00
Urban	59.74	6.63	4.85	28.29	0.49	100.00

Rural	16.64	33.09	3.55	46.06	0.65	100.00

Table 10. Percentage Usage by Material Used in Roofs (Source: Pakistan BUREAU of Statistics 2019-20[26])

There is an opportunity to take advantage of these characteristics of clay and other vernacular building materials and develop ways to translate them into modern building techniques that are appropriate to Pakistani conditions. Combining traditional wisdom with modern practices would result in a uniquely Pakistani green building with improved sustainability and energy efficiency.



In addition to materials, green building techniques for energy efficiency can also be found in the design elements of Pakistan's vernacular architecture. The vernacular architecture of Pakistan's provinces and rural areas has developed excellent passive design strategies based on the experience of past inhabitants, such as courtyard design adapted to regional climates, stairwell design, natural lighting and shading, ventilation, orientation, and thermal efficiency.

Establishing green building practices for the local climate of Pakistan requires taking advantage of the materials used in vernacular architecture and its passive building elements and translating them into new green building techniques. A prime example of this is the "Zig-Zag Kiln", a reinterpretation of vernacular architecture for energy efficiency and environmental mitigation using bricklaying techniques[27]. Appendix 2 shows the characteristics of vernacular building styles and materials for different climate zones in

Pakistan. Using them for customized green building standards will help develop the market and technology. This will also help develop Pakistan's own green building technologies and set best practices for countries in similar climates.

3) Existing Building Policies, Laws and Institutions in Pakistan

■ Government Organization and the Federal Government

1)

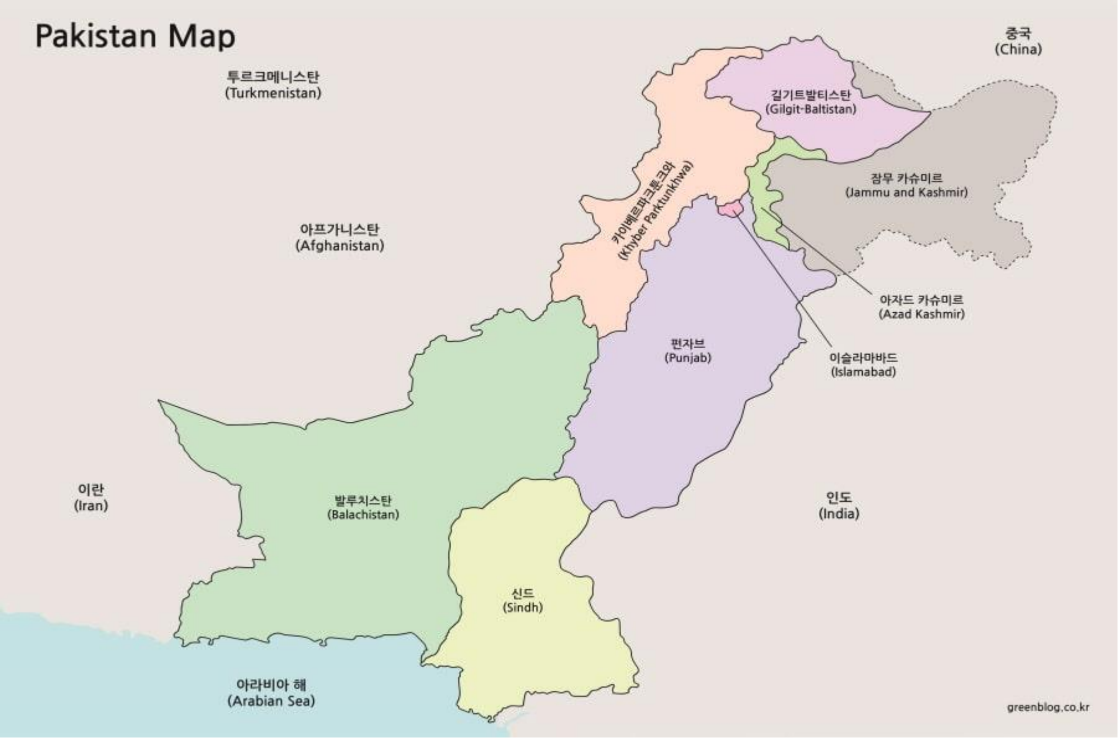


Figure 12. Map of Administrative Divisions in Pakistan (Source: greenblog.co.kr)

The government of Pakistan consists of the executive, legislative (Senate and National Assembly) and judicial (courts). It operates under a parliamentary system in which the Cabinet is the final decision-making body and the Prime Minister is the head of government. The Senate has 104 members and the National Assembly has 342 members. The current 22nd cabinet consists of 31 members, including the prime minister and the ministers of defense, economy, foreign affairs, and other ministries. The Prime Minister is the head of state and is elected by the National Assembly for a five-year term. As the head of state, the president of Pakistan is more of a symbolic position and the political system is primarily driven by the parliamentary system where the prime minister holds the real power.

The administrative units of Pakistan are one federal territory, two disputed territories, and four provinces. The governmental structure of Pakistan is divided into central and local governments. The local governments consist of four provincial governments - Punjab, Sindh, Khyber Pakhtunkhwa and Balochistan - headed by non-executive governors appointed by the President and governed by local laws. The two disputed territories - Gilgit Baltistan and Azad Jammu & Kashmir, a disputed territory with India - which operate independently of the judicial, legislative, and executive branches of the central government, except for diplomacy and defense. The current capital of Pakistan, Islamabad, and the National Capital Region form the federal territory. The central government is a federal government established under the Constitution and has sovereignty over all provinces. The federal government consists of the legislative (Senate and National Assembly), judicial (courts) and executive. The federal government operates under a parliamentary system, and the Cabinet is the final decision-making body of the government, headed by the Prime Minister.

■ Pakistan's Policy Trends in Energy and Climate Change Adaptation

Institution	Ministry of Energy	National Energy Efficiency & Conservation Authority	National Electric Power Regulatory Authority	Alternative Energy Development Board	Private Power & Infrastructure Board, PPIB
		NEECA	nepra	AEDB	
Roles	- Responsible for establishing and implementing the country's overall energy policy	- ENERCON reorganized into NEECA in 2016 - Develop programs and policies to improve energy efficiency, disseminate energy-saving technologies, and establish and monitor energy efficiency standards	- Power regulation and management: Issue production, transmission, and distribution permits and supply power to consumers - Establish and implement standards to ensure quality and safety in operations	- Established to promote the development and utilization of renewable energy resources	- Established to attract private investment to expand power infrastructure and ensure stable power supply

Table 11. Major Energy-related Institutions in Pakistan

In the energy and climate change sectors, Pakistan has institutional arrangements at the federal and local levels for policy, regulation, operations, and implementation. As shown in Table 11, federal institutions include the Ministry of Energy, the National Energy

Efficiency & Conservation Authority, and the National Electric Power Regulatory Authority, while the Alternative Energy Development Board and the Private Power & Infrastructure Board are responsible for supporting the development and deployment of relevant technologies. In addition, the Pakistan Engineering Council (PEC) supports the federal and local governments and is responsible for engineering education, certification, professional regulation, and licensing. Local government institutions include provincial energy efficiency and conservation agencies, such as the Punjab Energy Efficiency & Conservation Authority.

In 2013, Pakistan announced the National Power Policy 2013 (NPP-13) and the Framework for Implementation of Climate Change Policy, 2014-2030 (FPCP) to address the issues of power shortage[3] and climate change. More recently, the Renewable Energy Policy, 2006 (RE Policy 2006) was replaced by the Alternative Energy Development Policy, 2019 (ARE Policy 2019), which aims to increase the share of renewable energy from 5% in 2020 to 30% in 2030. In 2021, the National Energy Efficiency & Conservation Authority (NEECA) began developing minimum energy performance standards (MEPS) for electric motors, air conditioners, and LED lighting. NEECA's draft National Strategic Plan (2020-2023) envisioned a reduction of 3 million tons of oil equivalent (MTOE)[4] from the country's primary energy supply, contributing to a reduction in carbon emissions of 6.4 MtCO2e[13]. However, the actual implementation of many of these policies remains questionable due to the political-economic situation and natural disasters.

■ Green Building Policies, Laws and Institutions in Pakistan

There are currently four building codes in Pakistan.

- Building Code: Building Code of Pakistan (BCP) established in 1986 and amended in 2021.
- Seismic Provisions: Established in 2007 and included in the Building Code.

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[3] *In Pakistan, 27% of the population lacks access to electricity due to the country's growing population, poor transmission infrastructure resulting in significant power losses (18%), and difficulties in policy implementation. The shortage is particularly severe in rural areas[15].*

[4] *Industry (1.3 Mtoe), buildings (0.5 Mtoe), transportation (0.5 Mtoe), electricity (0.4 Mtoe), and agriculture (0.3 Mtoe) (Source: Ministry of Energy, Pakistan). In 2018, Pakistan's emissions were 489.87 MtCO2e.*

- Energy Code: Published in 2008 (BECP) and included in the Building Code as the Pakistan Building Energy Code (EP-2011) in 2011; promulgated in 2013; amended as the Energy Conservation Building Code 2023 (ECBC-2023) in 2023.
- Fire Safety Provisions: Established in 2016 and included in the Building Code.

Building codes and standards applicable to different regions of Pakistan are formulated by local governments, including development authorities, municipalities, and provincial boards. They define the basic requirements for occupant safety, health, accessibility and protection against hazards, earthquake, fire and structural protection of buildings in their respective jurisdictions[1]. In the past, the PEC was directly involved in the development and implementation of building codes through the organization of task forces, and ENERCON (National Energy Conservation Center) was involved in the development of energy codes and standards. Pakistan's current building code system is primarily prescriptive in nature, consisting of provisions and sets of standards that clarify the requirement that buildings be designed, constructed, protected, and maintained for the safety and comfort of the general public[1].

Pakistan's existing building code system focuses primarily on standards and legislation to meet the stringency requirements of certain elements, such as materials and equipment, related to the safety and amenities of buildings, including earthquake and fire (top of Table 12). On the other hand, the EU Switchasia framework presents a system of green building codes, as summarized at the bottom of Table 12. The system consists of three components: legislation, standards and practices, and design and assessment.

Green building codes take a performance-based approach through evaluation and design to determine whether a building complies with green building principles. This supports the effective implementation of green building practices, and regular revisions and additions to the codes ensure the achievement of sustainable development goals.

The green building code system should also consider improvements and linkages with current energy and safety standards (fire, structural, etc.).

Relevant legislation		Relevant provisions/codes	Features
Key building codes in Pakistan	**Building Code of Pakistan (2021) (BCP)**	Pakistan Building Energy Code (1990, 2011, 2023) → Replaced by Energy Conservation Building Code 2023 (ECBC-2023)	■ Pakistan's current building regulatory system is prescriptive or specification-based, consisting of codes and standard sets aimed at ensuring that buildings are designed, constructed, protected and maintained for the safety and comfort of the general public (primarily focusing on meeting the stringency of certain elements such as materials and equipment)[1].
		Building Code of Pakistan-Fire Safety Provisions 2016	
		Seismic Provisions of Pakistan Building Code	

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Legal/institutional Improvements to Establish Green Building[1]	**Green Building Code**	The functional goals and performance requirements of green buildings should reflect social expectations for building's safety and health levels.	■ Recommend to expand performance-based legal systems that are based on legislation, standards and practices, design and evaluation to the municipal level[28]. * Performance-based codes: Aimed at achieving specific outcomes, rather than meeting prescribed requirements.
	Standards and Practices	Adopted as a standalone reference document to comply with green building code requirements	
	Evaluation and Design	Tools to support the review and validation of green design	

Table 12. Current Major Building Regulations in Pakistan and Improvement Directions for Green Building Establishment Laws and Regulations

BECP (EP-2011) was developed by ENERCON (predecessor of NEECA) in 1990 as a legal system for improving energy efficiency of buildings in Pakistan based on the Indian ECBC. EP-2011 referenced the U.S. benchmark for commercial buildings, ASHRAE 90.1. It was incorporated into the Pakistan Building Code in 2013 to apply to new commercial, industrial, and large-scale construction projects. BECP-2011, which focused on energy efficient building materials, is no longer in effect as it has been replaced by the Energy Conservation Building Code 2023 (ECBC-2023). This new code is also more compatible with related standards from ARI, ANSI, and ASTM, among others. Table 13 shows the updates from the BECP (EP-2011) to the ECBC-2023.

ECBC-2023 provides the framework for minimum performance criteria for the elements prescribed in EP-2011 (building envelope, windows and openings, lighting, heating, ventilation, HVAC systems, etc.). In addition, ECBC-2023 recommends technologies such as passive design, sustainable and renewable energy, electric vehicle charging stations, and water reuse systems. While EP-2011 initially provided a comprehensive set of energy efficiency standards, shortcomings have been identified in some areas compared to the latest international standards. To this end, ECBC-2023 aligns the content and direction of the UN SDGs and the Paris Agreement, and is subject to regular revision every three years.

ECBC-2023 aims to improve the energy efficiency of buildings by promoting the use of green materials. It provides guidance on how to replace traditional building materials with greener options, and includes materials that support energy-efficient building design throughout building operations. Despite these efforts, it may be noted that it lacks quantitative standards. Furthermore, given that Pakistan's residential buildings are predominantly one- and two-story dwellings[23], the applicability of ASHRAE 90.1, which primarily covers standards for high-rise buildings in the U.S., and the feasibility of referencing ASHRAE 90.2, which covers standards for low-rise residential buildings, should be considered.

	Building code of Pakistan (Energy Provision-2011)[25]	Energy Conservation Building Code (ECBC) 2023[29]
Target	• New commercial building and theirs systems • New portions of existing buildings and their systems, if the conditioned area or connected load exceeds the scope below • New systems and new equipment in existing buildings • Increase in the electricity load beyond the limit of the scope below	• The ECBC 2023 applies to both residential buildings and commercial building • New commercial building and theirs systems • New portions of existing buildings and their systems, if the conditioned area or connected load exceeds the scope below • New systems and new equipment in existing buildings • Increase in the electricity load beyond the limit of the scope below
Scope	• Total connected load: 100kW or greater or • **Contract demand:** 125kVA or greater or • **Conditioned area**: 900m^2 or greater	• Total connected load: 50kW or greater or • **Contract demand:** 75kVA or greater or • **Conditioned area**: 200m^2 or greater

	or • Unconditioned buildings of covered area: 1,200m^2 or more	or • Unconditioned buildings of covered area: 300m^2 or more
Mandatory Elements	• Building envelopes • Building mechanical systems and equipment, including HVAC (Heating, Ventilating and Air Conditioning) • Service Water Heating • Lighting • Electrical power and motors	• Building envelopes • Building mechanical systems and equipment, including HVAC (Heating, Ventilating and Air Conditioning) • Service Water Heating • Lighting • Electrical power and motors • Others (Passive Design, Renewable energy, Electric vehicle charging points, water reuse systems, etc)
Case of any conflict	The relevant provisions of Safety, Health, or Environmental Codes shall prevail.	

Table 13. Comparison of Building Code of Pakistan (Energy Provisions-2011). (Detailed version: Appendix 3)

■ Government-led Green Home Building Programs

Pakistan has also attempted to revive its stagnant construction industry through government-led housing projects. Examples include the Ravi River Urban Development Project, the Bundle Island Project, and the NAYA (New) Pakistan Housing Project. The NAYA Pakistan Housing Project, in particular, was funded by the SWITCH-Asia[5] program to conduct green building research and develop green building guidelines, and was a large-scale housing project that aimed to build five million homes in seven areas within five years, with land provided by the government and financing provided by private investors. Despite these efforts and research, the development and establishment of green building institutions seems to have stagnated somewhat due to political and economic issues.

■ Evaluation and Certification Systems

Pakistan does not have its own green building performance rating systems and uses a variety of external criteria and evaluation and rating systems. The Pakistan Green Building Council published the Reference Guide for Building Design and Construction in Pakistan

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[5] *A program that provides EU funding for projects that promote clean technologies and sustainable industrial practices in a wide range of sectors (including energy efficiency in industrial plants and housing, agri-food and fisheries, tourism, logistics, etc.*

in 2018, which included the Guidelines for the Selection of Rating Systems[1] to encourage green building design.

- UN-Habitat/UNEP-10YFP/SHERPA: Guidelines for sustainable housing
- Green Rating for Integrated Habitat Assessment, GRIHA
- Leadership in Energy and Environmental Design (LEED)
- Building Research Establishment Environmental Assessment Method (BREEAM)
- Green Star Rating System (GSRS)
- ISBE/SBA 2009/SBAT 2016: Performance evaluation criteria
- Green Design with WB software EDGE (Excellence in Design for Greater Efficiency)
- Comprehensive Assessment System for Built Environment Efficiency (CASBEE)
- EU GB Rating System (zero energy standard)

The U.S. LEED certification has been increasingly recognized since 2008. As of 2018, there were 21 LEED-certified buildings in Pakistan, with the majority located in Karachi and the capital region[19]. Despite its dominance, the LEED certification system is more appropriate for countries in cooler climates, highlighting the need to develop a rating system for Pakistan's hot tropical climate and diverse climatic zones, taking into account cost and economic feasibility[1]. In this context, the approval of green building plans and compliance assessment by building control authorities should progressively aim at developing and achieving green performance certifications tailored to Pakistan's culture, architectural traditions and local climate.

The green building guidelines released in 2020 for the New Pakistan Housing Project (NPHP), which aims to build five million new homes, recommends the use of EDGE simulation software to assess the resource efficiency (energy, water, and materials) of buildings constructed under this housing project. The EDGE software is a residential building design and assessment program that is broadly applicable to different income groups and building types. It enables the selection of resource efficiency measures according to local conditions and needs, thus providing more flexibility[30].

Under NEPRA’s Net Metering Program (2015), more than 2,300 new licenses were issued from July 2019 to March 2020[13].

4) Construction Market and Green Building Support and Incentives in Pakistan

■ Construction Market in Pakistan

Pakistan's economy has demonstrated stable growth since the 2000s. According to the Pakistani Ministry of Finance, the construction market accounted for 2-2.5% of the country's GDP prior to the economic crisis. Historically, the construction industry had grown at an average annual rate of 6-8% before slowing down due to the 2008 global financial crisis, the 2021 earthquake, the 2022 floods, and the 2020s pandemic. The country is also facing rising construction costs driven by increases in the prices of imported cement, steel, and other building materials, as well as challenges in technological and process development.

The NPHP, which aimed to build five new homes to revitalize the construction market, is currently on hold. Government-led housing projects play an important role in Pakistan's construction market. However, political instability has hampered their progress. Despite this, there is growing importance of renewable energy buildings, which is leading to the emergence of relevant industries and economic support.

A study conducted by the U.S. National Renewable Energy Laboratory (NREL) identified the province of Baluchistan as an optimal location for solar power generation. Indeed, there has been a notable increase in the number of solar panel installations on new buildings in Islamabad and Baluchistan. As part of the Sindh government's initiative, solar panels have been installed in 200,000 homes across 10 districts in Sindh Province. The Sindh Solar Energy Project (SSEP) has invested USD 30 million in solar projects in rural areas with insufficient access to electricity, and the World Bank has provided USD 100 million in funding to the SSEP. The Sindh Solar Energy Project (SSEP) has initiated several flagship projects, including a 400 MW solar park in Manjhand Town, 20 MW of solar installations on public buildings in Karachi and Hyderabad, and solar installations in 200,000 homes in rural areas[31].

Furthermore, pilot projects have been implemented with the objective of stimulating the private market for green, renewable energy, with international support. For instance, the International Finance Corporation (IFC) launched a four-year campaign, "Lighting Pakistan," to promote private investment in lighting projects for consumers in remote villages in Pakistan. Similarly, the AEDB implemented the Off-Grid Electrification Pilot Project in Sindh and Punjab through a results-based financing (RBF) model. The German Agency for International Cooperation (GIZ, Deutsche Gesellschaft für Internationale Wusammenarbeit) has implemented several small-scale RBF projects in select villages in Punjab and Sindh [13]. Despite the current cost of solar power generation is higher than other renewable energy sources, it is expected that solar will become the preferred choice in the long term due to the local climate and infrastructure conditions. There is a growing number of relevant projects supported by international partners.

■ Economic Support for Green Building

Pakistan is working with various financial institutions and international organizations to provide economic support for the adoption of green building. In 2017, the State Bank of Pakistan (SBP) approved the green banking guidelines to encourage environmental risk management and climate finance by commercial banks. The green banking guidelines aim to mitigate the vulnerability of banking, fulfill their environmental responsibility, and provide funding needed for the transition of the economy towards a climate and environmentally friendly future.

In 2020, the Green Climate Fund (GCF) approved projects worth USD 7.2 billion, and Pakistan mobilized USD122 million through intermediary finance (UNDP, ADB, FAO). The Ministry of Climate Change (MoCC) supported two domestic organizations in their accreditation process through the GCF to access various financial instruments (grants, grant equivalents, long-term low-rate loans, equity, and guarantees). Below are international climate finance support programs in 2021[13].

- 1 project: Adaptation Fund
- 3 projects: Green Climate Fund (GCF)
- 15 projects complete out of 19 approved projects: Global Environment Fund (GEF)
- Limited access to Climate Investment Funds (CIFs) or key bilateral climate funds and instruments
- 1 project: Nationally Appropriate Mitigation Action (NAMAs)

Housing finance in Pakistan is particularly underfunded, with a housing finance to GDP ratio of 0.25%, one of the lowest in South Asia. In this context, movements to build a climate-responsive financial system, such as green bonds[6], provide an opportunity to lay the foundation for green finance, including green home mortgages, green home equity loans, and green commercial building loans. To this end, it is important to facilitate private capital investment, streamline project approval processes, and address domestic risk factors so that foreign investors are not deterred from investing in Pakistan.

■ Incentives

Incentives can be an effective policy instrument to encourage the implementation of the GBC in Pakistan. They may include easing regulations for building area or height, tax exemptions, other tax incentives, lower interest rates on construction loans, and duty-free importation of green technologies or materials.

In April 2020, the Pakistani government announced an incentive package worth over 100 billion Pakistani rupees to stimulate the country's sluggish construction sector. A core element of this incentive package was 10-year financial incentives to investors in the housing industry under the Naya Pakistan Housing Programme, a five-million new home construction project. Typical incentives included tax exemptions, incentives for expatriate Pakistani investors, and incentives worth 36 billion Pakistani rupees. These incentives were scheduled to end in December 2020, but tax exemptions were extended until June 2021 and others until the end of 2021[31]. Below are the summary and highlights of Pakistan's construction industry incentive packages in 2021.

Incentive package	Highlight (effective until December 31, 2021)
Local construction projects in Pakistan	- Tax exemption for local construction projects in Pakistan until December 31, 2021, regardless of the source of the funds.
Naya Pakistan Housing Programme)	- Taxes on investor profits reduced to one-tenth of the current level. - Grants worth 30 billion Pakistani rupees
Tax policy for construction materials	- No withholding tax on all items used in the construction industry except steel and cement
Facilitating new home construction	- Capital gains tax exemption on the sale of houses owned by individuals.

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[6] *Pakistan has issued green bonds through the Water and Power Development Authority (WAPDA). However, challenges remain in developing guidelines and establishing criteria*[45].

Adjusting tax policy for builders	- Taxes payable by builders calculated based on construction area instead of their operating income.
Adjusting sales tax conditions for the construction industry	- Sales taxes imposed on the construction industry reduced in consultation with provincial governments.
Adjusting real estate capital gains tax conditions	- Minimum ownership requirement to avoid capital gains tax for the selling of real estate reduced to three years from four years.
Construction Industry Development Board.	- Organized the Construction Industry Development Board.

Table 14. Key Contents of Pakistan's Construction Industry Incentive Package [31]

The effectiveness of these incentives and other initiatives launched after 2021 have not been identified. For the successful and sustainable implementation of the GBC, the effectiveness of incentive programs needs to be reviewed regularly and adjustments should be made accordingly.

■ Green Building Education in Pakistan

In Pakistan, a number of organizations such as the Sustainable Development Policy Institute (SDPI) and the Pakistan Green Building Council have organized workshops and seminars on green building. Below are examples of notable green building programs in Pakistan[19].

- LEED AP Examp Preparation Courses in 2016
- First-ever expo and conference held in Karachi in October 2016
- Two conferences at Greenbuild in 2018
- Five LEED technical workshops in 2018

The Pakistan Engineering Council (PEC) regulates the engineering profession and ensures that engineering graduates meet the knowledge, skills, and ethical requirements. As in the case of the PEC, it would be essential to establish separate or integrated entities to ensure continuous education, training, and skills development at various levels and drive strategies to pursue awareness campaigns.

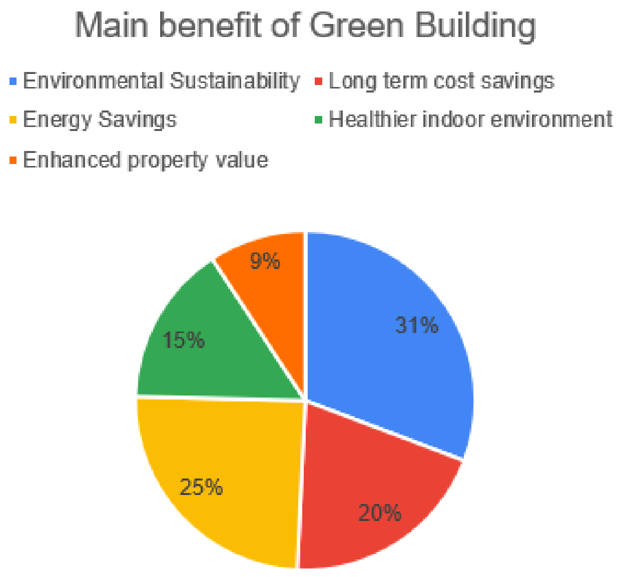
2. Awareness of green building among Pakistan Stakeholders

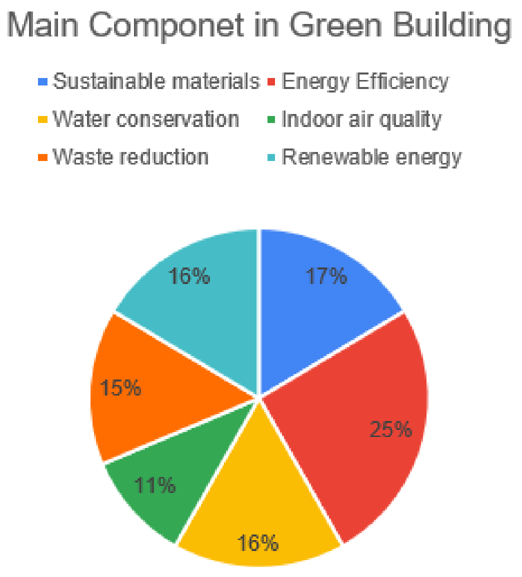
A survey was conducted among relevant professionals in Pakistan to understand the perceptions of professionals in the country and to inform the proposal and roadmap for the green building certification system. The survey focused on reviewing their understanding of green building and NDCs.

As a result, a total of 21 experts (20 men and 1 woman) responded, and it was found that they were not familiar with the system or standards for green building. However, they are aware of the NDCs and agree on the importance of green building and the need to apply it. The most important aspect of green building is energy efficiency, followed by sustainable development, water circulation, and activation of renewable energy, and waste management and indoor air quality management.

In addition, the greatest effects of green building are seen as environmental and economic, and it was suggested that a balanced development of the fields currently covered by green building, such as materials and energy, water cycle, and indoor environment, is needed.

However, 17 out of 21 experts surveyed have no experience in green building-related projects and understand NDCs, but most of them have not participated in related briefings and research, so it is concluded that awareness of green building and NDC realization in Pakistan is just beginning and more research and briefings are needed.





3. SWOT Analysis and Strategy

In consideration of the aforementioned context, a SWOT analysis was conducted to establish a code, standards and practices, a design and rating system for the establishment of green building in Pakistan(Table 15).

Strengths	Weaknesses
• **Abundant natural resources**: Abundance of renewable energy resources such as solar for energy efficient construction	• **Regulatory gaps:** Lack of adequate regulations and standards tailored to Pakistan's diverse climatic and socio-economic conditions
• **Government-led renewable energy projects:** Solar and other renewable energy projects for energy independence	• **Low economic power and limited funding**: Sluggish economic growth means heavy initial burden for upfront investment in green building; limited investment and financing for related projects, especially from the private sector
• **Government support**: The government of Pakistan recognizes the urgency of reducing carbon emissions and the importance of sustainable development; the central and local governments provide support tailored to local contexts	• **Lack of technology**: Difficulties in implementation due to lack of high-quality green building materials and technical professionals
• **Traditional passive design techniques**: Pakistan's vernacular building techniques incorporate many	• **Political instability**: Political instability makes it difficult to pursue long-term policies

passive design elements potentially applicable to green building • **High home ownership rates**: Over 90% of urban housing in Pakistan is owner-occupied, hence more acceptable to green building and easier to maintain • **Large domestic market and affordable labor**: Pakistan has a large domestic market and affordable labor, hence high growth potential for the green building market • **Continued investment in energy and infrastructure**: Continued investment in energy and infrastructure by governments and the private sector is expected to spur the adoption of green building	• **Existing regulatory constraints**: Existing building codes primarily focus on the safety and amenities of buildings and lack regulations on energy efficiency • **Inefficient design and poor construction practices:** Disorganized urban planning and high population densities have resulted in many poorly designed, inefficient, and inhospitable buildings with poor quality of living • **Poor business infrastructure**: Poor business environment due to poor infrastructure such as power shortages • **Difficult living conditions**: Poor living conditions due to security, sanitation, and environmental issues • **Inadequate insulation and HAVZC performance in existing buildings:** Existing buildings are poorly insulated and have underperforming heating and cooling systems, hence low energy efficiency • **Limitations in energy efficiency and conservation policies**: Pakistan's energy efficiency and conservation policies are still centered around commercial buildings; lack of relevant policies in the housing sector despite the household sector being the major consumer of electricity in Pakistan • **Lack of awareness and education:** Lack of awareness of sustainable architecture among the building industry and the general public; lack of relevant education and training programs
Opportunities	**Threats**
• **Increasing demand for green buildings:** Growing awareness of environmental issues drives demand for green building • **Energy cost savings:** Energy-efficient construction leads to long-term energy cost savings • **Strong commitment to economic stimulus and reform:** Strong government stimulus and willingness for economic reform facilitate green building • **Establishing green financial systems**: Opportunities to lay the foundation for green financing such as green home mortgages, green commercial building loans, etc. • **International cooperation projects:** Opportunities for cooperation with international organizations to attract funding to develop local knowledge and resources and introduce advanced technologies	• **Economic difficulties**: Economic instability may hinder investment attraction in green building • **Technology gap and high cost**: Technology gap with advanced countries and inflation may slow the adoption of the latest green building technologies • **Ongoing global conflicts and domestic political terrorism**: Global conflicts and domestic political unrest continue to create security challenges • **Dual crises of natural disasters and economic crises**: Economic and industrial uncertainties due to the potential risk of climate change leading to natural disasters and economic crises

Table 15. SWOT Analysis for the Adoption of Green Building in Pakistan

Strategies for introducing green building in Pakistan were derived from the results of the SWOT analysis, as shown in Table 16. Among them, government-led campaigns to promote green building seem to be particularly effective in Pakistan. There is an urgent need to introduce a rating system and item-specific rating criteria through a performance rating system that is suitable for Pakistan's climatic conditions. Once the green building code is implemented, the effectiveness of the code and the performance rating system should be reviewed and improved by monitoring the performance of all green building projects. With this strategy, Pakistan will be able to effectively develop a green building certification system and establish relevant standards.

Element	Strategy	Details
SO (Strengths-Opportunities)	**Promote green building with government energy and infrastructure investment and renewable energy resources**	Organize projects and campaigns in conjunction with solar and other renewable energy projects that attract support and funding from international organizations and the Pakistani government to promote green building and improve energy efficiency; introduce a green building certification scheme for awareness building
	Establish customized green building standards	Develop customized green building standards taking into account the different climatic zones of Pakistan; effectively implement the green building certification scheme with support from international organizations
	Build the foundation for green finance	Establish green bond and other financial systems to encourage private investment and streamline project approval processes
WO (Weaknesses-Opportunities)	**Introduce green building materials and technical professionals**	Collaborate with international organizations to introduce green building materials and technical professionals to close the gap in the workforce and skills for green building
	Ease upfront investment costs	Facilitate the adoption of the green building certification scheme by reducing upfront investment costs through financial support from the government and international organizations
	Prevent inefficient design through the legal and institutional environment for green building	Establish a green building code and legal foundations for green building certification; develop an effective green building roadmap including the phased application to different building uses; develop and distribute detailed standards for building design, construction, operation and maintenance
	Modernize traditional	Modernize traditional building techniques to evolve them into Pakistan's own green building techniques in response to climate

	building techniques	change and incorporate them into the green building certification scheme
ST (Strengths-Threats)	**Leverage the huge domestic market to drive green building technology and certification scheme adoption**	Leverage the high home ownership rate and the large domestic market to drive the adoption of green building technologies and encourage participation in green building to promote the certification scheme
WT (Weaknesses-Threats)	**Improve energy efficiency and tackle economic challenges by harmonizing with existing building codes**	Ensure harmonization with the existing building codes to improve energy efficiency, provide practical measures to address economic challenges, and ensure the effectiveness of the green building certification scheme
	Overcome political instability and raise public awareness	Support the streamlined introduction of the green building certification scheme by strengthening collaboration with the private sector and raising public awareness
	Stimulate the construction market through a green building certification scheme	Improve the value of residential buildings through the green building certification scheme; provide the foundation for revitalizing the construction market through tax benefits and eased building area/height regulations, and other incentives

Table 16. Strategic Recommendations for the Adoption of Green Building in Pakistan Based on SWOT Analysis

V. Green Building Standards and Certification Schemes in Pakistan

1. Directions

Pakistan still lacks relevant institutions and frameworks for sustainable built environment such as green building. Given the sluggish progress of green building and the challenging environment and constraints in Pakistan, there is an urgent need for a government-led green building framework.

This chapter focuses on the development of green building evaluation criteria for Pakistan. To maintain consistency with international cooperation projects, the proposed framework[7] of Switch Asia, the MoCC's "*Vision 2030 for a Green Building Code in Pakistan*[28]" (Vision2030) and "*Policy Guidelines for Green Building Code*[1]" in 2022 were considered and incorporated into the new framework, taking into account the findings of previous studies and compatibility with the criteria. These previous studies have shown that the components of Green Building Certification (GBC) in Pakistan focus on design, construction and maintenance throughout the lifecycle of the building.

The phases elaborated under the Naya Pakistan Housing Program (NPHP) and proposed as part of the green building strategy have been further divided into: Landing, Site Planning, Construction Process Planning, Basic Design, Specifications, During Construction, and Post Construction(Figure 13). The key factors to be considered in these phases include energy, efficient water use, materials and systems, and waste management, which were considered for the development of the criteria.

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[7] *A- SITE PLANNING & DEVELOPMENT, B - GREEN BUILDING CONSTRUCTION, C- RESOURCE EFFICIENCY, D - POST-COMPLETION GREEN BUILDING ACTIONS, E – GREEN BUILDING CODE COMPLIANCE & INFORMATIVE REFERENCES*

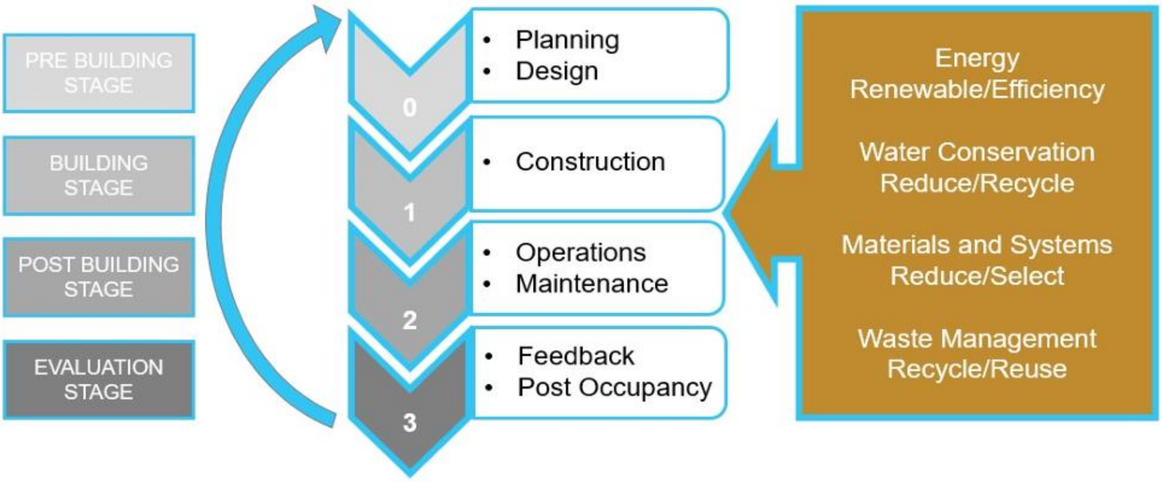
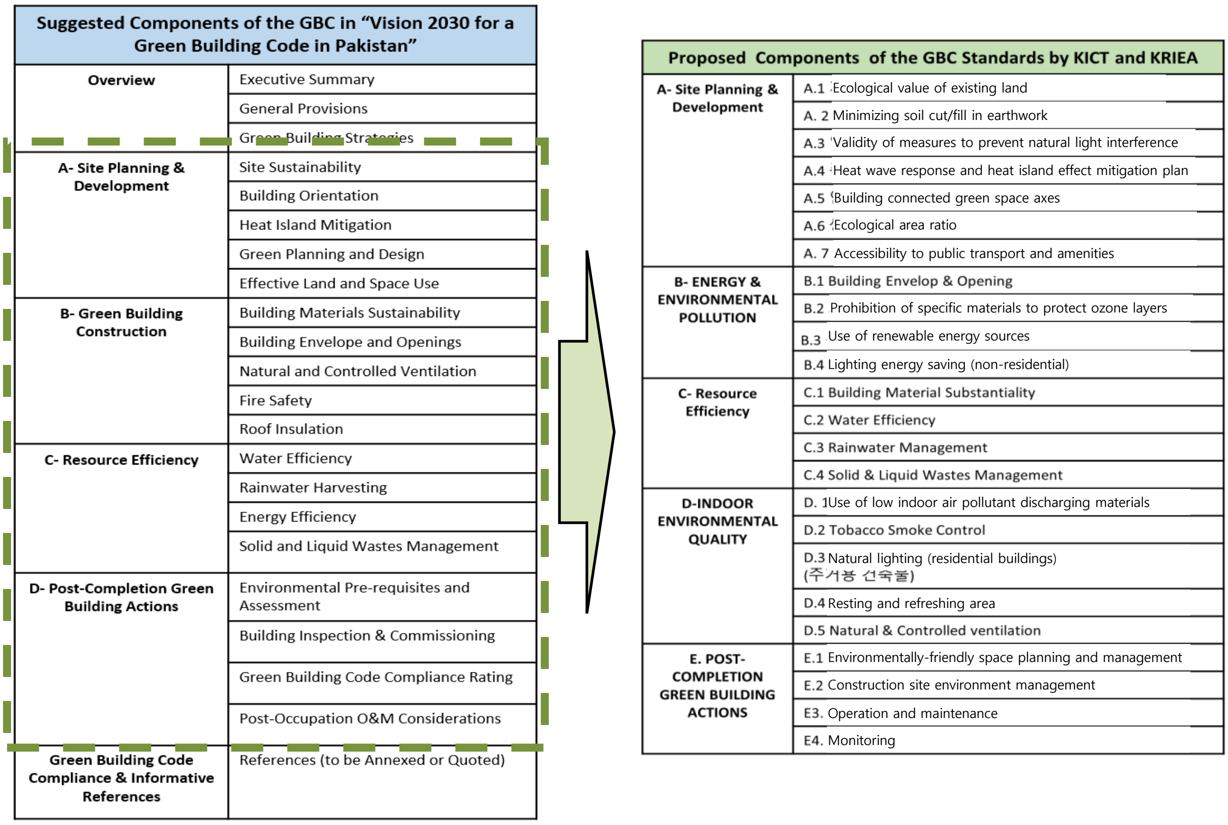


Figure 13. Stages of Impact Assessment of a Green Building Code from "Naya Pakistan Housing Programme (NPHP)[30]"

Switchasia's Vision 2030 report[28] specifically identifies heat island effect, urban flooding, water scarcity, and earthquakes as vulnerabilities that require special attention in the Pakistan Green Building Code, and suggests responses to them, as shown in Table 17. For earthquake preparedness, the detailed criteria can be updated in conjunction with the earthquake-related provisions of the Pakistan Building Code, while measures to address heat island effect, urban flooding and water scarcity were considered in the development of the framework for the detailed criteria presented here.

Vulnerability	Possible Countermeasures
Extreme heat (Increasing Energy Consumption/Demands)	Energy, Renewable/ Efficiency Materials and Systems, Reduce/Select
Urban Flooding	Waste Management, Recycle/Reuse Water Conservation Materials and Systems Need for integration or linkage with existing relevant regulations
Water Scarcity	Water Conservation, Reduce/Recycle
Earthquake	- Materials and Systems, Reduce/Select - Need for integration or linkage with existing relevant regulations

Table 17. Vulnerable environmental factors in Pakistan and green building mitigation strategies[28]



Suggested Components of the GBC in "Vision 2030 for a Green Building Code in Pakistan"	
Overview	Executive Summary
	General Provisions
	Green Building Strategies
A- Site Planning & Development	Site Sustainability
	Building Orientation
	Heat Island Mitigation
	Green Planning and Design
	Effective Land and Space Use
B- Green Building Construction	Building Materials Sustainability
	Building Envelope and Openings
	Natural and Controlled Ventilation
	Fire Safety
	Roof Insulation
C- Resource Efficiency	Water Efficiency
	Rainwater Harvesting
	Energy Efficiency
	Solid and Liquid Wastes Management
D- Post-Completion Green Building Actions	Environmental Pre-requisites and Assessment
	Building Inspection & Commissioning
	Green Building Code Compliance Rating
	Post-Occupation O&M Considerations
Green Building Code Compliance & Informative References	References (to be Annexed or Quoted)

Proposed Components of the GBC Standards by KICT and KRIEA	
A- Site Planning & Development	A.1 Ecological value of existing land
	A. 2 Minimizing soil cut/fill in earthwork
	A.3 Validity of measures to prevent natural light interference
	A.4 Heat wave response and heat island effect mitigation plan
	A.5 Building connected green space axes
	A.6 Ecological area ratio
	A. 7 Accessibility to public transport and amenities
B- ENERGY & ENVIRONMENTAL POLLUTION	B.1 Building Envelop & Opening
	B.2 Prohibition of specific materials to protect ozone layers
	B.3 Use of renewable energy sources
	B.4 Lighting energy saving (non-residential)
C- Resource Efficiency	C.1 Building Material Substantiality
	C.2 Water Efficiency
	C.3 Rainwater Management
	C.4 Solid & Liquid Wastes Management
D-INDOOR ENVIRONMENTAL QUALITY	D. 1Use of low indoor air pollutant discharging materials
	D.2 Tobacco Smoke Control
	D.3 Natural lighting (residential buildings) (주거용 건축물)
	D.4 Resting and refreshing area
	D.5 Natural & Controlled ventilation
E. POST-COMPLETION GREEN BUILDING ACTIONS	E.1 Environmentally-friendly space planning and management
	E.2 Construction site environment management
	E3. Operation and maintenance
	E4. Monitoring

Figure 14. Switch-Asia's Proposed Top-level Structure and Sub-components for Pakistan GBC (Left [28]) and the Revised Proposed Structure (Right) from this Study

Based on the literature review of previous studies, a standard framework for the Pakistan GBC has been developed in consideration of areas of need for Pakistan, policy feasibility and effectiveness, residents' health requirements, and environmental conservation, as shown in Figure 14. In this process, part of the broad sub-component topics was regrouped, consolidated or elaborated, and more specific topics were developed to elaborate actionable items to achieve environmental and human sustainability.

Pakistan's current building regulatory system is primarily prescriptive or elemental specification-based. It is centered around codes and standards that require buildings be designed, constructed, protected, and maintained for public safety and convenience. While an approach that specifies both code requirements and measures to meet them may be appropriate for a prescriptive-based system, such as Pakistan's building code, earthquake code, fire safety code, and energy efficiency code, it may not fit a performance-based system[28]. Thus, for the effective implementation of the green building code and rating system, it is suggested that local governments introduce their own versions of PGBC with reference to a performance-based system based on the organizational structure shown in Figure 14.

In particular, the structure presented in this study emphasizes environmental sustainability through the sub-criteria items, i.e., prohibiting the use of certain ozone-depleting substances and the use of renewable energy sources to fight climate change. In addition, "building envelope and openings" and "sustainability of building materials" were consolidated as “energy” items for the efficiency and practicality of building envelope design and simplification of the system. It also includes items for indoor environmental quality and residents' health. The functional objectives and performance requirements of the new green building code and rating system reflect society's expectations for building safety and health.

2. Implementation and Operation Strategy of Pakistan’s Green Building Code and Certification System

■ Plan to Introduce a Government-led Green Building Rating System

In 2018, residential construction projects led by the private sector increased sharply, accounting for 35% of the total construction market[32], leading to expectations of an increase in the share of residential construction. Nevertheless, the low penetration of green buildings and the lack of relevant material markets and professionals remain challenges to the diffusion of low-carbon buildings. In Korea, a government-led green building rating system has been established under the Green Building Construction Support Act, which has led to the rapid development of a related industry ecosystem. In addition, the establishment of green building and the development of evaluation criteria have raised public awareness. This positive aspect can also work for Pakistan to adopt green building, and the development of a government-led green building rating system would lead to the establishment of an industrial base and public awareness. Figure 15 shows the progressive development of the rating system.

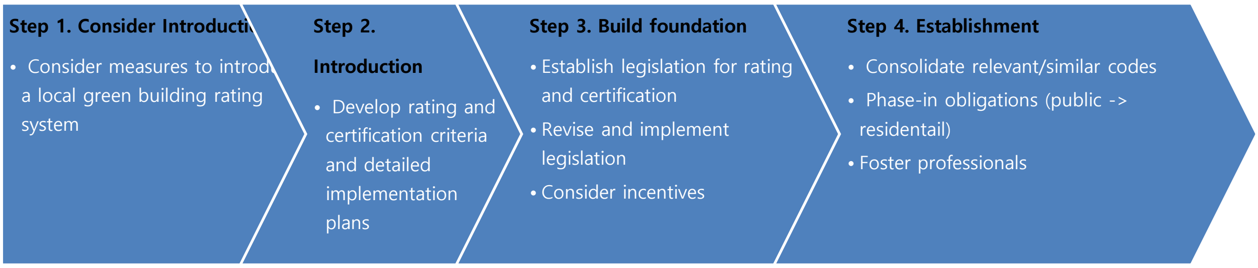


Figure 15. Gradual Implementation Plan for the Establishment of Green Building Regulations in Pakistan

■ Green Building Code Framework

In general, the PGBC will follow the steps shown in Table 18, starting with the formation of a task force and technical committees, followed by data collection, drafting, feedback, and finalization and approval.

Phase	Agency	Action	Description
1	MoCC	Mobilize a task force and technical committees	Organize a task force chaired by the federal minister for climate change; technical committees start working on the GBC; assess and identify zoning policies, building codes, obstacles, etc.; analyze environmental hotspots and resource tradeoffs
2	MoCC	Collect and compile criteria	Collect, organize, and compile topic-specific criteria based on preliminary reports from technical committees; criteria should be expressed both in quantitative and qualitative terms
3	MoCC	Circulate a draft GBC	Circulate the draft GBC to key stakeholders; reach an agreement on proposed sections, provisions, criteria, etc.
4	MoCC	Review the draft and collect feedback	The task force reviews comments and observations on the draft GBC and submits them to the MoCC; formal validation process
5	MoCC	Finalize and legally approve the GBC	Finalize the green building code; approval from relevant agencies; review by the Ministry of Justice for nationwide enforcement; seismic design, energy, and fire safety codes remain as separate regulations

Table 18. Preparatory Stage for Pakistan Green Building Council (GBC) as Proposed by Switch-Asia [28]

As shown in Table 19, the PGBC will cover the purpose of green building, basic planning, building energy management, green building certification, and training of green building professionals. The code will also serve as a legal basis for the review of the national green building masterplan every five years, consideration of performance and the roadmap, the implementation of the certification scheme, and the designation of an organization dedicated to green building.

Category	Details
Chapter 1. General Provisions	Purpose, definitions, basic principles, etc.
Chapter 2. Green Building Masterplan, etc.	Establish a green building masterplan every five years
Chapter 3. Building Energy and Greenhouse Gas Management	Establish a GHG emissions and energy consumption information system Manage the total energy consumption of buildings by region Limit the total energy consumption of individual buildings Improve the energy performance of existing buildings Submit energy conservation plans
Chapter 4. Green Building Rating System	Green building certification system
Chapter 5. Green Building Practice and Support	Foster professionals in green building Designate a green building center

Table 19. Establishing of legal framework for the Pakistan Green Building Code

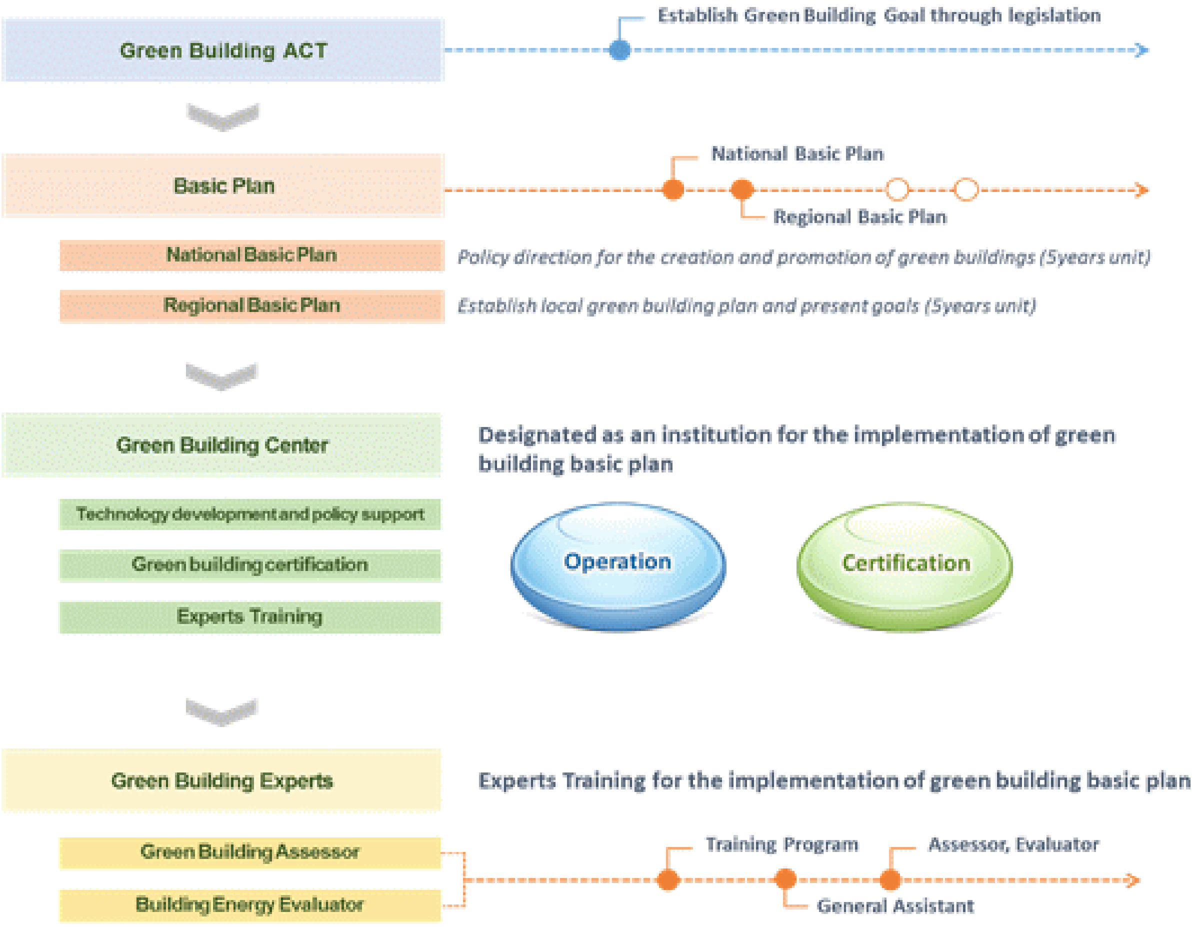


Figure 16. Legal and Institutional Framework for the Promotion of Green Building

Figure 16 is a conceptual illustration of the legal and institutional framework for achieving the green building targets. The top section shows the process of setting green building targets under the Green Building ACT, and below that are two basic plans (National Basic Plan and Regional Basic Plan). These plans are used to set policy directions and targets for the creation and promotion of green buildings at the national and local levels every five years. The GBC and subsequent building regulations, reference standards, and ordinances can be amended, revised, or repealed (if necessary) through the five-year review and update process. This allows new construction methods and technologies to be incorporated into the code, including those for residential and non-residential buildings in both urban and rural areas. In addition, for the first five years after promulgation, the GBC will cover certain types of buildings (e.g., residential and apartment buildings with at least three stories, excluding single/double-family dwellings) and then gradually expand the scope every five years. In applying these regulations, it will be necessary to monitor and respond flexibly to market and economic conditions.

The middle part of the figure describes the introduction of the "Green Building Center" for the implementation of the Green Building Basic Plans. The center will be responsible for technological development, policy support, green building certification, and professional training.

The bottom part explains the progression to "Green Building Experts" in two professional streams: Green Building Assessors and Building Energy Evaluators. These professionals will receive training for the implementation of the Green Building Basic Plans. The figure shows pathways for expert, evaluator, and assessor training and for general assistants, indicating how these professionals will be trained and placed in relevant positions. The two ovals on the right, "Operation" and "Certification", respectively symbolize the operation of the green building center and the certification process.

■ Example of Organizational Structure and Operational Mechanisms for the Green Building Certification System

The organizational structure for the operation of the green building code and rating system consists of a government organization, an operating agency, and an authentication agency.

Figure 17 illustrates an example of the green building certification process from application to certification with the roles of each organization and the relationship between them. The roles of relevant organizations in Pakistan have been identified based on the GBC organizational structure section[28] of "Vision 2030 for a Green Building Code in Pakistan".

- **Government organization**: The highest governing body with the legal authority to designate the management organization and designate/accredit the certification body. In Pakistan, this structure should be designed taking into account the relationship and authority between the central government (Ministry of Climate Change, Ministry of Housing & Works) and the federal government (green building divisions or authorities having jurisdiction (AHJs)).
- **Operating agency**: Responsible for operating the certification management system, reviewing certification results, facilitating green building certification, providing training and consultation services, developing the certification system, and promoting related initiatives. This may be the Pakistan Green Building Council (PGBC) or a separate organization designated under the GBC.
- **Building owners**: Apply for green building certification and receive certificates
- **Authentication agency**: Responsible for conducting document reviews and on-site inspections and preparing reports. This may be the Pakistan Green Building Council (PGBC) or a separate organization designated under the GBC. The authentication agency should have technical experts (professional assessors) to communicate directly with the building owner or applicant, verify the applicability of the regulations and review the documentation. Their expertise and integrity should be assured for the fair operation of the system.
- **Deliberative committee (third party review)**: A group of experts in various fields to review the reports and determine assessment results (e.g., architects, engineers, community representatives, etc.)
- **Certification operating committee**: Responsible for reviewing the green building certification criteria and making decisions on system improvements. May be affiliated with the Pakistan Engineering Council (PEC), the Pakistan Council of Architects and Town Planners (PCATP), etc.

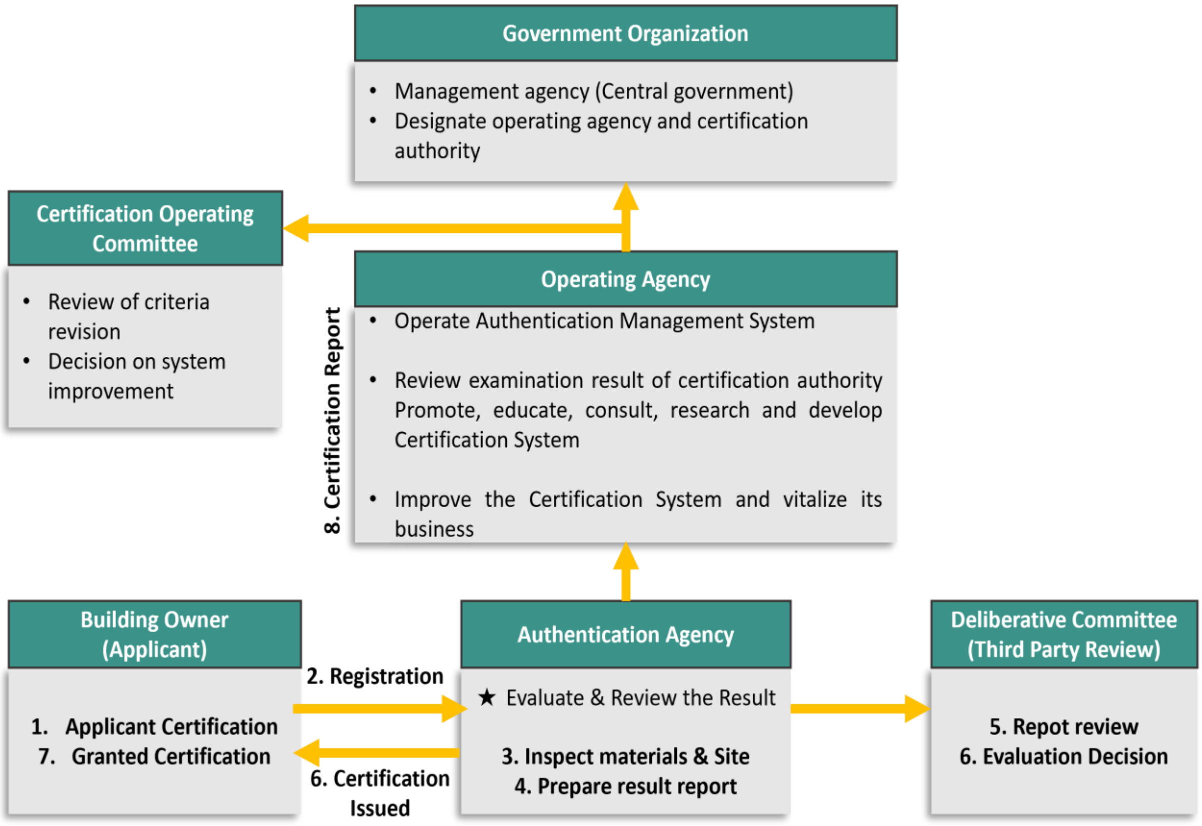


Figure 17. Green Building Certification System and Certification Process (Example)

■ Roles and Importance of the Operating Agency (tentatively named “Green Building Center)

The operating agency (Green Building Center) plays an important role in maintaining and developing the green building certification system. It is responsible for operating the certification management system, reviewing the evaluation results of the certification body, promoting the certification system, training, consulting, investigation, research and development, improving and revitalizing the certification system, training, managing and supervising professional evaluators, and analyzing and utilizing certification statistics, etc. It may also serve as a certification body in the early stages of the program.

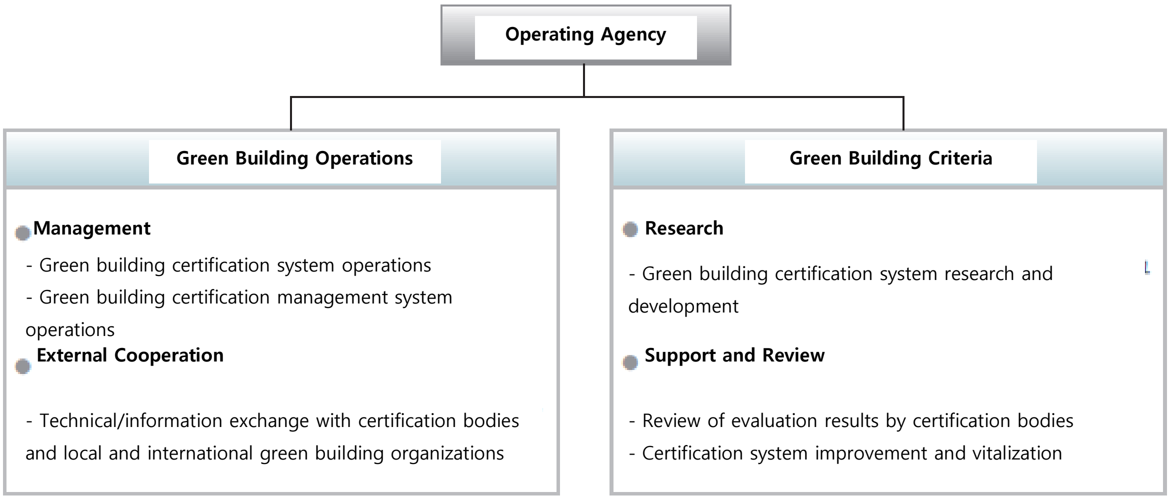


Figure 18. Organizational Structure by Function for Green Building Operating Agencies

The Green Building Center assigns dedicated certification system operating personnel at the Green Building Operation Center to perform practical tasks related to the operation of the system. Below is the anticipated organizational structure of the Green Building Center.

- Director
- Staff dedicated to system operation
- Staff dedicated to criteria
- Staff dedicated to administrative support

The Green Building Center may consist of the following teams:

- Green Building Operations Team: Responsible for policy and program marketing, certification data management, global networking, administrative support, and training management
- Green Building Criteria Team: Responsible for the development and support of certification criteria and training of certification evaluators

It may also have the following committees:

- Criteria Committee: Professionals responsible for establishing and revising technical criteria for the certification system

- Operating Committee: Professionals responsible for the overall certification system operations

With this structure and role, the Green Building Center will be able to effectively support the operation and development of the green building certification system in Pakistan.

■ Green Building Center's Roles

System operations	- Operate sectoral committees and subcommittees, including the Deliberative Committee - Interpret certification criteria, operate a certification result appeal system, and verify evaluation results - Present mid/long-term policy directions for green buildings and provide institutional support (seminars, discussions, etc. for system development) - Support networking with government departments, certification bodies, and educational institutions (regular meetings, workshops, meetings, etc.)
Certification criteria development and other research activities	- Develop certification criteria and regularly review and revise them - Produce and disseminate detailed guidelines for certification and organize education and training workshops for certification bodies - Provide lectures, symposiums and other education to relevant industries such as design and construction - Conduct research to build a foundation for green building certification criteria
Information system development	- Establish databases of information system and certification performance, evaluation results, etc. - Provide certification-related information such as statistical data on certification applications and results - Follow-up management of certification information and certified buildings
External cooperation	- Operate external channels to monitor, evaluate, improve, and supplement green policies and systems - Establish a cooperation system with overseas organizations related to green buildings and support international networking for branding and promotion of the system

Table 20. Examples of the typical scope of work to be undertaken when designated as a Green Building Center

The Green Building Center can play a pivotal role in the adoption and promotion of green building aimed at reducing emissions and achieving energy efficiency. Table 20 shows the general scope of work of the Green Building Center.

■ Phased Plans for Implementing a Green Building Certification System

Establishing a green building policy and system requires a phased approach to planning and implementation, as shown in Table 21. The first step is to prepare the certification system and lay the groundwork for green building certification. During this phase, goals are defined, strategies are established, a certification process is developed, green building criteria are established, and the legal basis for green building certification is established based on a mid- to long-term roadmap. It also includes research, effectiveness analysis, initial testing, pilot projects, and the establishment of a mid- to long-term roadmap for green building policy development.

The second phase, "System Implementation," is where the developed certification criteria and methodologies are demonstrated in real-world settings. With a particular focus on the certification process, it validates the developed rating system and verifies its compliance with the green building criteria.

In the third phase, the developed certification criteria and system are be revitalized and promoted. Efforts are made to disseminate proven green building criteria and methodologies, introduce proven new technologies throughout the industry, and raise public awareness. This is an important process for establishing sustainable building standards and raising public awareness of green building.

Phase 1 (Preparation): Designate an operating agency and elaborate its roles	Designate the operating agency; develop business guidelines and manuals Establish a certification process Establish a detailed roadmap for the operation of the operating agency Review certification criteria and processes through pilot projects Establish certification evaluator training and registration system Establish a certification business system
Phase 2 (Implementation): Operate the system and conduct certification services	Establish certification criteria and implement certification for public buildings Establish certification result verification procedures Acquire certification result data
Phase 3 (Vitalization): Establish certification operations and conduct certification services	Revise certification criteria based on review of certification performance Implement certification for large buildings Develop training programs for the general public Consider measures to vitalize the certification system

Table 21. Phased plan for implementing the green building certification system

3. Overview of the Pakistan Green Building Certification (PGBC)

■ Objectives of the Green Building Rating System in Pakistan

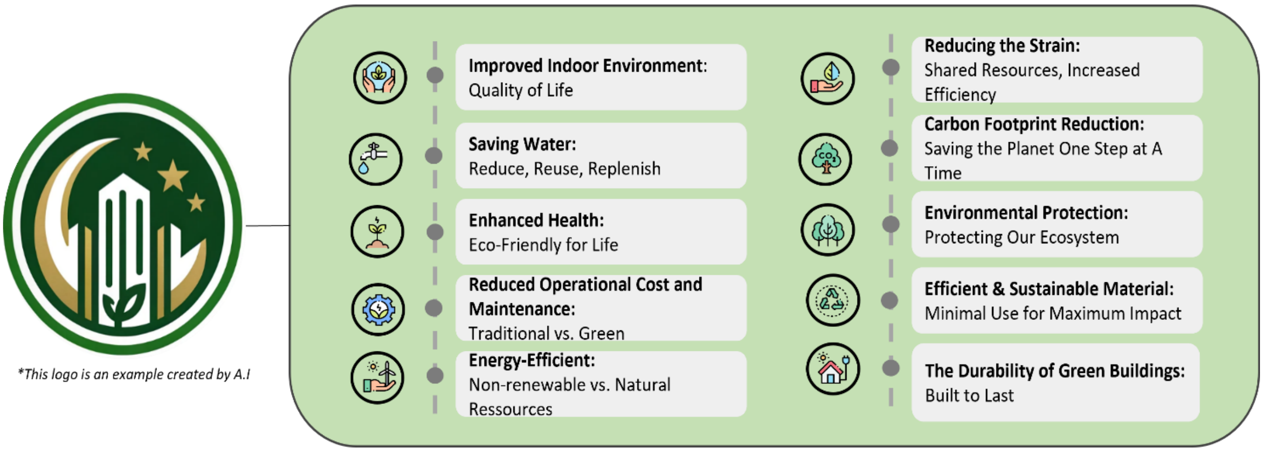


Figure 19. Aim of the Pakistan Green Building

The Pakistan Green Building Certification (PGBC) aims to promote green building practices that fit Pakistan's climate conditions and contribute to energy saving and pollution mitigation by assessing the impact on the environment and residents throughout the building lifecycle, from materials and design to construction, maintenance, and disposal.

Figure 19 describes the key benefits of green building in addressing Pakistan's current issues and specific goals for improving the environment and quality of life for residents.

- **Improved indoor environment**: Aim to improve the quality of life for residents; this can be achieved by improved indoor air quality, increased natural light, and pleasant climate control.

- **Saving water**: An important element for resource protection; measures to reduce water consumption, reuse water, and replenish natural water resources; this contributes to addressing water scarcity issues and achieving sustainable living.

- **Enhanced health:** Enhance the health of occupants by reducing harmful substances discharged from buildings, using green materials, and providing a nature-friendly living environment.

- **Reduced operational cost and maintenance:** Discover and develop cost-effective technologies and design options between traditional and green building methods to reduce long-term costs.
- **Energy efficiency:** Use natural resources and passive design to save energy and improve building efficiency.
- **Reducing the strain:** Achieved through resource sharing and increased efficiency; aim to optimize the use of shared resources and reduce the environmental strain through efficient resource management.
- **Carbon footprint reduction:** Everyday practices to save the planet; reduce carbon emissions in the building process and promote sustainable lifestyles.
- **Environmental protection**: Protect natural environments and ecosystems through waste management and pollution prevention
- **Efficient and sustainable material**: Select the least expensive and most sustainable materials to achieve the maximum benefit; encourage the use of high-efficiency materials and recyclable materials.
- **Durability of green buildings**: Encourage building designs that last longer.

By achieving these detailed goals for green building, Pakistan will be able to protect the environment, improve the quality of life for residents, and improve the energy efficiency and insulation performance of buildings.

■ Green Building Dissemination Roadmap and Buildings Subject to Certification

To create a foundation for green building in Pakistan, the following application and diffusion strategies can be employed.

- **Strategy 1. Phased green building policy application**: Target buildings can be classified and prioritized by size and use, or by mandatory and voluntary certification. The size and scope of the targets can be gradually expanded as green building becomes industrialized.

- Example 1) Mandatory certification: Public buildings with a gross floor area of 3,000 m2 or more
- Example 2) Multi-household (residential) buildings with 300+ units

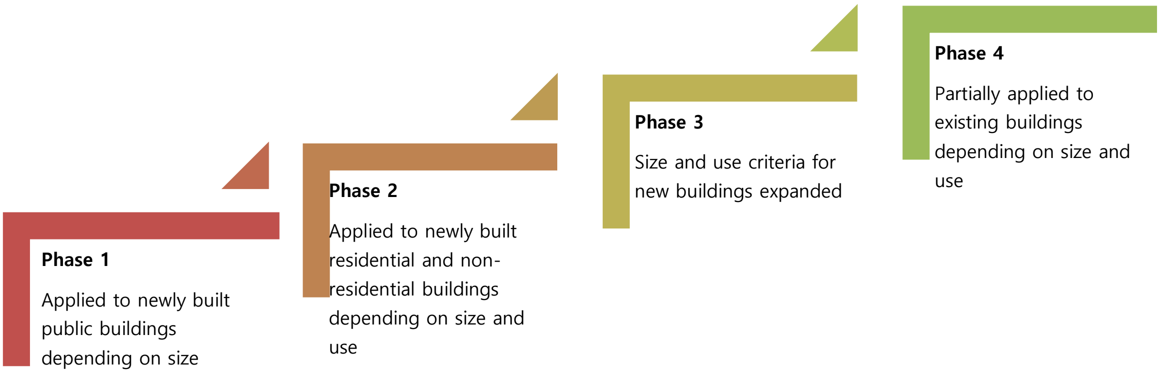


Figure 20. Phased application and expansion of green building (example)

Figure 20 shows an example of a phased approach to the application and expansion of green building. In the first phase, the certification system requires new construction projects by public institutions to obtain mandatory certification and strongly encourages other buildings to be certified as well. It also encourages the expansion of relevant markets and the development of professional human resources. In the second phase, new buildings will be subject to mandatory certification based on their size and use, and the application of the system will be encouraged through incentive programs. In the third phase, stricter criteria will be applied to the buildings subject to mandatory certification in the previous phase, and the certification system will be further extended to buildings with other uses. Finally, in the fourth phase, some stricter criteria will be applied to new buildings, and the requirements for existing buildings will gradually move from voluntary to mandatory certification for long-term development. This long-term roadmap should be monitored from time to time, and the direction and scope may be revised during the five-year review process. Mandatory requirements should be addressed in the Green Building Code, certification standards, and other building codes.

- **Strategy 2. Enabling policies for the voluntary acceptance of the green building certification system**: Another strategy is to encourage voluntary use of the certification system by providing a range of economic support and incentive programs based on analysis of existing systems and case studies (e.g. tax incentives, financial support, low interest loans, easing building requirements, etc.).

It is recommended that Pakistan's Green Building Code specify buildings subject to the green building certification system. It should encompass all buildings, with exclusions for military installations and other structures for which the system is inapplicable. Buildings are broadly divided into new buildings and buildings in use (Figure 21, Figure 22). These categories can be further subdivided into residential and non-residential buildings. Residential buildings are typically categorized into multi-household, regular, and standalone houses. However, a re-categorization of buildings in Pakistan seems essential. Non-residential buildings are those not used for residential purposes. These can be sub-categorised into commercial and office buildings, or into schools and other facilities as the industrialization of green building progresses. Buildings used for two or more purposes, which may consist of one or multiple wings, can also be evaluated as a separate category of complex building.

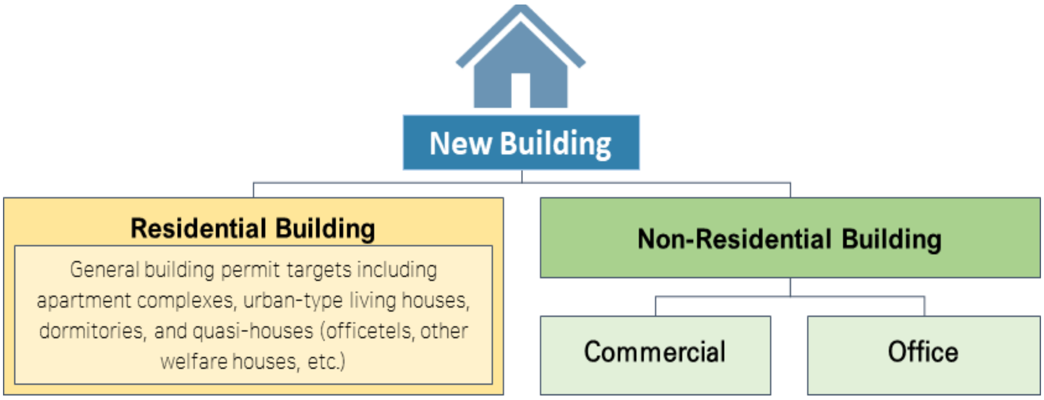


Figure 21. Pakistan Green Building Certification Target Classification – New building

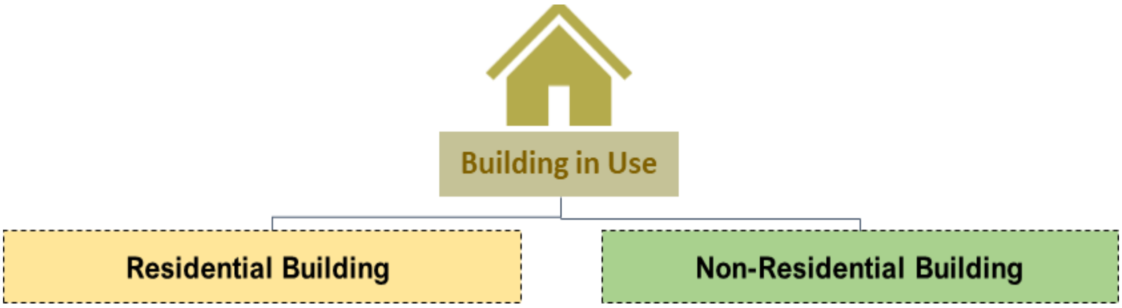
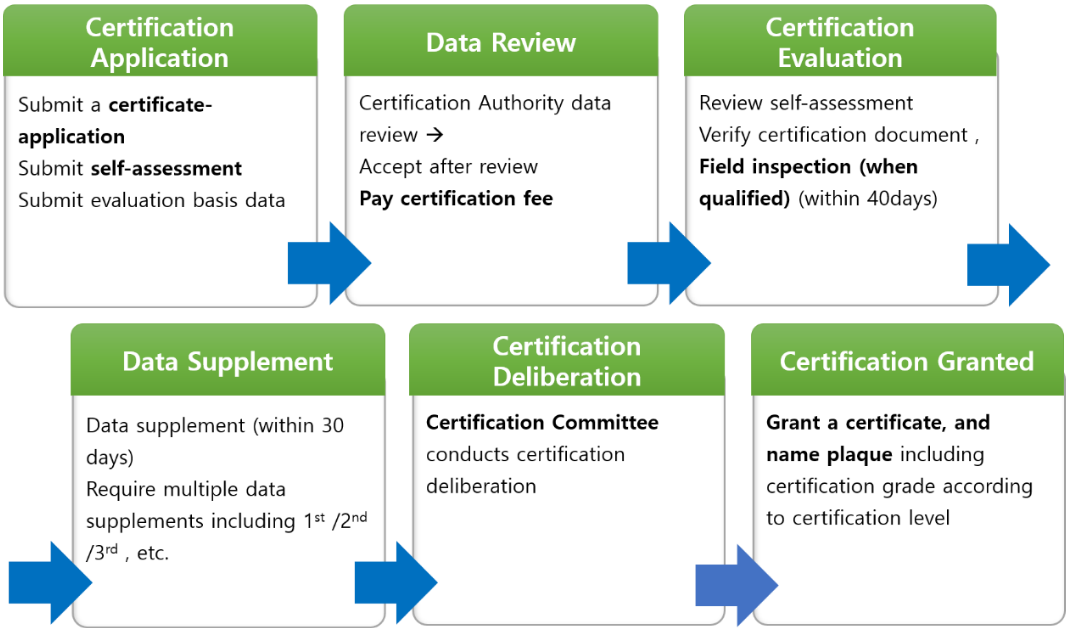


Figure 22. Pakistan Green Building Certification Target Classification – Building in Use

However, given that Pakistan is still in the early stages of introducing green buildings, the rating system needs to be simplified. The rating system considered in this study is based on green building criteria for new residential and non-residential buildings. As the green building industry and expertise develops, the criteria can be gradually expanded to cover a wider range of scales and uses, as shown in Figure 20.

4. Certification Process



Certification Application

Submit a **certificate-application**
Submit **self-assessment**
Submit evaluation basis data

Data Review

Certification Authority data review →
Accept after review
Pay certification fee

Certification Evaluation

Review self-assessment
Verify certification document ,
Field inspection (when qualified) (within 40days)

Data Supplement

Data supplement (within 30 days)
Require multiple data supplements including 1st /2nd /3rd , etc.

Certification Deliberation

Certification Committee conducts certification deliberation

Certification Granted

Grant a certificate, and name plaque including certification grade according to certification level

Figure 23. Green Building Certification Procedure (Example)

The PGBC will be a voluntary certification system, administered by an organization designated by the government. The certification system will comprise six processes, as shown in Figure 23. These processes outline the steps to obtain certification for a building or system that meets the green building criteria. The initial step is the submission of an application for certification. This entails the provision of all necessary documentation and self-assessment results by the applicant seeking certification. The next step is for the certification body to review the submitted documentation and for the applicant to pay the applicable certification fees. Additional information may be requested at any stage of the process. A key aspect of the certification process is the deliberation conducted by the Deliberative Committee, which provides input for the final certification decision. In the certification evaluation phase, the documentation and the results of the on-site inspection are reviewed to determine whether to grant certification. For new buildings, the pre-certification evaluation may entail a review of drawings, specifications, and system performance data to ascertain whether PGBC requirements are met in all building plans prior to construction. This is followed by the implementation phase to guarantee compliance with the identified pre-certification requirements. Upon certification, a certificate and plaque for the applicable rating are awarded.

The process is designed to guarantee transparency and consistency, offering formal acknowledgment that the building meets the defined quantitative and qualitative performance criteria for green building. The process is intended to standardize the certification process and serve as a resource for stakeholders, providing clarity on the expectations and documentation required for each stage.

5. Rating Standards

There are four green building ratings granted based on the score achieved in the certification evaluation (Best, Excellent, Good, and Standard). Different criteria may be applied to new and existing buildings as shown in Table 22.

Category		Best (Green Level 1)	Excellent (Green Level 2)	Good (Green Level 3)	Standard (Green Level 4)
New	Residential	74 or higher	66 or higher	58 or higher	50 or higher
	Non-residential	80 or higher	70 or higher	60 or higher	50 or higher
Existing	Residential	69 or higher	61 or higher	53 or higher	45 or higher
	Non-residential	75 or higher	65 or higher	55 or higher	45 or higher

Table 22. Score criteria by certification level (example)

6. Green Building Certification Fees and Validity

- Green building certification operations encompass a range of activities. It is essential to estimate certification fees in consideration of the work involved and the activities required to operate the system. These fees consist of the labor costs of professionals who review the design plans and related documents, as well as the costs associated with on-site inspections and other necessary activities.

- A green building certificate is valid for a period of five years from the date of issuance. Buildings that have obtained green building certification may request an extension, which must be submitted no earlier than 180 days before expiry and no later than the expiration date. The validity of the certificate may be extended only once for up to five years.

7. Incentives and Financial Support for Green Building Certification

Incentive systems are designed to promote the adoption of green building practices among architects and building owners by offering economic benefits (such as tax exemptions) or easing the requirements for buildings that have obtained green certification. Local governments should develop policies and incentive models that align with their specific circumstances, consider existing incentives, expected outcomes, feasibility, and more.

- Promoting and vitalizing green building practices by providing various incentives for buildings that have obtained green building certification and developing economic support models for green building construction.

- Examples of incentives

Incentive (example)	Description
Tax exemptions or reductions	Monetary benefits for taxes related to the construction and acquisition of the building (property tax, acquisition tax, etc.)
Relaxation of building standards	Allowing for higher floor area ratios, higher building heights, etc.
Financial and institutional incentives for green building-certified contractors	- Extra credit for participation in state-owned building projects - Relaxation of gratuitous donation requirements for housing construction projects ...

Table 23. Example of incentives related to green building certification

VI. PGBC’s Assessment Structure and Criteria

In this chapter, the PGBC’s assessment structure is defined and detailed criteria are discussed.

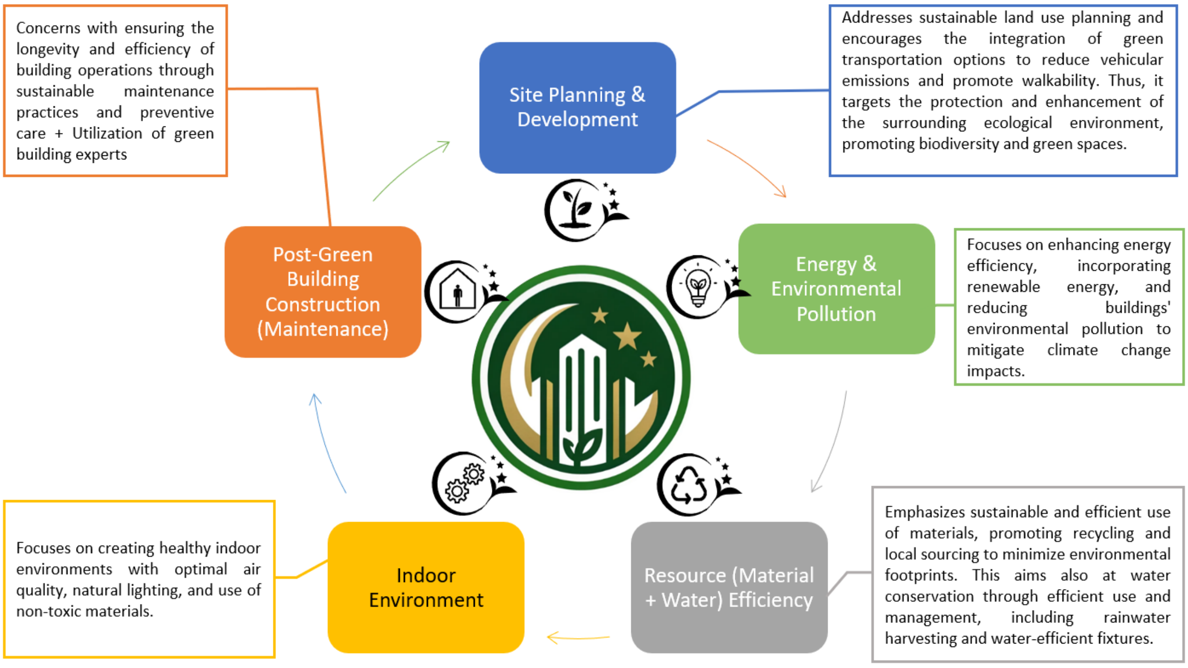
The assessment structure has been re-configured in considered of Pakistan’s circumstances, and detailed assessment criteria with clearly defined quantitative standards to measure building performance have been developed.

1. Pakistan Green Building Code Structure

Based on the analysis results and strategies discussed in Chapter II, five areas of green building assessment in Pakistan (land use and transportation, ecological environment, energy and environmental pollution, materials, resources and water cycle management, indoor environment, and maintenance) have been developed as shown in Table 24. The details of item-specific calculation criteria are presented in Appendix .

As previously noted in studies, the GBC should address several key areas, including area development and land use, building energy efficiency, green building safety, fire safety, water efficiency and grey water disposal, energy efficiency, gas supply, indoor air quality and comfort, material resource conservation and waste management, and more. It should be noted that the Earthquake Provisions (SPBC, 2007) and the Fire Safety Provisions (FSPBC, 2017) are closely associated with Fire Safety and Seismic Safety Design Standards. These should be taken into consideration in line with the detailed assessment items presented herein.

Pakistan Green Building Certification 2024



Concerns with ensuring the longevity and efficiency of building operations through sustainable maintenance practices and preventive care + Utilization of green building experts

Addresses sustainable land use planning and encourages the integration of green transportation options to reduce vehicular emissions and promote walkability. Thus, it targets the protection and enhancement of the surrounding ecological environment, promoting biodiversity and green spaces.

Focuses on enhancing energy efficiency, incorporating renewable energy, and reducing buildings' environmental pollution to mitigate climate change impacts.

Focuses on creating healthy indoor environments with optimal air quality, natural lighting, and use of non-toxic materials.

Emphasizes sustainable and efficient use of materials, promoting recycling and local sourcing to minimize environmental footprints. This aims also at water conservation through efficient use and management, including rainwater harvesting and water-efficient fixtures.

Area	Assessment
A. Site Planning & Development	Consider relevance to the external environment in terms of conserving or restoring the ecological functions of the land to the greatest extent possible; minimize the direct impact of the development process on the diversity of species to ensure the biota of the habitat.
B. Energy & Environmental Pollution	Evaluate architectural and system-level measures for energy consumed to building operations
C. Resource Efficiency	Assess the use and input of low-carbon materials and resource-cycling materials that contribute to reducing environmental pollution and impact in consideration of the impact of materials throughout the building process
	Assess rainwater management and utilization methods for conserving water and pursuing an efficient water cycle
D. Indoor Environmental Quality	Assess the thermal, acoustic, light, and air environments by considering aspects related to minimizing harm to occupants' and neighbors' health and wellbeing
E. Post-Completion Green Building Actions	Assess architectural methods to minimize and maximize environmental impact through proper maintenance

Table 24. Description of the PGBC's categories

Figure 24 shows the percentage of points for each item included in the Pakistan Green Building Assessment, with a total score of 100. Section B, Energy and Environmental Pollution, accounts for the largest portion in the scoring system, followed by Section D, Indoor Environmental Quality, and Section C, Resource Efficiency, Section A, Site Planning and Development, and Section E, Post-Completion Green Building Actions.

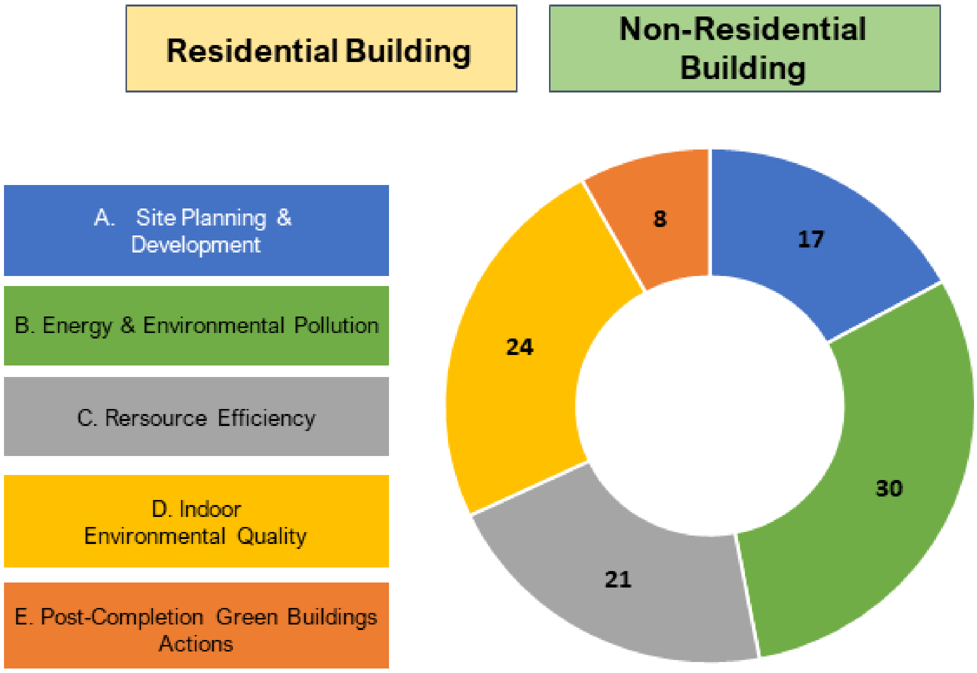


Figure 24. Weighting of the criteria of PGB2024 Certification'

2. Criteria

These six aspects of the PGBC will be applied to new buildings in a pilot project. They entail detailed evaluation criteria and metrics as summarized in Figure 25. Area-specific criteria are shown in

Appendix 4. Review Analysis on the Pakistan Green Building Certification - Energy

SUMMARY

Green buildings are gaining widespread recognition as an important pathway for reducing greenhouse gas (GHG) emissions that stem from the construction and building sectors. In a rapidly urbanizing nation of approximately 230 million people, where the construction sector significantly contributes to energy consumption and greenhouse gas emissions, the need for green buildings is extremely critical. The transition to green construction not only aligns with global sustainability practices but also contributes to energy conservation, reduced GHG emissions, and improved living conditions in Pakistan. This report highlights the energy-efficient building practices and challenges in Pakistan, highlighting country's nascent yet much needed transition towards sustainable construction practices. The work navigates through various aspects of green building adoption, including the regulatory landscape, challenges, global comparisons, and technology integration, with a focus on Pakistan's unique climate and building typologies.

Challenges in Green Building Adoption in Pakistan

Pakistan faces several challenges in embracing green building or energy efficient practices due to weak implementation frameworks for building energy codes, limited access to eco-friendly construction materials, shortage of skilled and qualified labor force, high costs associated with low-carbon construction techniques, and the predominance of subpar construction practices, particularly in rural areas. Moreover, there's a lack of awareness about the benefits of green building, and the absence of comprehensive guidelines and policies promoting green construction.

Regulatory Landscape and Governance Structure

The report highlights and provides insights into the governance structure and building regulations in Pakistan indicating the multiple stakeholders at the national, provincial and district levels involved in policy-making and implementation. One of the key areas for intervention is need for enhanced capacity development and robust enforcement mechanisms for implementing stakeholders.

Building Energy Codes

Pakistan's journey in developing and implementing building energy codes is explored, from the establishment of the first Energy Building Code in 1990 to the recent Energy Conservation Building Code 2023. The report emphasizes that these codes are yet to gain widespread adoption at the local government level while citing barriers like legal, regulatory, technical, institutional and financial challenges.

Green Building Technologies

Various green building technologies applicable to Pakistan's hot climate are discussed concentrating on sustainable construction materials, green insulation, efficient windows, cool roofs, low-emitting materials, efficient HVAC systems, solar panels, automation, efficient lighting, and water conservation.

It also underscores the cost considerations for the majority of consumers and the need for a skilled workforce to effectively implement these technologies.

Building Envelope and Energy Efficiency

The role of the building envelope in ensuring energy efficiency is underscored while emphasizing the importance of thermal resistance, vapor control, effective seals, and airflow control.

The building and construction sectors, collectively responsible for approximately 38% of greenhouse gas (GHG) emissions and accounting for 35% of total energy consumption. Developing nations, including Pakistan, are witnessing growing populations and increasing income levels. As a result, the demand for construction and infrastructure development continues its upward trajectory, leading to a surge in GHG emissions within the construction and building sector.

Pakistan's building sector significantly contributes to the nation's energy landscape, accounting for 23% of total energy consumption and a substantial 54% of the country's electricity consumption. Remarkably, the building sector (residential, commercial, and public) of Pakistan is continuously growing for the past two decades, representing a compound annual growth rate of 12.3%. This surge in demand could be attributed to rapid urbanization, resulting in increased construction activity and rising living standards.

While, the construction sector made a substantial contribution to Pakistan's GDP in FY22, amounting to approximately PKR 1,848 billion. This marks a notable growth of around 31.1% compared to the previous fiscal year when it contributed PKR 1,409 billion. On average, the construction sector's contribution to the Pakistan’s GDP stands at around 3%.

Green buildings are gaining widespread recognition as an important pathway for reducing greenhouse gas (GHG) emissions that stem from the construction and building sectors. Green buildings present a holistic approach that prioritizes environmentally friendly materials and processes, while carefully minimizing resource utilization across each phase—from design, and construction to operations and eventual demolition.

This report serves as a review of the current landscape of building construction practices, regulations, standards, and policies in Pakistan. It also delves into barriers impeding the widespread adoption of energy buildings codes within the country and outlines a strategic pathway for their effective implementation. Despite the implementation of various policies and regulatory measures, including the introduction of building energy codes, the adoption of energy-efficient and green building practices remains in its early stages in Pakistan.

The major barriers to effectively adopting energy efficient and green building practices in Pakistan are weak enforcement of building energy codes, lack of awareness of potential benefits, high upfront costs, limited access to environmentally friendly construction materials and a shortage of skilled workers. These challenges are compounded by the higher upfront costs associated with low-carbon construction methods and technologies.

It is within this context that the role of green buildings assumes vital importance, exceeding both economic and environmental perspectives. This align perfectly with Pakistan's ambitious objectives of attaining low carbon growth, as outlined in the Pakistan's Nationally Determined Contributions (NDCs). As Pakistan deals with the multifaceted challenges posed by its demographic changes and growing energy demands, the adoption of green building practices emerges as an opportunity for sustainable progress and harmonious coexistence with the environment.

However, it is also important to acknowledge the ground realities that the construction landscape in Pakistan, particularly in rural areas in most part diverges from established engineering design, construction norms, and standards. This has led to a proliferation of low-quality construction and buildings throughout the country.

Housing in Pakistan can be broadly categorized into three classes: "pukka" houses, which are constructed using substantial and durable materials such as stone, brick, cement, concrete, or timber; "kuchha" houses, characterized by their use of less-durable materials like mud, bamboo, reeds, or thatch, constituting approximately 35% of housing stock; and "semi-pukka" houses (11%), which represent a blend between the two categories. Among these, the better-quality "pukka" houses make up approximately 54% of the total.

Even in urban areas, ramshackle neighborhoods, locally known as "katchi abadis," dominate the landscape and can be found in metropolitan cities across the country. These areas typically lack proper planning and regulation, leading to a dearth of safe drinking water, adequate sanitation facilities (similar to rural areas), and buildings that often exhibit structural weaknesses and safety hazards. Alarmingly, approximately half of all urban residents in Pakistan are residing in such unplanned and underserved areas.

Addressing the disparities in construction practices and housing quality, especially in rural and informal urban settlements, remains a pressing challenge. The promotion of sustainable and green building practices, coupled with improved urban planning and infrastructure development, stands as a crucial step towards ensuring safer and more resilient living conditions for a significant portion of Pakistan's population.

2. GREEN BUILDINGS OVERVIEW

Green building is a holistic concept rooted in the understanding that the built environment can profoundly impact the natural world and its occupants. It strives to amplify positive effects and mitigate negative ones throughout a building's entire life cycle.

GREEN BUILDINGS AND THEIR CORE PRINCIPLES

Green building, also known as sustainable or high-performance building, represents the practice of developing structures and employing processes that prioritize environmental responsibility and resource efficiency. This approach spans the entire life cycle of a building, from initial site selection to design, construction, operation, maintenance, renovation, and eventual demolition. It expands upon and complements the traditional building design considerations of cost-effectiveness, utility, durability, and occupant comfort.

It is important to note that energy efficiency is the first step to green building, and as a principle all green properties should be energy efficient. Green buildings incorporate a range of environmentally friendly and resource-efficient measures throughout their life cycle. The overarching goal of this concept is to minimize a building's negative impact on the environment while maximizing its positive contributions to both the natural surroundings and the well-being of the people who inhabit it. This holistic approach not only supports sustainability but also fosters a healthy built environment. Key areas of emphasis in green building practices include the efficient use of energy, water, and other resources, ensuring high indoor environmental quality, and minimizing adverse impacts on the natural environment.

Broadly, green building adheres to planning, design, construction, and operations with following key considerations:

- Prioritize **energy efficiency** and energy-saving technologies and renewable sources.
- Promote **water conservation,** minimizing water use and often incorporating sustainable water management.
- Improve **Indoor Environmental Quality** by enhancing air quality, daylight, and thermal comfort.
- Utilize **Sustainable Construction Materials** while choosing eco-friendly, and locally sourced materials.
- Reduce **environmental impact** and preserving natural surroundings.

Thus, a green building goes beyond construction, promoting sustainability, resource efficiency, and a healthier living environment.

GREEN BUILDINGS VS. ENERGY-EFFICIENT VS. TRADITIONAL: WHAT SETS THEM APART?

Distinguishing between traditional building, energy-efficient and green buildings is important to understand the core principles construction approach and align sustainability goals. Green buildings, energy-efficient buildings, and traditional buildings differ significantly in their approach to construction and their impact on the environment. Green buildings provide a broad spectrum of sustainable practices that extend beyond energy efficiency, while energy-efficient buildings primarily focus on minimizing energy consumption. Whereas traditional buildings lack the sustainability features and efficiency measures found in both green and energy-efficient buildings.

Figure 1: Traditional buildings, energy efficient buildings and green buildings (Source: author)

Green Buildings

Green or Sustainable buildings incorporate holistic approach to reduce their environmental footprint throughout their entire life cycle. While energy efficiency is a significant consideration, green buildings go beyond this and include a range of environmental aspects, including water efficiency, waste management. Green buildings predominantly use sustainable materials in construction and take into consideration for the building's overall impact on the natural environment. Green buildings also prioritize the well-being of occupants, indoor air quality, and minimizing resource consumption for more sustainable and environmentally responsible.

Energy Efficient Buildings

While the entire focus of energy-efficient buildings is to reduce energy consumption and promote efficient energy use. They typically employ efficient technologies and strategies to optimize heating, cooling, lighting and cooking. While these buildings contribute to environmental sustainability by reducing GHG emission and lowering energy costs, their scope is limited in comparison to green buildings. Hence, energy-efficient buildings may not necessarily address other critical environmental concerns like material sourcing.

Traditional Buildings

Traditional or conventional buildings typically follow established practices without specific considerations for sustainability. While they serve their intended purposes, they tend to be less environmentally friendly compared to green or energy-efficient buildings. Traditional buildings may rely on older, less efficient technologies and materials, resulting in higher energy consumption and a larger environmental impact over their lifespan.

GLOBAL LANDSCAPE OF GREEN BUILDINGS

Green building practices have gained significant traction worldwide. With rising concerns of climate change and sustainability considerations, countries across the globe are embracing sustainability practices in construction. While many countries are widely adopting green building practices, it's important to highlight that USA, Europe, China, and India have achieve significant progress in this areas. Over the last few years, the investments in energy efficiency has seen significant growth with an annual investments amounting to over US$ 250 as highlighted in the Figure 2 below.

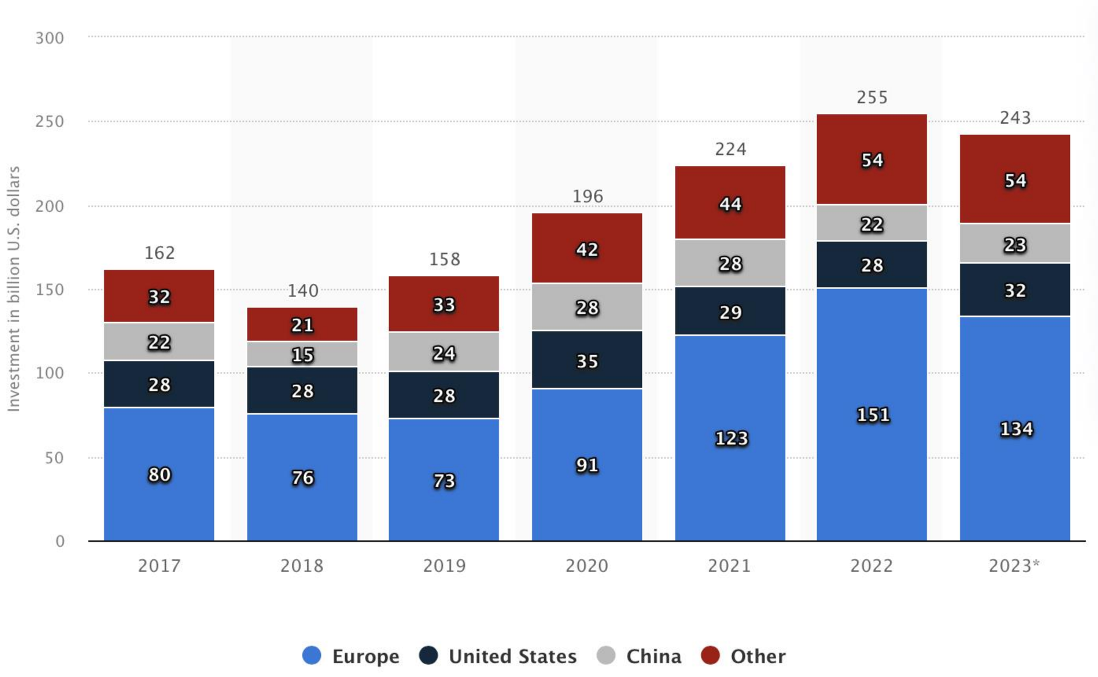


Figure 2: Annual investment in energy efficiency in the buildings sector worldwide from 2017 to 2023, in Europe, U.S. China (Source: Statista 2023)

U.S.A

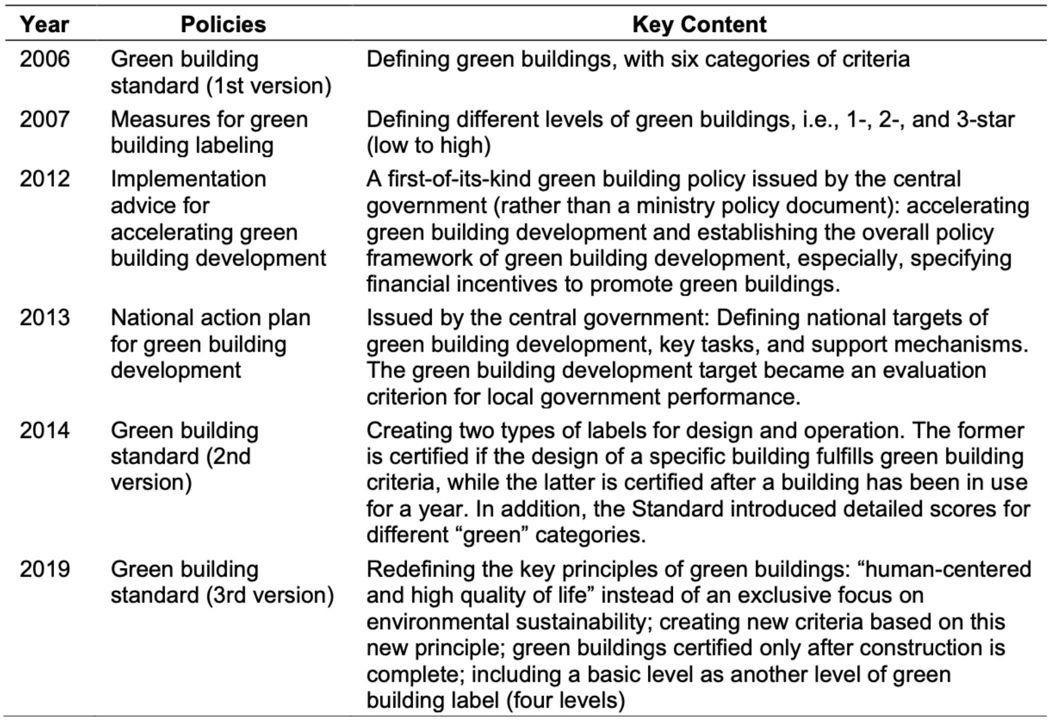
The United States is the world leader in green buildings by a significant margin. The US has been pioneering and has taken the lead in green building initiatives, thanks to organizations such as the U.S. Green Building Council (USGBC) and their successful implementation of the LEED (Leadership in Energy and Environmental Design) certification system. LEED has become a global standard for sustainable building practices, focusing on energy efficiency, water conservation, and indoor air quality. The US is proud of its diverse range of LEED-certified projects, covering residential, commercial, and public sectors.

The growth of the green building market in the United States is primarily driven by several key factors, including a progressive increase in regulations at the local, state, and federal levels, attractive financial incentives for building developers and owners, and the active role of the U.S. government in promoting sustainable development practices and reducing carbon emissions. While for the end users, operating cost savings, shorter payback periods and increased asset value in new green buildings and green retrofits are reported to be the key triggers.

CHINA

China has undergone substantial urbanization and economic expansion, resulting in a substantial increase in its building stock. Since 2006, the Chinese government has been promoting green buildings by implementing various measures, including providing information, enhancing skills, setting clear goals and regulations, offering financial incentives, and presenting examples of successful green buildings. The table 1 below outlines some of the main policies in practice to encourage green building development in China.

Table 1: Key policies regarding green buildings in China.



Year	Policies	Key Content
2006	Green building standard (1st version)	Defining green buildings, with six categories of criteria
2007	Measures for green building labeling	Defining different levels of green buildings, i.e., 1-, 2-, and 3-star (low to high)
2012	Implementation advice for accelerating green building development	A first-of-its-kind green building policy issued by the central government (rather than a ministry policy document): accelerating green building development and establishing the overall policy framework of green building development, especially, specifying financial incentives to promote green buildings.
2013	National action plan for green building development	Issued by the central government: Defining national targets of green building development, key tasks, and support mechanisms. The green building development target became an evaluation criterion for local government performance.
2014	Green building standard (2nd version)	Creating two types of labels for design and operation. The former is certified if the design of a specific building fulfills green building criteria, while the latter is certified after a building has been in use for a year. In addition, the Standard introduced detailed scores for different "green" categories.
2019	Green building standard (3rd version)	Redefining the key principles of green buildings: "human-centered and high quality of life" instead of an exclusive focus on environmental sustainability; creating new criteria based on this new principle; green buildings certified only after construction is complete; including a basic level as another level of green building label (four levels)

INDIA

Green buildings are a growing trend in India. According to the US Green Building Council, India has the second highest number of green buildings outside of the US region, following only China. It is expected to become more popular as the country moves towards a sustainable future. To promote green buildings, the government has set up various incentives and promotion schemes. The National Buildings Code of India (NBCI) and Energy Conservation Building Code (ECBC) are few of them. These measures aim to promote high-performance and energy-efficient buildings in India. The Indian government provides several incentives to encourage green building and LEED certifications in India. Some examples include:

- **Tax benefits -** The Indian government offers tax benefits to developers of LEED-certified buildings through the Income Tax Act. Developers can claim up to 100% depreciation on the cost of green building assets, such as solar panels, rainwater harvesting systems and waste management systems.

- **Loans** - The Indian government provides low-interest loans through the Indian Renewable Energy Development Agency (IREDA) for building projects with green certifications.
- **Public procurement -** The Indian government has implemented a policy that requires all government buildings to be certified green and meet green building standards.
- **State-level incentives** - Many states in India have their own policies and plans to promote green building certification, such as providing subsidies and tax exemptions to promote energy-efficient buildings and renewable energy projects.
- **Fast-track approvals** - Buildings that are certified green are eligible for incentives such as fast-track approvals, expedited inspections and reduced building fees.
- **Promotion of renewable energy** - The government also provides subsidies and tax benefits to promote renewable energy in the country; this can indirectly promote LEED-certified buildings.

EUROPEAN UNION

The European Energy Performance of Buildings Directive introduced an energy performance label for buildings from “A” to “G,” with “A” being the most energy efficient. Many European Member Countries adopted a decree requiring office buildings to have an energy performance label of “C” or higher by 2023 and an “A” label by 2030. An office building falling short of the requirements can no longer be used, sold, or leased, effectively making it a stranded asset.

Energy Performance Certificates (EPC) provide information to consumers on buildings they plan to purchase or rent. They include an energy performance rating and recommendations for cost-effective improvements. Certificates must be included in all advertisements in commercial media when a building is put up for sale or rent.

An EPC typically has two ratings: an energy label, which rates the primary energy consumption of the building, and a climate label, which rates the amount of greenhouse gases emitted. Both are given one of the seven classifications from A to G as shown in the Figure 3.

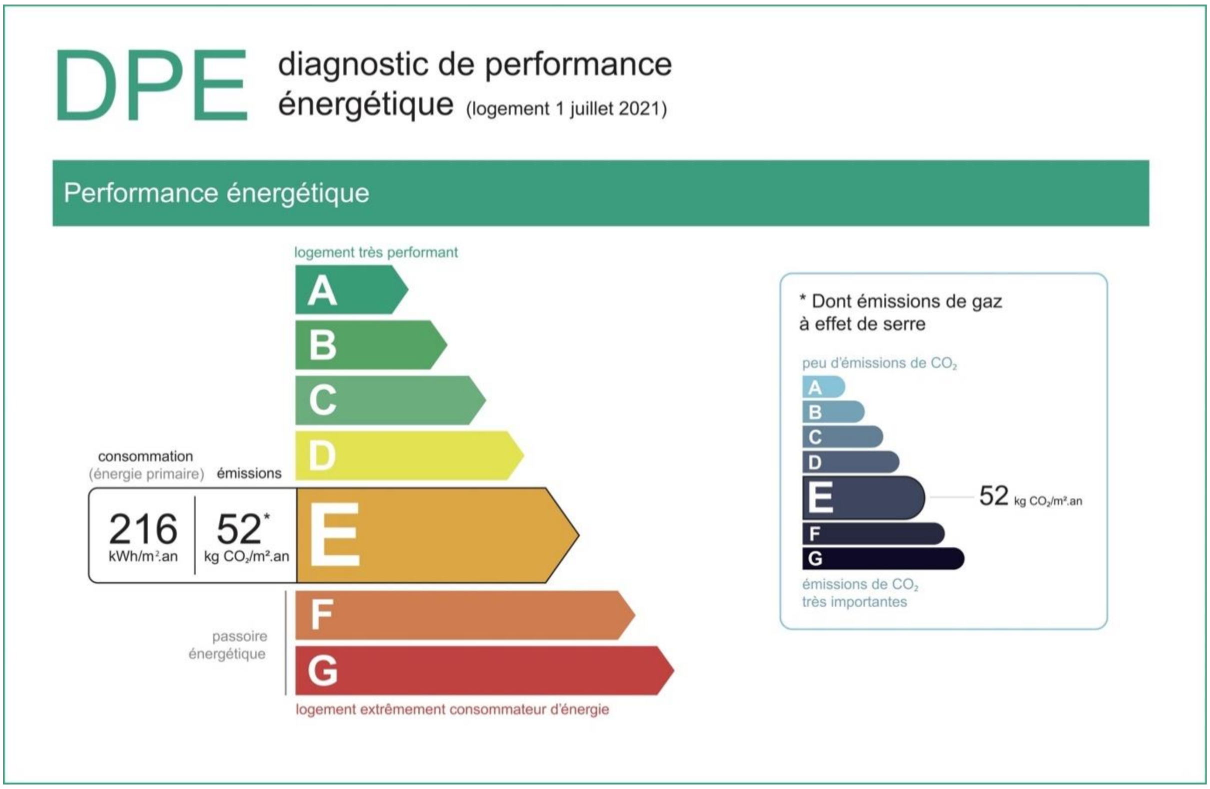


Figure 3: Energy Performance Certificate – energy and climate ratings implemented in France.

Figure 4 provides an overview of the number of green buildings in various countries, as reported by the Leadership in Energy and Environmental Design (LEED) rating system. LEED is a widely recognized certification system for sustainable and green building practices. The United States leads the pack with a substantial number of green buildings, reflecting the country's strong commitment to sustainability and environmentally friendly construction practices. China follows as the second-largest contributor to green building projects; Canada ranks third on the list. While India emerges as a prominent player in the global green building landscape, The United Arab Emirates (UAE) rounds off the top five.

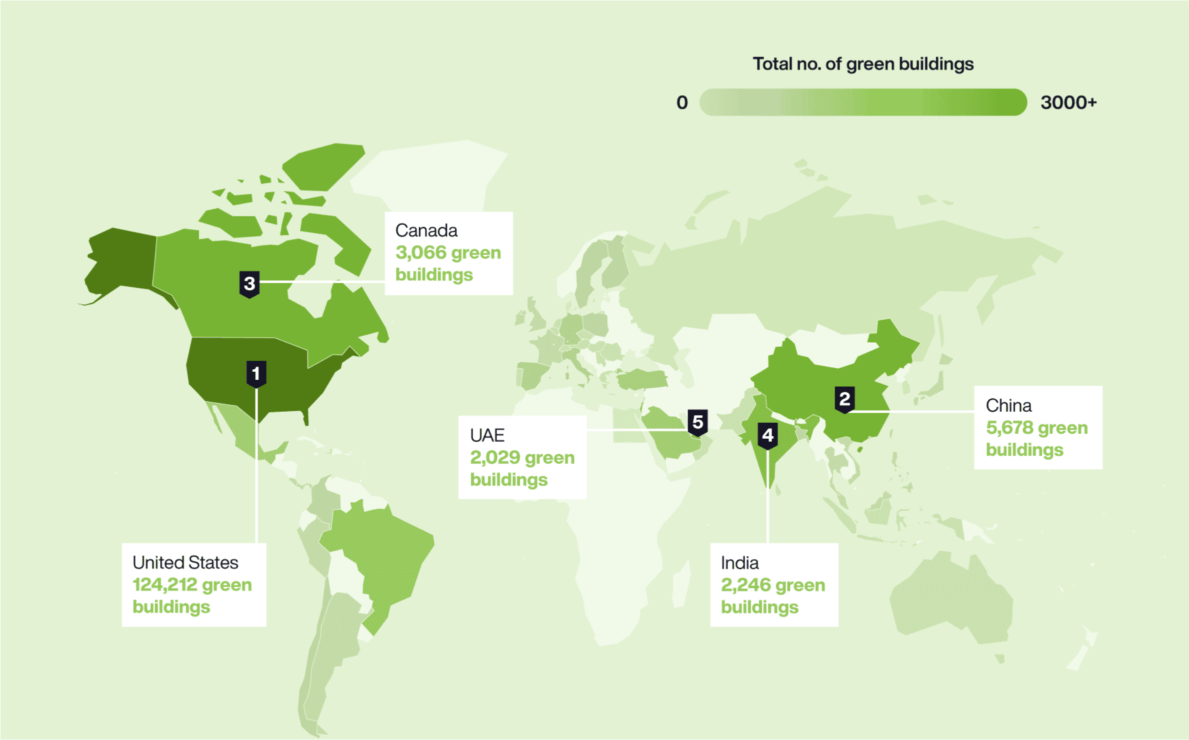


Figure 4: Countries with most green buildings in the world (Source: Uswitch)

BARRIERS AND CHALLENGES TO ADOPTION OF GREEN BUILDINGS

The primary challenge that stands out when it comes to scaling the adoption of green buildings is the high upfront cost of implementation. This high cost not only raises rental expenses but also creates hurdles in attracting both investors and tenants, making green buildings less accessible to individuals with limited capital.

While green buildings offer positive environmental benefits and play a crucial role in reducing greenhouse gas emissions, there are several challenges hindering their widespread adoption of green buildings.

Key barriers to financing green buildings include:

1. **Split Incentives** - Within the building market, an issue arises where different parties have conflicting incentives. For instance, developers may be hesitant to invest in green building design due to upfront costs, while the cost savings will primarily benefit future owners.
2. **Developer Hesitance** - Developers may be reluctant to absorb the additional upfront costs associated with green building design, especially when the financial benefits accrue over extended periods, potentially beyond their ownership.

3. **Building Longevity vs. Investment Holding Periods** - Mismatches often occur between the longevity of green buildings and the relatively short holding periods for real estate assets in investment portfolios.
4. **Minimal Landlord Incentives** - In cases where tenants are responsible for utility bills, landlords may have limited incentives to invest in energy efficient equipment.
5. **Subsidized or Government-Controlled Energy Prices** - Subsidized or government-controlled energy prices can affect the motivation to invest in energy efficiency.

In addition, lack of awareness and education is also a key challenge. There is a substantial need for increased awareness, information dissemination, and education regarding the benefits of green building, both for individual well-being and broader public benefits. Besides, limited access to technical resources also hinders the adoption. Limited access to design, construction materials, and skilled workers also impede the construction of green buildings. While in case of Pakistan, the fundamental challenge is the weak enforcement of building codes. The absence of comprehensive building codes, guidelines, standards, and policies that promote and incentivize green building practices can pose a significant challenge to their widespread adoption.

POLICY INSTRUMENTS TO PROMOTE GREEN BUILDINGS

To promote the widespread adoption of green building practices, governments and regulatory bodies worldwide have implemented a diverse array of policies and incentives. These initiatives serve as critical drivers for the integration of sustainable construction methods and the reduction of environmental impacts in the building sector.

1. Codes and Standards

One of the fundamental pillars of green building promotion is the development and enforcement of building codes and standards that prioritize energy efficiency, water conservation, and environmental responsibility. These codes set the benchmark for sustainable construction practices and ensure compliance with eco-friendly building materials and technologies.

2. Tax Incentives

Tax incentives are powerful tools to encourage green building investments. Leading countries in the green building space offer many tax credits or deductions to individuals or businesses that undertake green building projects. These incentives not only reduce the financial burden of green construction but also stimulate economic activity in the sustainable building sector.

3. Grants and Subsidies

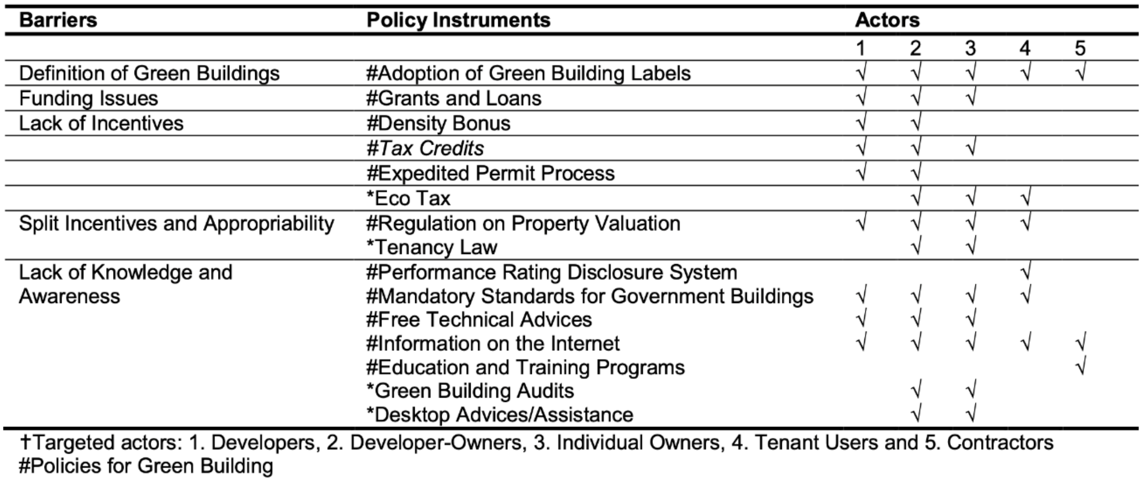
Grants and subsidies are another vital policy instrument. They provide financial support to offset the additional or premium costs associated with green building practices. These incentives are particularly valuable for individuals and organizations looking to invest in environmentally responsible construction.

4. Loans

Accessible loans with favorable terms can significantly impact green building adoption. Low-interest or green-focused loans make it more affordable for builders and homeowners to invest in sustainable construction methods and energy-efficient technologies.

5. Public Investment and Procurement

Governments can lead by example through public investment in green building projects and sustainable infrastructure. Additionally, public procurement policies that prioritize environmentally friendly construction materials and practices can drive demand for green building products and services.



Barriers	Policy Instruments	Actors				
		1	2	3	4	5
Definition of Green Buildings	#Adoption of Green Building Labels	√	√	√	√	√
Funding Issues	#Grants and Loans	√	√	√		
Lack of Incentives	#Density Bonus	√	√			
	#*Tax Credits*	√	√	√		
	#Expedited Permit Process	√	√			
	*Eco Tax		√	√	√	
Split Incentives and Appropriability	#Regulation on Property Valuation	√	√	√	√	
	*Tenancy Law		√	√		
Lack of Knowledge and Awareness	#Performance Rating Disclosure System				√	
	#Mandatory Standards for Government Buildings	√	√	√	√	
	#Free Technical Advices	√	√	√		
	#Information on the Internet	√	√	√	√	√
	#Education and Training Programs					√
	*Green Building Audits		√	√		
	*Desktop Advices/Assistance		√	√		

†Targeted actors: 1. Developers, 2. Developer-Owners, 3. Individual Owners, 4. Tenant Users and 5. Contractors
#Policies for Green Building

Table 2: barriers and policy instruments to promote green buildings by engaging key stakeholders.

Table 2 provides a snapshot of key barriers and corresponding policy instruments with indication of key actors involved in green building practices.

COST OF BUILDING GREEN

The cost of building green is not a one-size-fits-all proposition but varies significantly based on numerous factors, including local climatic conditions, the availability and cost of eco-friendly building materials, the accessibility of energy- and water-efficient equipment, and the presence of technical expertise in green construction. Consequently, determining an exact cost for green building across different countries can be challenging due to these varying influences.

Figure 5: Cost of Green Buildings over Time

Numerous studies suggest that green building projects typically incur an additional cost ranging from 5% to 15% when compared to conventional construction methods. However, what makes green building particularly attractive is the relatively short payback period, usually falling within the range of 3 to 5 years. This means that the upfront investment in green building practices is often recouped through operational cost savings and efficiency gains within a relatively short timeframe.

Due to the limited availability of comprehensive data, determining the precise cost premium associated with green building in Pakistan remains a challenge. The cost dynamics of green building can vary significantly based on local conditions, materials, and practices, making it essential to gather specific and regionally relevant data for accurate assessments. It is reasonable to assume that the additional investment or premium cost associated with building green can pose a primary barrier to the widespread adoption of green buildings in developing countries, particularly in the case of Pakistan.

However, while specific cost premiums may not be readily available, it's important to acknowledge the broader trends and principles associated with green building. Generally, green building practices may involve a high initial upfront investment compared to conventional construction methods, though lower operating costs over the period of building reduces the total cost of ownership as presented in the Figure 5.

Certified green buildings offer a range of tangible benefits, including lowered operating expenses and enhanced resource efficiency. These benefits manifest in reduced utility bills, decreased waste output, and lower maintenance costs. In terms of energy and water consumption, green buildings can achieve savings exceeding 20% compared to conventional buildings. This translates to substantial savings for green homeowners, typically ranging from 15% to 20% on their utility bills. In the commercial sector, green buildings have demonstrated remarkable cost-effectiveness, with operating expenses falling between 18% and 37% lower than those of traditional buildings.

3: GOVERNANCE STRUCTURE AND BUILDING REGULATIONS IN PAKISTAN

The governance structure and building regulations in Pakistan are multifaceted, involving multiple layers of stakeholders at the national, provincial and district levels. A sporadic regulatory framework of energy efficient buildings in Pakistan is in place, though it is not uniform across different parts of the country. Therefore, the enforcement and compliance to building regulations vary significantly across the country and there are serious governance issues in the construction industry in Pakistan.

NATIONAL LEVEL OVERSIGHT ON BUILDING RELATED POLICY AND REGULATIONS

These are the key stakeholders at National Level in Pakistan and play a significant role in policy formulation and the establishment of regulatory frameworks, although they typically do not directly oversee the enforcement of these standards at the operational level.

1. **Ministry of Housing and Works** - At the national level, the Ministry of Housing and Works plays a pivotal role in setting the governing framework for buildings and construction, particularly for federal agencies. This ministry provides policy guidance and regulatory oversight to promote safe and sustainable building practices for Federal Government owned buildings.
2. **Pakistan Engineering Council (PEC)** - The enactment of a building code comes under the purview of PEC (Act of 1975-Section 25). Thus, PEC is responsible for developing the Building Codes of Pakistan and monitoring construction and engineering works. PEC also plays a critical role in establishing construction standards for engineering and construction firms in Pakistan.
3. **Pakistan Council of Architects and Town Planners (PCATP) -** PCATP is instrumental in regulating and accrediting professionals in the fields of architecture and town planning. Their involvement ensures that building designs adhere to best practices in urban planning and architecture.
4. **National Energy Efficiency and Conservation Authority (NEECA)**: NEECA operates under the Ministry of Energy and is tasked with developing Energy Building Codes to promote energy-efficient construction practices. This authority focuses on achieving energy efficiency goals in the construction sector.

PROVINCIAL AND DISTRICT LEVEL GOVERNANCE AND IMPLEMENTATION

In Pakistan, the building regulations for implementation involve various government entities and building authorities at both the provincial and local levels. These entities have distinct roles and responsibilities pertaining to construction standards and practices, yet their effectiveness in achieving their objectives has faced challenges.

Each province has its own relevant Department of Urban Development and Housing which are tasked with overseeing urban development and housing initiatives within their respective provinces, including the formulation and implementation of building regulations. While Building Control

Authorities at the provincial level regulate construction practices, and issue building permits down to the district level and are responsible for ensuring compliance with local building codes.

Moreover, in major urban centers such as Karachi, Islamabad, and Lahore, Development Authorities are responsible for developing and enforcing their own local building by-laws. District Building Control Authorities also play a role in scrutinizing building designs, conducting on-site inspections of construction projects, and issuing occupancy permits. Then there are Municipal and Town corporations with jurisdiction over specific areas and enforce their own building by-laws and regulations. Additionally, there are Cantonment Areas, which maintain their own governance structures and building by-laws, operating independently from municipal regulations.

Despite this multi-layered framework and institutions, the effectiveness of these agencies in delivering their objectives has faced challenges, raising questions about their ability to consistently enforce building regulations and ensure compliance with building codes across the country.

COMPLIANCE AND IMPLEMENTATION OF BUILDING CODES

In Pakistan, compliance with building codes is primarily the responsibility of design professionals, contractors while provincial and building authority officials are responsible for enforcement of the building codes. However, it's important to note that the enforcement framework is still evolving and significantly vary in maturity across different cities.

Compliance mechanisms typically involve verifying proposed designs in alignment with local building by-laws. In some major cities like Karachi, Islamabad and Lahore; there is a growing trend to vet structural designs, although this practice is not yet common in all urban areas.

For government-owned buildings, construction is supervised either by nominated consultants or by the government organization itself, ensuring adherence to approved designs and specifications. While building designs often align with the Building Codes of Pakistan, construction quality may vary and may not always conform to standard specifications.

BUILDING ENERGY CODES IN PAKISTAN

PAKISTAN BUILDING ENERGY CODE 1990

The establishment of building energy codes in Pakistan falls within the jurisdiction of the Pakistan Engineering Council (PEC), as outlined in the PEC Act of 1975 (Section 25). Any code pertaining to building construction undergoes review and approval by the PEC. Earlier, energy conservation efforts in Pakistan have been undertaken by the National Energy Conservation Centre (ENERCON), established as part of a USAID project in 1985 under the Ministry of Planning & Development.

Pakistan's first-ever Energy Building Code was introduced in 1990. ENERCON, in collaboration with the Environment and Urban Affairs Division, developed this Building Energy Code for Pakistan as an addendum to the Building Code of Pakistan 1986 (BCP 1987), which served as Pakistan's First National Building Code. It is worth noting that this code operated as an advisory guideline and was not made mandatory.

Over the years, the administrative oversight of ENERCON has shifted. In 1993, it was transferred to the Ministry of Water and Power and subsequently to the Ministry of Environment in 1996. In 1997, ENERCON became an attached department of the Ministry of Environment but was later transferred back to the Ministry of Water and Power in 2011.

In 2007, Pakistan revised and published its second Building Code of Pakistan (BCP 2007), prompted by the devastating earthquake in 2005, with a focus on strengthening seismic provisions. BCP 2007 established minimum regulations for earthquake considerations in building systems. Notably, BCP 2007 draws heavily from the Uniform Building Code (UBC) 1997, with indigenous adjustments primarily in seismic zonation. Buildings designed under BCP 2007 adhere to design specifications closely aligned with UBC 97. Material specifications are referenced to ASTM specifications, governing the quality assurance of materials such as steel, concrete, and bricks.

PAKISTAN BUILDING ENERGY CODE 2011 (ENERGY PROVISIONS 2011)

In 2011, ENERCON, in collaboration with the Pakistan Engineering Council (PEC), initiated the development of a new Building Energy Code for Pakistan, referred to as Energy Provisions-2011. This code received official endorsement from PEC and was officially introduced in 2013. Energy Provisions-2011 initially featured a single climate zone for building envelopes, primarily based on ASHRAE Standard 90.1 - 2013, with Pakistan being designated as Climate Zone 1, centered around Karachi. However, recognizing the country's diverse climate conditions, the code did not serve the purpose in terms of climate zoning to address thermal performance across various part of the country.

Energy Provisions-2011 established minimum energy efficiency requirements and was tailored to guide the design and construction of new high-end residential and commercial buildings, as well as specific building clusters meeting defined criteria. These criteria included a total connected load of 100 kW or more, a contract demand of 125 kVA or greater, a conditioned area exceeding 900 m^3, or unconditioned buildings with a covered area exceeding 1200 m^2. Consequently, Energy Provisions-2011 had a limited scope, primarily targeting larger institutional, commercial, and industrial buildings.

In 2016, ENERCON underwent a transformation, evolving into the National Energy Efficiency and Conservation Authority (NEECA) through NEECA Act 2016, functioning as an attached department within the Ministry of Water and Power. It is important to note that while the first energy conservation building code for Pakistan was introduced by ENERCON in 1990, its practical implementation remained voluntary. Following the 18th amendment in Pakistan's constitution, NEECA's provincial responsibilities were transferred to provincial energy departments.

NEECA ENERGY CONSERVATION BUILDING CODE (ECBC) 2023

In 2023, NEECA introduced the Energy Conservation Building Code 2023 (ECBC-2023), representing a revised and updated version of the Building Code of Pakistan (Energy Provisions-2011). ECBC-2023 is designed to incorporate state-of-the-art technologies, facilitating the implementation of energy efficiency and conservation measures. This updated code primarily targets high-end domestic and commercial consumers, aiming to conserve energy while maintaining public safety.

ECBC-2023 includes various aspects, including building envelope optimization, passive building design principles, building insulation, retrofitting of existing buildings for enhanced energy efficiency, energy analysis through monitoring devices, exploration of renewable and geothermal energy integration within buildings, and the introduction of energy management systems.

The scope of this code has been expanded and applies to buildings and building clusters that meet specific criteria, including a total connected load of 50 kW or greater, a contract demand of 75 kVA or greater, a conditioned area of 200 m² or more, or unconditioned buildings with a covered area exceeding 300 m². It extends its coverage to fully detached, semi-detached, and un-detached residential as well as commercial buildings.

Local authorities play a significant role in the implementation of ECBC-2023, particularly as part of the building construction permit application and approval process. Additionally, the code is designed to undergo periodic revisions every three years to ensure its continued relevance and effectiveness. Its comprehensive coverage includes energy-efficient and low-emission construction materials, passive building design principles, energy appliance monitoring devices, electric vehicle charging infrastructure, energy management systems, building insulation, and the integration of renewable and geothermal energy solutions.

PUNJAB BUILDING ENERGY CONSERVATION BUILDING CODE 2017

As per the provisions of the NEECA Act 2016, provinces were granted the authority to amend, enhance, or develop their own Building Energy Codes tailored to local climatic conditions. Punjab took the lead in establishing the Punjab Energy Efficiency and Conservation Agency (PEECA) in 2016, following the enactment of the National Energy Efficiency and Conservation Act-2016. All provinces were encouraged to establish energy efficiency and conservation bodies. PEECA commenced work on reviewing and modifying the code originally developed by ENERCON/NEECA, known as the Pakistan Building Code (Energy Provisions-2011). Punjab introduced Punjab Building Energy Conservaiton Building Code 2017. In accordance with Energy Provisions – 2011), this code was applicable to buildings and building clusters that have a total connected load of 100 kW or greater, or a contract demand of 125 kVA or greater, or a conditioned area of 900 m^2 or greater, or an unconditioned building of covered area of 1,200 m^2 or more.

PAKISTAN GREEN BUILDING GUIDELINES 2016

Pakistan Green Building Guidelines were established by Pakistan Green Building Council (PGBC). This serves as a reference guide of building design and construction in Pakistan. PGBC is a non-profit organization dedicated to fostering a sustainable future in Pakistan through the promotion of resource-efficient green buildings and communities, emphasizing cost savings, energy efficiency, water conservation, and responsible use of natural resources. Pakistan GBC is currently a prospective member of the World Green Building Council, it serves as the exclusive representative of the World GBC within Pakistan.

Pakistan Green Building Council PGBC has developed its own rating system based on Pakistan-specific Green Building Guidelines. The first version of SEED-Sustainability in Energy and Environmental Development is published in Oct 2016 by PGBC. SEED is aims to address sustainable and socially responsible thinking about how buildings and communities are planned, constructed, maintained, and operated There are four tiers in certification depending on the points achieved by a building. The certifications are silver, gold, platinum, and titanium; the last one being the highest point scored.

PEC GREEN BUILDING CODE OF PAKISTAN 2023

Recently Pakistan Engineering Council (PEC) released the Green Building Code of Pakistan in May 2023 based on the 2021 edition of the International Green Construction Code (IgCC) as reported by International Code Council (ICC) In 2016, EU SWITCH-Asia in collaboration with the Ministry of Climate Change, UN Environment, and UN Habitat-Pakistan launched the Sustainable Consumption and Production (SCP) Programme in Pakistan, focused on the SDG-12 and provided guidelines for the transformation of the conventional built practices into a green built environment across Pakistan.

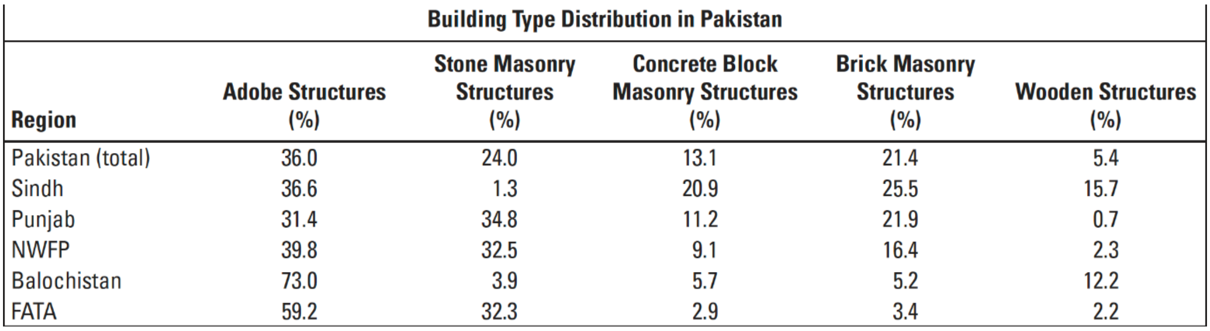
As part of this program, EU SWITCH-Asia SCP Programme, UN Environment, and UN-Habitat successfully developed Policy Guidelines - Green Building Code for Pakistan, in line with the commitment of the Government to pursue climate resilient and green development initiatives.

The Ministry of Climate Change along with relevant stakeholders including Pakistan Engineering Council is working on the development of the Green Building Code for greening the Building Construction Sector in Pakistan.

ASSESSMENT OF BUILDING GROUPS AND TYPES IN PAKISTAN

Access to comprehensive data on building stock presents a considerable challenge in Pakistan, primarily due to the fragmented nature of the construction industry. With numerous stakeholders at the federal, provincial, and district levels, a centralized repository of information is challenging to establish. While the Pakistan Bureau of Statistics is a key resource for such data, it currently offers limited information without a clear breakdown of building types, such as residential, commercial, office spaces, or other categories.

The majority of the building stock consists of non-engineered structures. According to the Pakistan Bureau of Statistics, housing in Pakistan falls into three broad categories: "pukka" houses, constructed using durable materials like stone, brick, cement, concrete, or timber; "kuchha" houses, constructed with less durable materials like mud, bamboo, reeds, or thatch, constituting approximately 35% of the housing stock; and "semi-pukka" houses (11%), representing a hybrid between the two. Among these, the higher-quality "pukka" houses make up approximately 54% of the total housing stock.



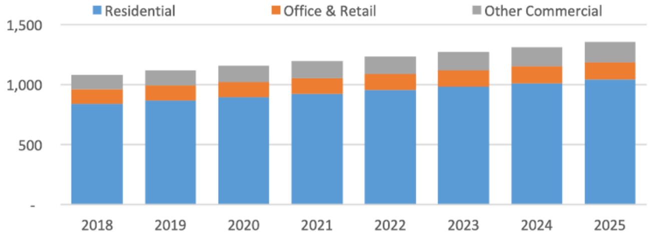
Building Type Distribution in Pakistan

Region	Adobe Structures (%)	Stone Masonry Structures (%)	Concrete Block Masonry Structures (%)	Brick Masonry Structures (%)	Wooden Structures (%)
Pakistan (total)	36.0	24.0	13.1	21.4	5.4
Sindh	36.6	1.3	20.9	25.5	15.7
Punjab	31.4	34.8	11.2	21.9	0.7
NWFP	39.8	32.5	9.1	16.4	2.3
Balochistan	73.0	3.9	5.7	5.2	12.2
FATA	59.2	32.3	2.9	3.4	2.2

Table 3: Building Stock Distribution by type of Construction.

The building stock in the Pakistan can be classified into five categories depending upon the material used in walls and roofs. Regarding building types, Pakistan features diverse construction typologies, including brick masonry, block masonry, stone masonry, adobe masonry, reinforced concrete structures, and wooden and timber constructions. The distribution of buildings in Pakistan encompasses adobe structures (36%), stone masonry (24%), concrete block masonry (21%), brick masonry (21.4%), and wooden and timber constructions (5.4%) as highlighted in Table 3. Reinforced concrete (RC) frame structures are predominantly found in urban areas and constitute a relatively small percentage of the overall building stock in Pakistan. Due to their limited prevalence compared to other construction types, RC structures are not separately categorized in the building type distribution. Instead, they are included within the broader classification of brick masonry structures in Table 3.

According to the International Finance Corporation, the Pakistani building market consists of 79% residential buildings and 21% commercial buildings as highlighted in Figure 6. In terms of area, residential spaces encompass around 1,000 million square meters, while office, retail, and other commercial spaces occupy over 300 million square meters in Pakistan. The total real estate market size is projected to exceed $290 billion by 2025, with the commercial market accounting for $54 million and the residential market exceeding $234 million. However, the green building market's share remains relatively small, at less than $10 billion, and its growth is expected to be gradual in the coming years.



Market through 2025	Total market	Green market
Commercial	USD 53.45 B	USD 1.55 B
Residential	USD 232.6 B	USD 9.84 B
Total Residential Units	3,100,000	140,000

Figure 6: Composition of Building Market Space in in Pakistan by Commercial, residential and office space. (Source: International Finance Cooperation IFC)

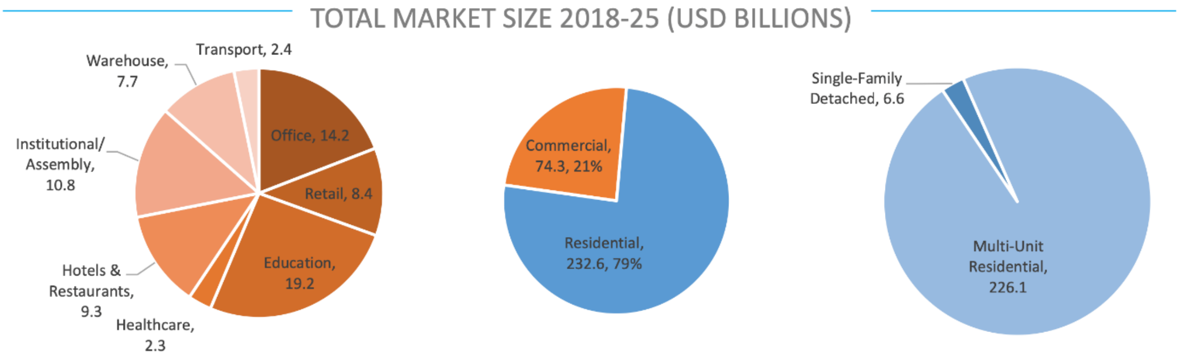
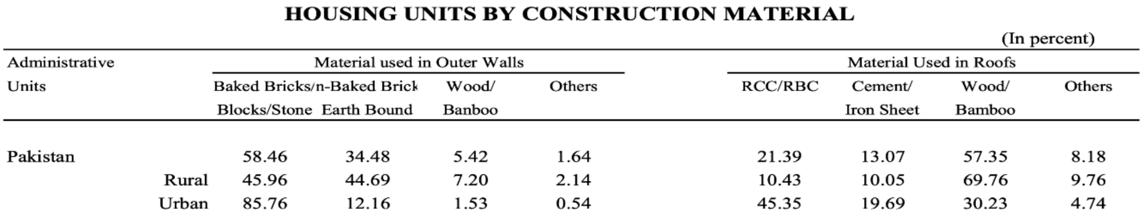


Figure 7: Total Market Size of Buildings in Pakistan (Source: International Finance Cooperation IFC)

Table 5 presents the description of the main load-bearing elements in different building types in Pakistan. Primary elements are the vertical load-bearing members. Secondary elements are the horizontal load-bearing members, while tertiary elements are the floors and roofs.

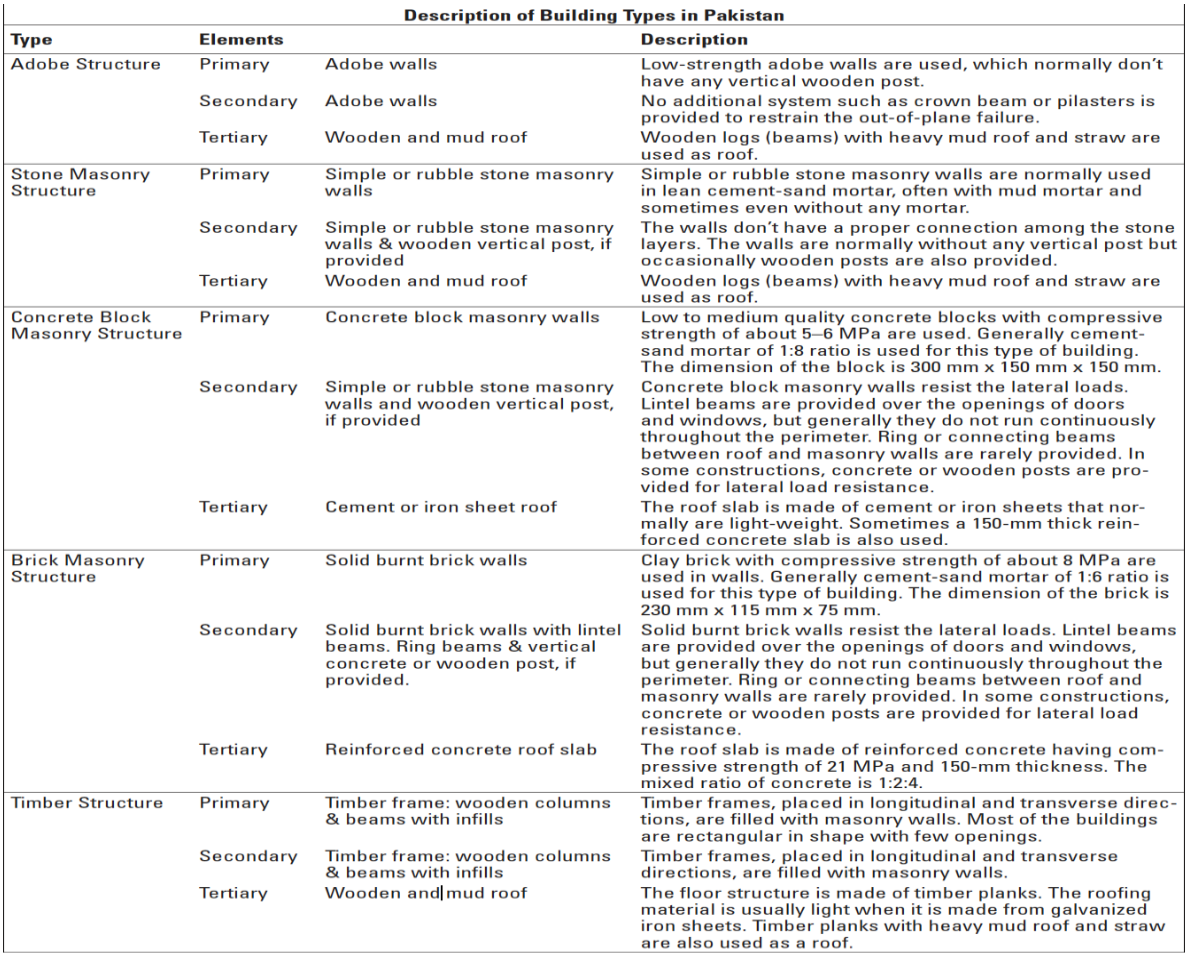


HOUSING UNITS BY CONSTRUCTION MATERIAL

(In percent)

Administrative Units		Material used in Outer Walls				Material Used in Roofs			
		Baked Bricks/ Blocks/Stone	n-Baked Brick Earth Bound	Wood/ Banboo	Others	RCC/RBC	Cement/ Iron Sheet	Wood/ Bamboo	Others
Pakistan		58.46	34.48	5.42	1.64	21.39	13.07	57.35	8.18
	Rural	45.96	44.69	7.20	2.14	10.43	10.05	69.76	9.76
	Urban	85.76	12.16	1.53	0.54	45.35	19.69	30.23	4.74

Table 4: Housing Units in Pakistan by Construction Material (Source: Pakistan Bureau of Statistics)



Description of Building Types in Pakistan

Type	Elements		Description
Adobe Structure	Primary	Adobe walls	Low-strength adobe walls are used, which normally don't have any vertical wooden post.
	Secondary	Adobe walls	No additional system such as crown beam or pilasters is provided to restrain the out-of-plane failure.
	Tertiary	Wooden and mud roof	Wooden logs (beams) with heavy mud roof and straw are used as roof.
Stone Masonry Structure	Primary	Simple or rubble stone masonry walls	Simple or rubble stone masonry walls are normally used in lean cement-sand mortar, often with mud mortar and sometimes even without any mortar.
	Secondary	Simple or rubble stone masonry walls & wooden vertical post, if provided	The walls don't have a proper connection among the stone layers. The walls are normally without any vertical post but occasionally wooden posts are also provided.
	Tertiary	Wooden and mud roof	Wooden logs (beams) with heavy mud roof and straw are used as roof.
Concrete Block Masonry Structure	Primary	Concrete block masonry walls	Low to medium quality concrete blocks with compressive strength of about 5–6 MPa are used. Generally cement-sand mortar of 1:8 ratio is used for this type of building. The dimension of the block is 300 mm x 150 mm x 150 mm.
	Secondary	Simple or rubble stone masonry walls and wooden vertical post, if provided	Concrete block masonry walls resist the lateral loads. Lintel beams are provided over the openings of doors and windows, but generally they do not run continuously throughout the perimeter. Ring or connecting beams between roof and masonry walls are rarely provided. In some constructions, concrete or wooden posts are provided for lateral load resistance.
	Tertiary	Cement or iron sheet roof	The roof slab is made of cement or iron sheets that normally are light-weight. Sometimes a 150-mm thick reinforced concrete slab is also used.
Brick Masonry Structure	Primary	Solid burnt brick walls	Clay brick with compressive strength of about 8 MPa are used in walls. Generally cement-sand mortar of 1:6 ratio is used for this type of building. The dimension of the brick is 230 mm x 115 mm x 75 mm.
	Secondary	Solid burnt brick walls with lintel beams. Ring beams & vertical concrete or wooden post, if provided.	Solid burnt brick walls resist the lateral loads. Lintel beams are provided over the openings of doors and windows, but generally they do not run continuously throughout the perimeter. Ring or connecting beams between roof and masonry walls are rarely provided. In some constructions, concrete or wooden posts are provided for lateral load resistance.
	Tertiary	Reinforced concrete roof slab	The roof slab is made of reinforced concrete having compressive strength of 21 MPa and 150-mm thickness. The mixed ratio of concrete is 1:2:4.
Timber Structure	Primary	Timber frame: wooden columns & beams with infills	Timber frames, placed in longitudinal and transverse directions, are filled with masonry walls. Most of the buildings are rectangular in shape with few openings.
	Secondary	Timber frame: wooden columns & beams with infills	Timber frames, placed in longitudinal and transverse directions, are filled with masonry walls.
	Tertiary	Wooden and mud roof	The floor structure is made of timber planks. The roofing material is usually light when it is made from galvanized iron sheets. Timber planks with heavy mud roof and straw are also used as a roof.

Table 5: Description of the main load-bearing elements in different building types in Pakistan.

CURRENT PRACTICES IN CONSTRUCTING BUILDINGS IN PAKISTAN.

As emphasized in the previous section, the adoption and enforcement of Building Energy Codes in Pakistan remain non-mandatory and face significant challenges in garnering support from local governments. To date, none of the local councils have officially embraced the adoption of these Building Energy Codes in true sense, which demonstrates the presence of legal, regulatory, technical, institutional, and financial obstacles in construction practices in the country.

In urban centers, there exists a degree of regulatory compliance and enforcement that leads to a notably higher quality of construction compared to other parts of the country. However, the construction practices in rural areas raise substantial concerns. The construction in these areas is often unplanned, illegal, unsafe, and unhygienic.

One of the critical concerns related to such construction practices in Pakistan is their vulnerability to natural disasters, particularly earthquakes and floods. Many buildings in rural areas lack the structural integrity necessary to withstand seismic activity and other natural calamities. This vulnerability leads to tragic consequences, including the loss of human lives, livestock, and valuable resources.

PIONEERING GREEN BUILDING LEED CERTIFICATIONS IN PAKISTAN

The total area covered by Green Buildings as referred as LEED-certified buildings in Pakistan currently stands at an impressive 13.25 million square feet. This encouraging trend in LEED certification becomes evident when comparing the present scenario to that of 2014 when there were merely 10 LEED-certified buildings. Currently, Pakistan has over 60 such certified structures, highlighting a significant upsurge in the adoption of sustainable and environmentally responsible building practices across the country.

The Leadership in Energy and Environmental Design (LEED) is a certification program primarily designed for new commercial building projects, utilizing a point-based system to assess and rate the environmental sustainability of a structure.

The LEED rating is determined by the number of points a building accumulates, reflecting its level of "greenness" in terms of energy efficiency, water conservation, air quality, and the use of environmentally friendly building materials, both during construction and throughout its operational life. LEED-certified buildings are categorized based on their credit points: 40-49 credits for LEED-certified, 50-59 for LEED Silver, 60-79 for LEED Gold, and 80 or more credits earn the prestigious LEED Platinum designation. Projects seeking LEED certification earn points in various categories, including energy efficiency and indoor air quality.

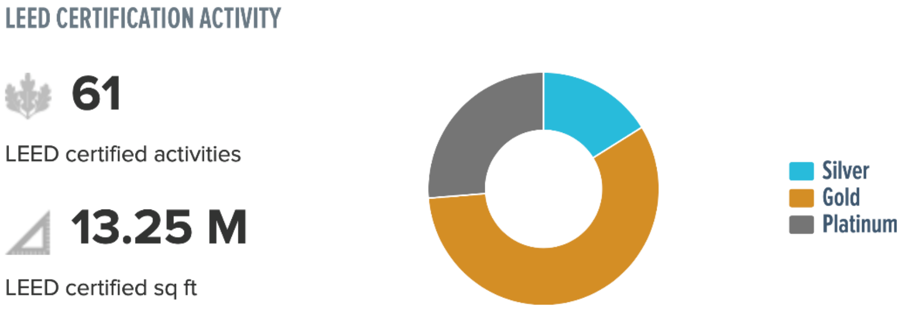


Figure 8: LEED Certification Activity Snapshot in Pakistan

According to the Green Building Information Gateway (GBIG), Pakistan boasts over 60 LEED-certified green buildings recognized by the US Green Building Council, with an additional 2 buildings receiving the Achiever Award. Notably, more than a quarter (26%) of these certified buildings have achieved the highest Platinum rating, followed by Gold-rated buildings comprising 57%, and Silver-rated structures making up 16% of the total. This indicates a significant presence of green building projects in Pakistan that prioritize sustainability and environmental performance across various categories.

5. BUILDING ENVELOPE AND BUILDING PERFORMANCE

A building envelope serves as a protective shield that separates the interior of a building from the external environment, including its walls, roofs, fenestration (doors and windows), and insulation. Its primary function is to ensure the comfort and well-being of occupants by regulating the transfer of heat, air, and moisture between the inside and outside of the building.

What sets energy-efficient building envelopes apart is their ability to do more than just create a barrier; they actively respond to the surrounding environment, leading to significant reductions in energy consumption. These envelopes are designed with advanced features like high-quality thermal insulation, effective vapor barriers, superior seals for windows and doors, and mechanisms to control airflow, thereby minimizing the infiltration of outdoor air. These elements work in unison to maintain a comfortable and energy-efficient indoor environment.

Climate type	**Design strategies for energy-efficient facades**
Heating-dominated	The building envelope receives solar heating. Walls can be used as thermal masses for thermal storage. Better insulation to minimize thermal losses. Natural daylight is used. Facades have increased glazing areas to allow for natural light; light shelves that redirect light into interior spaces are used.
Cooling-dominated	Appropriate shading techniques can be employed to protect from direct solar gain. Use insulation to reduce solar heat gain. Design to facilitate natural ventilation (wing walls).

	Natural daylight should be used in such a way that solar heat gain is minimized.
Mixed climates	Use shading devices to protect facade from direct solar radiation during warm days. Use passive solar design for heating during cold seasons. Use natural daylight and with increased glazed areas of walls with shading devices.

Table 6: Climate-specific design of energy efficient envelopes.

A building envelope acts as a barrier that separates the interior from the external world. It's similar to the shell of a building, offering defense against the elements outside.

During the winter, the building envelope plays a crucial role in preventing the escape of indoor heat to the cold outdoors. Conversely, in the scorching summer months, it keeps the cool air inside while fending off the sweltering heat.

In a country like Pakistan, where the demand for cooling is high across much of the nation, the design of the building envelope must be carefully orchestrated to cater to these cooling requirements. This involves considering factors that enhance energy efficiency and minimize the need for excessive cooling.

Building envelope systems are typically categorized as either "tight" or "loose." A tight building envelope minimizes air leaks, achieved through meticulous insulation, sealants, and energy-efficient windows. Why strive for such a tight seal? It grants occupants greater control over the indoor environment, ensuring comfort and energy efficiency.

In hot climates like Pakistan's, the design of an energy-efficient building must focus on preventing air and moisture infiltration and reducing heat gains. Achieving this involves creating a tight building envelope, as well as thoughtful considerations such as building orientation, size, shape, and the selection of appropriate windows and doors. These elements together contribute to a building's ability to combat the challenges posed by high temperatures and ensure a comfortable indoor climate.

Figure 9: Illustration of the flow of energy through a building. The amount of energy supplied from an external source is less than the total heat loss of the building, because occupants, electrical devices and especially windows add "free" energy.

6. GREEN BUILDING TRANSFORMATION: TECHNOLOGY OPTIONS AND PATHWAYS

In Pakistan, traditional construction practices often avoid the incorporation of efficient and green technologies. Upfront cost is a major consideration when it comes to the selection and integration of sustainable and efficient technologies in Pakistan. For most consumers, especially in a developing economy like Pakistan, the upfront expenses associated with adopting these technologies can be a significant barrier. Many households and businesses operate on tight budgets, making it challenging to justify the initial investment in green technologies, even though they offer long-term savings and environmental benefits.

Green building technologies cover across both the construction and operational phases of green buildings and offers a comprehensive approach to sustainable development. Below are some technology options for Pakistani Green Building Market often used in Green Buildings worldwide.

Sustainable Construction Materials: Green buildings prioritize the use of sustainable construction materials that offer better thermal insulation and reduce heat absorption. Examples include recycled materials, thermal mass construction, and reflective surfaces.

Green Insulation: Green buildings incorporate insulation materials that provide high thermal resistance, helping to maintain cooler indoor temperatures and reduce the need for excessive air conditioning.

Variable Drives: Variable drives and efficient Heating, Ventilation and Air Condition (HVAC) systems enable precise control of air conditioning and ventilation, optimizing energy use.

Efficient Windows: Energy-efficient windows with low solar heat gain coefficients allow natural light while blocking excess heat, reducing the reliance on artificial lighting and cooling systems.

Cool Roofs: Cool roofs are designed to reflect sunlight and absorb less heat and these are highly effective in hot climates. Cool roofs keep buildings cooler, thus reducing the overall cooling load.

Low Emitting Materials: Green buildings prioritize low emitting materials which release fewer volatile organic compounds (VOCs). This not only improves indoor air quality but also reduces the heat generated by off-gassing materials.

Efficient Heating, Ventilation, Air Conditioning (HVAC): High-efficiency HVAC systems with advanced controls ensure precise temperature control, reduce energy consumption and enhance indoor comfort.

Solar Panels (Passive and Active): Solar panels are a key feature in green buildings for both passive and active design elements, such as optimum shading and orientation, maximize natural cooling, while active solar panels harness the solar radiation for onsite energy generation.

Automation, Controls, and Building Monitoring: Advanced automation and control systems help optimize energy use by adjusting lighting, HVAC, and other systems based on occupancy and outdoor conditions.

Efficient Lighting: Efficient lighting solutions, including LED technology and occupancy sensors, reduce electricity consumption.

Water Conservation: Water-efficient fixtures and systems ensure water resources conservation and efficiency. Green buildings incorporate low-flow faucets and rainwater harvesting systems to minimize water consumption.

COST BENEFIT OF ANALYSIS OF GREEN BUILDINGS TECHNOLOGY MEASURES

The majority of research on the advantages of green buildings primarily stems from studies concentrated on developed economies. In contrast, there exists a limited amount of well-structured data regarding green buildings and their economic merits within developing nations, including Pakistan. Green buildings are characterized by their superior efficiency compared to conventional buildings, and have the potential to decrease operational expenses, boost income streams, and mitigate the risks associated with both the physical and transitional aspects of climate change. This section investigates into multiple case studies that underscore the business rationale and economic advantages of adopting green building technologies, particularly the building insulation, solar PV integration and efficient lighting.

BUILDING INSULATION IMPACT ON ENERGY AND COST SAVINGS IN HOT CLIMATES: SAUDI CASE STUDY

Building insulation plays a pivotal role in enhancing the energy efficiency and overall sustainability of structures. In this comprehensive analysis, we evaluate four distinct insulation strategies, ranging from having no insulation to insulating either the roof or walls individually, and a combination of both. The primary focus is on quantifying the benefits of building insulation, particularly in terms of cost and energy savings.

Since there is a limited information and reliable data on case studies on impact of building insulation on energy and cost savings in Pakistan, we have examined a case study in Saudi Arabia, which shares similar climate characteristics with Pakistan. It could provide valuable insights into the impact of building insulation on energy and cost savings in hot climatic conditions. Such case studies can help inform decisions related to insulation strategies for residential buildings in Pakistan and other regions with comparable climates.

Alternative insulation strategies	**No insulation (BC)**	**Insulated roof only**	**Insulated walls only**	**Insulated roof and walls**

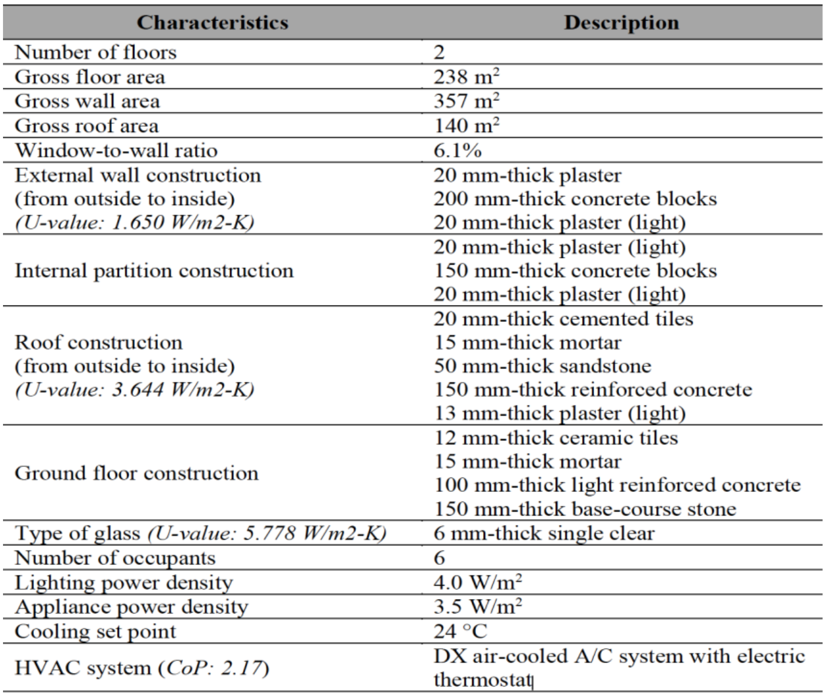
Optimum thickness (cm)	0	8	4	6
Energy consumption kWh/sq.m/y	193.07	156.11	178.57	135.59
Percentage of conserved energy (%)	0	19.14	7.51	29.77
Cost of consumed energy in 30 years	68,926.0	5,5731.3	63,749.5	48,405.6
Cost of conserved energy/year	0	439.8	172.6	684.0
Cost of optimum thickness $/sq.m	0	1642.7	2094.4	4373.7
Cost saving (%)	0	16.8	4.5	23.4
Payback period (years)	0	3.73	12.14	6.39
CO2 emission (kg/year)	12,742.1	10,393.7	11,563.7	8,868.4

Table 7: Cost Benefit Analysis of Building Insulation on energy and cost savings, and corresponding payback period.

This table provides a comparison of different insulation strategies for a building with insulted roof only, insulated walls only and insulations of roof and wall, evaluating them based on various factors such as energy consumption, cost, energy conservation, CO2 emissions, and payback period.

The building under consideration is a residential building; a detached family house. The residential building consists of two storeys and has a total built floor area of 238 square meters. Additionally, it is situated on a land area measuring 500 square meters.

1. **No Insulation (BC)** Without any insulation, energy consumption is the highest at 193.07 kWh/sq.m/year. This energy inefficiency translates into higher utility bills and increased environmental impact, with CO2 emissions of 12,742.1 kg/year.
2. **Insulated Roof Only** By insulating just the roof with an optimum thickness of 8 cm, energy consumption drops to 156.11 kWh/sq.m/year, resulting in a 19.14% reduction in energy use. This reduction significantly cuts both energy bills and CO2 emissions (10,393.7 kg/year).
3. **Insulated Walls Only** Insulating only the walls (4 cm thickness) reduces energy consumption to 178.57 kWh/sq.m/year, a 7.51% reduction, with corresponding cost and CO2 emission savings.
4. **Insulated Roof and Walls** The most effective strategy is insulating both the roof and walls (6 cm thickness), resulting in the lowest energy consumption of 135.59 kWh/sq.m/year, a remarkable 29.77% reduction compared to no insulation. The CO2 emissions are also the lowest at 8,868.4 kg/year.



Characteristics	Description
Number of floors	2
Gross floor area	238 m^2
Gross wall area	357 m^2
Gross roof area	140 m^2
Window-to-wall ratio	6.1%
External wall construction (from outside to inside) *(U-value: 1.650 W/m2-K)*	20 mm-thick plaster 200 mm-thick concrete blocks 20 mm-thick plaster (light)
Internal partition construction	20 mm-thick plaster (light) 150 mm-thick concrete blocks 20 mm-thick plaster (light)
Roof construction (from outside to inside) *(U-value: 3.644 W/m2-K)*	20 mm-thick cemented tiles 15 mm-thick mortar 50 mm-thick sandstone 150 mm-thick reinforced concrete 13 mm-thick plaster (light)
Ground floor construction	12 mm-thick ceramic tiles 15 mm-thick mortar 100 mm-thick light reinforced concrete 150 mm-thick base-course stone
Type of glass *(U-value: 5.778 W/m2-K)*	6 mm-thick single clear
Number of occupants	6
Lighting power density	4.0 W/m^2
Appliance power density	3.5 W/m^2
Cooling set point	24 °C
HVAC system (*CoP: 2.17*)	DX air-cooled A/C system with electric thermostat

Table 8: Building Characteristics of residential detached house under analysis for examining the impact of building insulation.

COST SAVINGS AND PAYBACK PERIOD

1. **Insulated Roof Only** Insulating the roof reduces the cost of consumed energy to $55,731.3 over 30 years, saving $13,194.7. This represents a cost saving of 16.8%, with a relatively short payback period of 3.73 years.
2. **Insulated Walls Only** While insulating only the walls results in cost savings of $7,176.5 over 30 years, the payback period is longer at 12.14 years. The cost saving percentage is 4.5%.

3. **Insulated Roof and Walls** This strategy yields the highest cost savings, with a total of $48,405.6 saved over 30 years, representing a substantial 23.4% cost reduction. The payback period is also relatively short at 6.39 years.

This analysis demonstrated that insulating both the roof and walls is the most effective strategy in terms of energy conservation, with a 29.77% reduction in energy consumption compared to no insulation. This strategy also leads to the lowest CO2 emissions and the shortest payback period, indicating its environmental and economic benefits. Insulating the roof only is the second-best option, with significant energy savings and a reasonable payback period. Insulating walls only provides moderate energy savings and has the longest payback period. While no insultation results in the highest energy consumption, costs, and CO2 emissions.

COST-BENEFIT ANALYSIS FOR SOLAR PV INSTALLATION ON A COMMERCIAL BUILDING IN PAKISTAN

Solar panels are a key feature in green buildings for both passive and active design elements, such as optimum shading and orientation, maximize natural cooling, while active solar panels harness the solar radiation for onsite energy generation. It is important to underline the financial aspects of installing a solar photovoltaic (PV) system.

Solar PV integration is a key feature of green buildings and aligns perfectly well with global sustainability goals, reducing energy consumption and costs, and contributing to environmental conservation. Many green building certifications such as LEED often requires the inclusion of renewable energy sources like solar PV. As Pakistan continues to address its energy demand and environmental challenges, the adoption of solar PV systems in construction projects holds immense potential to create a more sustainable and resilient built environment while offering economic benefits to building owners and occupants.

The cost benefit analysis of integration of Solar PV is straight forward in Pakistan. We will underline the financial merits of implementing a solar photovoltaic (PV) system in a commercial building located in Pakistan as an integrated feature of green building. Our proposal suggests the installation of a 50 kW as grid connected solar PV system will require an initial investment of US$50,000. We assume the cost of solar system, including installation at US$1,000 per kW. Considering Pakistan's solar PV capacity factor, averaging around 25%, a 50-kW solar PV system is projected to generate 107,310 kWh of electricity annually.

The first step in our cost-benefit analysis is to determine the annual savings realized through the solar PV system. Given that the system generates 107,310 kWh of electricity annually at 25% capacity factor, the annual cost savings can be calculated as follows:

- Annual Savings = Solar PV Electricity Production × Cost of Electricity from Grid

- Annual Savings = 107,310 kWh × $0.15/kWh (PKR 45/kWh) = $16,096.50 (or 4,819,950 PKR at US$-PKR exchange rate of 300)

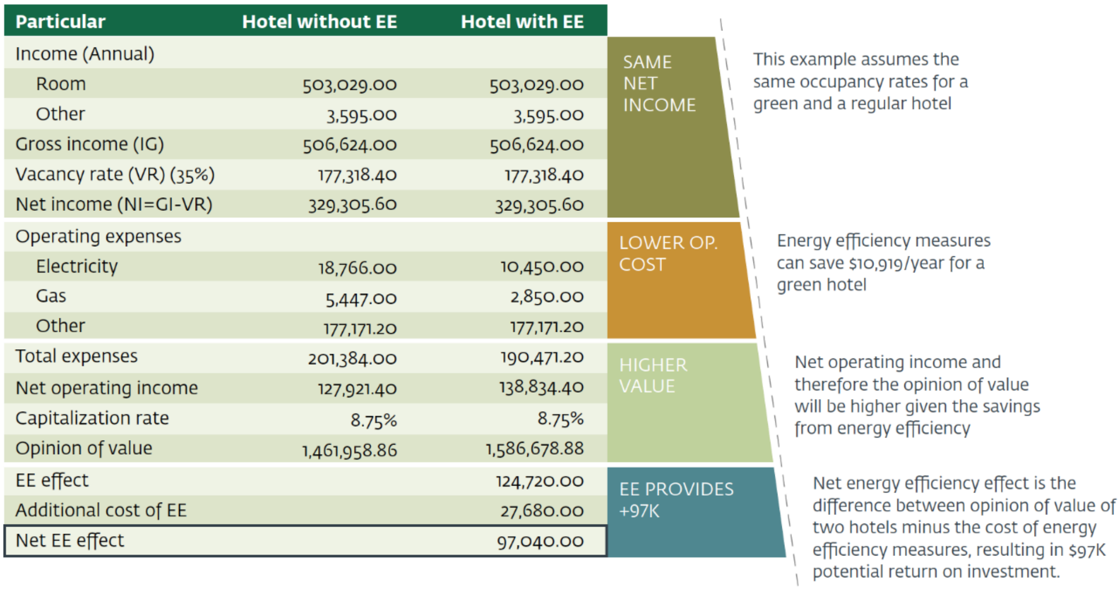
Hence, the solar PV system is expected to deliver annual savings of approximately US$ 16,096.50 or PKR 4,819,950 by reducing the need for grid electricity assuming the average cost of US$ 0.15 per kWh of grid electricity.

The payback period is a crucial metric that indicates when the initial investment is recovered through the annual savings. In this scenario, the payback period for installing a 50-kW solar PV system is calculated as follows:

- Payback Period = Initial Investment / Annual Savings
- **Payback Period** = $50,000 / $16,096.50 ≈ **3.10 years**

Generally, the expected lifespan of a solar PV system is 25 years, the total savings could accumulate to several hundred thousand dollars over 25 years duration, underscoring the long-term financial advantages of this solar PV system. Hence, this demonstrates that substantial economic benefits of incorporating solar PV technology into commercial buildings in Pakistan as an integrated feature of a green building. Not only does it contribute to sustainability efforts, but it also yields impressive cost savings, making it an attractive and environmentally responsible investment option for commercial property owners.

Likewise, widespread use of LED lighting will have a substantial impact on energy savings, as they offer substantial savings in comparison to incandescent lighting. Hence, installing LEDs is one of the most cost-effective options for reducing energy intensity in buildings with shortest payback period within the range of 1-2 years.



Particular	Hotel without EE	Hotel with EE
Income (Annual)		
Room	503,029.00	503,029.00
Other	3,595.00	3,595.00
Gross income (IG)	506,624.00	506,624.00
Vacancy rate (VR) (35%)	177,318.40	177,318.40
Net income (NI=GI-VR)	329,305.60	329,305.60
Operating expenses		
Electricity	18,766.00	10,450.00
Gas	5,447.00	2,850.00
Other	177,171.20	177,171.20
Total expenses	201,384.00	190,471.20
Net operating income	127,921.40	138,834.40
Capitalization rate	8.75%	8.75%
Opinion of value	1,461,958.86	1,586,678.88
EE effect		124,720.00
Additional cost of EE		27,680.00
Net EE effect		97,040.00

This example assumes the same occupancy rates for a green and a regular hotel

Energy efficiency measures can save $10,919/year for a green hotel

Net operating income and therefore the opinion of value will be higher given the savings from energy efficiency

Net energy efficiency effect is the difference between opinion of value of two hotels minus the cost of energy efficiency measures, resulting in $97K potential return on investment.

Figure 10: Green hotel value example (India) Effects of energy efficiency (EE) on the value of a hotel (USD)

Figure 10 above demonstrates a case of hotel value chain in India with lower operating costs due to energy savings can help increase the valuation of green buildings. It demonstrates as to how energy efficiency could increase the valuation of a green hotel by 6.6 percent.

CULTIVATING A GREEN-TECH WORKFORCE FOR GREEN BUILDING IN PAKISTAN

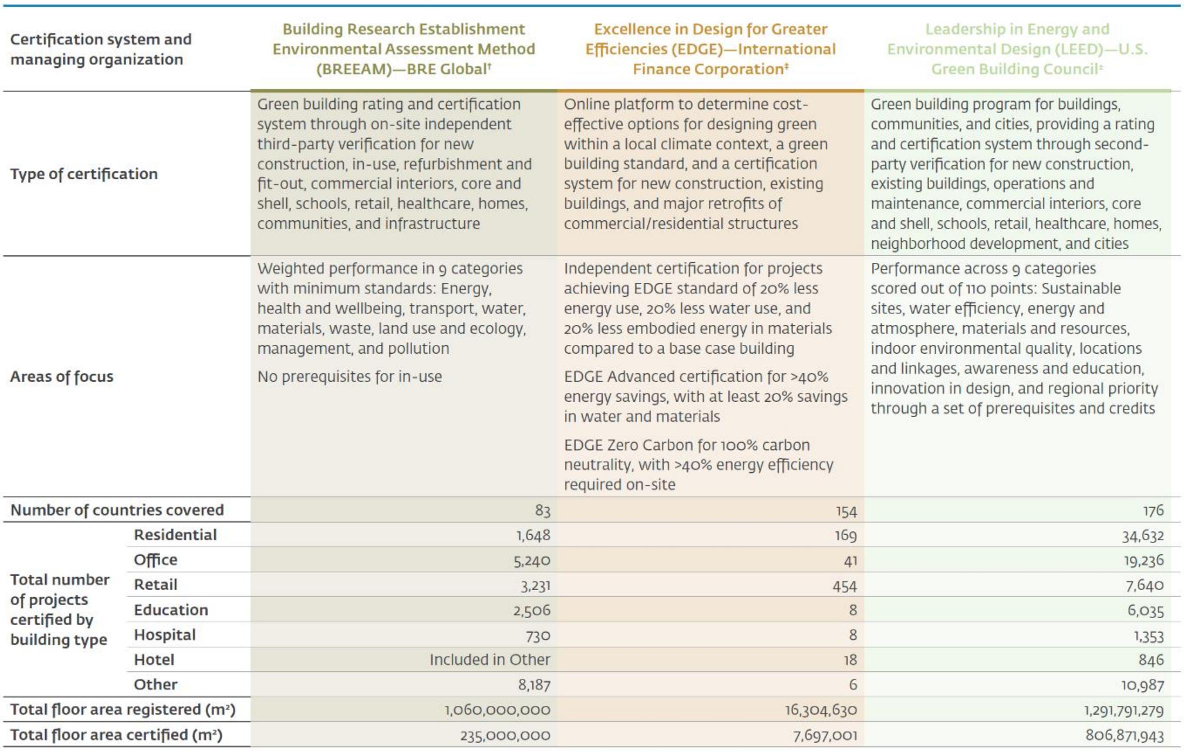
It is essential to emphasize the critical need for capacity development and skills enhancement in Pakistan's construction industry. To effectively incorporate the green building technologies mentioned above, there is a significant requirement for a proficient cadre of technical human resources. This would require providing a continuous, rigorous and adequate training and education to architects, engineers, contractors and other construction professionals who play pivotal roles in the design, development, and implementation of these technologies.

Building a skilled workforce capable of deploying the potential of sustainable construction materials, energy-efficient systems, and eco-friendly practices would be critical in the successful adoption of green building technologies. These measures would not only enhance the Pakistan’s technological capabilities but also develops a culture of innovation and excellence in the construction sector leading to contributing to a greener and sustainable built environment.

7. GREEN BUILDING CERTIFICATIONS IN PAKISTAN: FINDING THE RIGHT FIT

Green building certification programs have played an important role in expanding the market for sustainable and green construction practices. They accomplish this by evaluating and benchmarking building achievements across various dimensions of sustainability, including energy efficiency, design, construction, and operational performance. These programs offer an essential layer of validation through third-party verification and certification.

Globally, notable certification programs like Leadership in Energy and Environmental Design (LEED), Building Research Establishment Environut Assessment Method (BREEAM), and Excellence in Design for Greater Efficiencies (EDGE) have gained widespread adoption in the building and construction industry. Besides, many countries have developed their own building certification systems gaining inspiration from BREEAM and LEED while tailoring them to address local priorities and market conditions. Over 85 countries have adopted national or local building certification programs, which can be voluntary or mandatory for all or part of the buildings sector. Figure 11 provides a comparative overview of three prominent international certification programs: LEED, BREEAM, and EDGE. It illustrates the diversity in their approaches, areas of focus, and the extent of their adoption across different systems.



Certification system and managing organization		Building Research Establishment Environmental Assessment Method (BREEAM)—BRE Global†	Excellence in Design for Greater Efficiencies (EDGE)—International Finance Corporation‡	Leadership in Energy and Environmental Design (LEED)—U.S. Green Building Council§
Type of certification		Green building rating and certification system through on-site independent third-party verification for new construction, in-use, refurbishment and fit-out, commercial interiors, core and shell, schools, retail, healthcare, homes, communities, and infrastructure	Online platform to determine cost-effective options for designing green within a local climate context, a green building standard, and a certification system for new construction, existing buildings, and major retrofits of commercial/residential structures	Green building program for buildings, communities, and cities, providing a rating and certification system through second-party verification for new construction, existing buildings, operations and maintenance, commercial interiors, core and shell, schools, retail, healthcare, homes, neighborhood development, and cities
Areas of focus		Weighted performance in 9 categories with minimum standards: Energy, health and wellbeing, transport, water, materials, waste, land use and ecology, management, and pollution No prerequisites for in-use	Independent certification for projects achieving EDGE standard of 20% less energy use, 20% less water use, and 20% less embodied energy in materials compared to a base case building EDGE Advanced certification for >40% energy savings, with at least 20% savings in water and materials EDGE Zero Carbon for 100% carbon neutrality, with >40% energy efficiency required on-site	Performance across 9 categories scored out of 110 points: Sustainable sites, water efficiency, energy and atmosphere, materials and resources, indoor environmental quality, locations and linkages, awareness and education, innovation in design, and regional priority through a set of prerequisites and credits
Number of countries covered		83	154	176
Total number of projects certified by building type	Residential	1,648	169	34,632
	Office	5,240	41	19,236
	Retail	3,231	454	7,640
	Education	2,506	8	6,035
	Hospital	730	8	1,353
	Hotel	Included in Other	18	846
	Other	8,187	6	10,987
Total floor area registered (m²)		1,060,000,000	16,304,630	1,291,791,279
Total floor area certified (m²)		235,000,000	7,697,001	806,871,943

Figure 11: Selected widely used international green building certification programs. (Source: International Finance Cooperation – IFC)

In case of Pakistan, the Pakistan Green Building Council (PGBC) has introduced its own rating system known as SEED (Sustainability in Energy and Environmental Development), which was first published in October 2016. SEED is a localized and tailored version, inspired by the LEED certification system for Pakistan and is designed to promote sustainable and socially responsible practices in the planning, construction, maintenance, and operation of buildings and communities. SEED offers four tiers of certification based on the points earned by a building: silver, gold, platinum, and titanium, with titanium being the highest achievable certification level, indicating the highest level of sustainability and environmental performance. PGBC has certified a couple of iconic buildings in Pakistan with SEED certification, which include the Parliament House and President House in Islamabad.

CHALLENGES IN GREEN BUILDING CERTIFICATION FOR PAKISTAN

The limited adoption of PGBC's SEED certification system can be attributed to a lack of a coherent and integrated approach among various policy and regulatory stakeholders. One significant reason for this limited adoption is that PGBC, as a non-state entity, has not gained the necessary support and recognition from major industry players and regulators. It's worth noting that successful certification systems, such as the Indian Green Building Council operate as non-governmental and not-for-profit institution.

Another challenge in the building industry is the proliferation of various institutions attempting to develop their own building codes and guidelines. This has resulted in multiple codes being established but with little to no enforcement. To address this issue, it is essential to establish a framework where key stakeholders share responsibilities and collaborate effectively.

A robust institutional arrangement is required, where policy and regulatory organizations like NEECA, PEC, and relevant ministries work closely with implementing agencies to develop a unified building certification system. The responsibility for enforcing these building codes rests with implementing agencies such as municipal corporations, metropolis development authorities, provincial building control departments, and real estate developers.

The Pakistan Green Building Council (PGBC) could play a crucial role by serving as an accredited body for certifying green buildings and acting as a bridge between policy and regulatory institutions and implementing agencies. Additionally, there is a need for capacity building at both the policy and regulatory levels, as well as within implementing agencies to ensure the effective implementation of green building practices and codes.

BRIDGING THE GAP BETWEEN BUILDING REGULATIONS AND IMPLEMENTATION IN PAKISTAN

In Pakistan, the challenge of promoting building energy efficiency and green construction practices lies not in the development of regulations but in their effective enforcement. Despite various initiatives to establish energy-efficient building codes and green building frameworks, these efforts have often failed to translate into on-ground implementation.

Key institutions like the National Energy Efficiency and Conservation Authority, Pakistan Engineering Council and relevant Ministries of Energy and Climate Change have made strides in creating these codes, but they remain largely unimplemented at the local level, where construction projects are carried out. The top-down approach taken by these policy interventions has overlooked the practical challenges and complexities faced by local developer.

To address this issue, a more pragmatic approach is needed, focusing on direct collaboration with local authorities in major cities like Islamabad, Lahore, or Karachi. Initiating pilot programs in collaboration with the Capital Development Authority in Islamabad, for example, can serve as a valuable testing ground for green building codes. Successes and lessons learned from these pilots can then be extended to other urban areas in Pakistan, ensuring that energy efficiency and green construction practices are not just words on paper but integral components of the country's building sector.

FROM GENERIC TO SPECIFIC: ENERGY EFFICIENT AND GREEN BUILDING CODE FOR PAKISTAN

One of the limitations in developing green building and energy-efficient codes is their one-size-fits-all approach. These regulations often attempt to apply the same standards to all building types, whether they are schools, commercial offices, high-rises, residential apartments, or single-family homes. This lack of differentiation can hinder the effectiveness of these codes.

Looking to the Indian Green Building Construction Industry as a model, we can see how they have evolved by developing distinct ratings for different building types. They have created separate rating systems for green homes and low-income housing to cater to specific needs. Moreover, they have gone even further by developing separate rating standards for various commercial building types, including new buildings, existing buildings, healthcare facilities, data centers, schools, and offices. Pakistan can benefit from this approach by creating case-specific green building codes for each building type.

To achieve this, a bottom-up approach to developing green building codes is essential. Urgent action is needed to not only adopt policies requiring existing and new buildings to meet green building criteria but also to establish and enforce relevant laws and regulations for their effective implementation. These laws should offer incentives to commercial builders, such as tax benefits and expedited permits, while penalties should be imposed where necessary to ensure compliance with green building standards. This comprehensive approach is crucial to drive the adoption of green building practices in Pakistan.

Figure 12: Green Building Certification of Parliament House of Pakistan. Source Pakistan Green Building Council.

THE NEED FOR BUILDING ENERGY USE BENCHMARKS IN PAKISTAN

One crucial step in promoting energy efficiency in buildings is establishing baseline energy use benchmarks for different building types. Unfortunately, Pakistan has yet to conduct a comprehensive benchmark analysis for energy use in various types of buildings.

Benchmarking when applied to building energy use, serves as a valuable tool to measure a single building's energy performance over time, relative to similar buildings, or to modeled simulations of a reference building built to specific standards like energy codes. This practice offers benefits to regulators, building owners, facility operators, managers, and designers.

Benchmarking facilitates energy accounting, allowing facilities to compare their energy use with similar ones to identify opportunities for improvement and quantify or verify energy savings. In the commercial building sector, energy performance benchmarking has become a standard practice, especially as rising energy costs and environmental concerns emphasize the importance of energy management. To effectively manage energy use, it's essential to measure and benchmark it accurately.

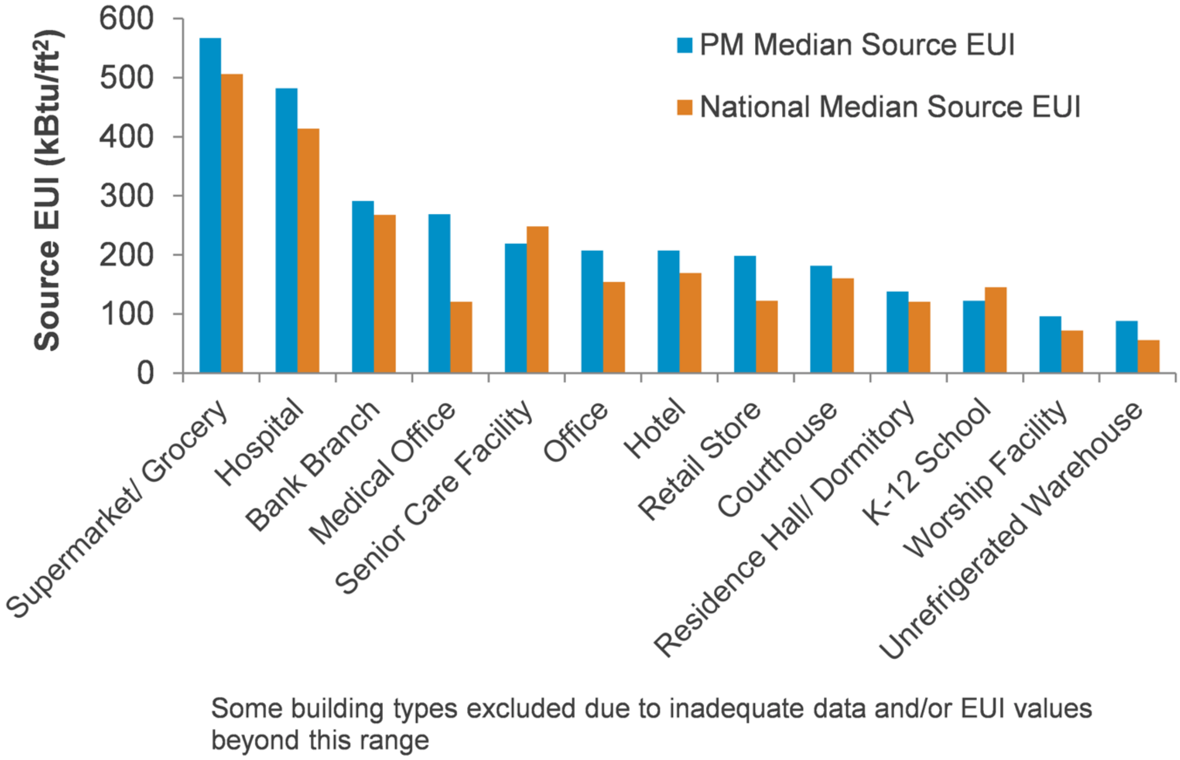


Figure 10: Typical EUI for selected buildings. This graph is based on research EPA conducted on more than 100,000 buildings (Source: https://duanetilden.com/2016/12/19/benchmarking-buildings-by-energy-use-intensity-eui/)

After implementing effective benchmarking and acquiring comprehensive data on the energy use intensity of various building types, this valuable information can serve as a baseline for assessing energy efficiency. Building upon this foundation, the establishment of a performance-based energy efficiency rating system becomes both feasible and beneficial.

This rating system would allow for a robust evaluation of a building's energy performance, taking into account factors such as energy consumption patterns, sustainability practices, and resource efficiency. By moving beyond simplistic metrics and adopting a performance-based approach, regulators in Pakistan could provide building owners and stakeholders with a more accurate and comprehensive assessment of their buildings' energy efficiency. This, in turn, can incentivize further investments in green technologies and practices, ultimately driving the adoption of energy-efficient building solutions across the country

POLICY RECOMMENDATIONS ON PROMOTING GREEN BUILDING CERTIFICATION IN PAKISTAN

1. **Benchmarking and Data Collection**
   Benchmarking is a foundational step toward managing and improving energy efficiency before we begin developing any further green building codes or energy efficiency codes. NEECA, PEC, and PEECA along with development authorities and building control units should work together to develop a comprehensive benchmarking program to assess the energy performance of different building types. This will require establishing a baseline and collecting data on energy use in various sectors.
2. **Tailored Green Building Codes and Certification Programs for Pakistan's Specific for Building Types**
   Instead of adopting generic international codes and green building certification programmes, develop customized green building codes specific to different building types (e.g., residential, commercial, industrial) building upon the existing international codes and guidelines. We can learn from international best practices, such as the Indian Green Building Council's approach, and apply a bottom-up methodology for code development.
3. **Enforcement of Building Energy Codes by empowering Implementing Agencies**
   The foremost challenge in Pakistan lies in the enforcement of existing building energy codes. Policy makers should prioritize and ensure the effective implementation of these regulations at the local level. This requires collaboration with development authorities and building control departments at local and provincial levels to make compliance mandatory for all new construction and renovations.
4. **Pilot Green Building Programs using Bottom-Up approach with key implementing agencies and institutions.**
   Launch pilot programs focused on green building initiatives in major urban centres like Islamabad, Lahore, and Karachi. These areas can serve as testing grounds for implementing and refining green building codes and practices. Successful outcomes can then be scaled up to other regions.
5. **Incentives and Penalties**
   Introduce financial incentives for developers and builders who adhere to green building standards. This could include tax benefits, expedited permit approvals, and other rewards. Simultaneously, impose penalties for non-compliance with energy efficiency and green building regulations to create a stronger deterrent.
6. **Local Green Building Product Manufacturing**
   Collaborate with the green building construction industry to promote the local production of green building products and materials. Support research and development efforts to innovate sustainable construction materials that align with the specific needs and climatic conditions of Pakistan. Establish partnerships with local manufacturers to ensure the availability and affordability of these eco-friendly materials.
7. **Sourcing Green Materials**

Work with industry experts, builders, manufactures and academia to establish green supply chain with local manufacturers and facilitate the sourcing of green building materials through sustainable supply chains. Encourage builders and developers to prioritize the use of locally sourced and environmentally friendly materials in their projects. Provide guidance and incentives for incorporating recycled, renewable, and low-impact materials into construction practices.

8. **Capacity Building and Training**
   Invest in capacity development and skills training to build a proficient workforce capable of designing, implementing, and maintaining green building technologies. Collaborate with educational institutions and industry associations to offer relevant training programs.
9. **Public Awareness and Education**
   Launch public awareness campaigns to educate the general population about the benefits of green buildings and energy-efficient practices. Foster a culture of sustainability and encourage individuals to make eco-conscious choices in their homes and workplaces.
10. **Stakeholder Collaboration is the key to promoting green and sustainable buildings.**
    Collaborate closely with stakeholders at all levels, including government agencies, industry associations, environmental organizations, and international partners. Formulate a cohesive strategy that leverages the strengths and resources of each stakeholder group.
11. **Robust Monitoring and Evaluation Framework for Energy Efficient and Green Buildings**
    Establish a robust monitoring and evaluation system to track the impact of energy efficiency and green building policies. Periodically assess the effectiveness of these policies and make data-driven adjustments if needed.
12. **International Collaboration and Learning from other successful regional initiatives.**
    Engage in international collaboration and knowledge sharing with countries that have successfully implemented energy efficiency and green building initiatives. Learn from their experiences and adapt relevant strategies to the Pakistani context.

8. CONCLUSION

Green buildings are gaining widespread recognition as an important pathway for reducing greenhouse gas (GHG) emissions that stem from the construction and building sectors. In a rapidly urbanizing nation of approximately 230 million people, where the construction sector significantly contributes to energy consumption and greenhouse gas emissions, the need for green buildings is extremely critical. The transition to green construction not only aligns with global sustainability practices but also contributes to energy conservation, reduced GHG emissions, and improved living conditions in Pakistan.

Pakistan's construction and building sector plays a pivotal role in the nation's economic landscap. The sector faces both challenges and opportunities in its transition towards green building practices and energy-efficient construction.

With a burgeoning population, rapid urbanization, and increasing energy demands, the need for sustainable and environmentally responsible building practices has never been more pressing. Green buildings, which prioritize energy efficiency, resource conservation, and environmental responsibility across their entire lifecycle, offer a promising solution to mitigate the environmental impact of the construction industry.

However, several hurdles impede the widespread adoption of green building practices in Pakistan, primarily due to high initial costs, limited access to sustainable construction materials, a shortage of skilled labor, and an overarching emphasis on energy efficiency and comprehensive green building practices in existing policies.

Robust green and sustainable building policies are vital to incentivize the production and use of low-carbon construction materials, aligning with Pakistan's ambitious carbon neutrality goals outlined in its Nationally Determined Contributions (NDCs).

The construction and building sector, with its significant contribution to energy consumption and GHG emissions, requires strong policy support for the adoption of green building practices. The journey towards a greener and more sustainable built environment demands collaboration among policymakers, industry stakeholders, civil society, and the public.

Efforts must focus on strengthening regulatory frameworks, including building energy codes, raising public awareness, improving access to sustainable materials, enhancing skills through capacity development, and offering financial incentives to offset initial costs. Monitoring, evaluation, and local government engagement would also be vital to enforce building energy codes and promote green practices at the grassroots level.

Furthermore, research and development initiatives should be encouraged to tailor cost-effective green building technologies to Pakistan's diverse climate and building typologies. International collaboration and public-private partnerships could provide valuable insights and investment opportunities.

In achieving these goals, Pakistan can expedite its transition to a greener, more sustainable built environment, contributing to global sustainability objectives while reaping economic, environmental, and societal benefits. As the nation continues to experience the rapid urbanization and high energy demands, the adoption of green building practices emerges as an opportunity for Pakistan towards sustainable economic and development growth.

Appendix 5. Review Analysis on the Pakistan Green Building Certification – Architecture

1. INTRODUCTION

PURPOSE OF THE REVIEW AND ANALYSIS

The purpose of this review and analysis is to comprehensively examine the current state of building design practices in Pakistan, with a focus on identifying existing situations, challenges, and opportunities within the construction sector of the country. The analysis focuses mainly on residential, commercial, and public buildings in Pakistan. Through a thorough examination of relevant literature, industry trends, and case studies, this document seeks to provide a detailed assessment of the key factors influencing current building design in Pakistan such as building orientation, window-to-wall ratio (WWR), biophilic design elements, and renewable energy integration. By doing so, it aims to shed light on the strengths and weaknesses of existing approaches, pinpoint areas in need of improvement, and uncover opportunities for improvement. The value of the design phases is given below in Figure 1, the analysis is conducted keeping the value chain under consideration.

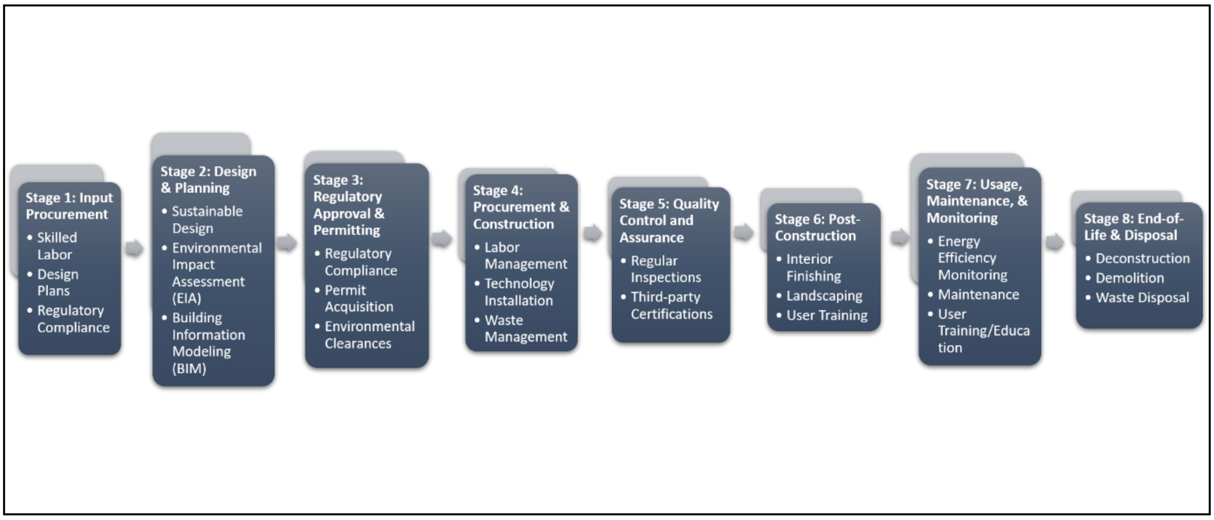


Figure 26- Value Chain Analysis of the Design Phases of Green Buildings in Pakistan

This analysis will serve as a valuable resource for architects, designers, and stakeholders in the construction industry of Pakistan, enabling them to make informed decisions and strategically leverage emerging trends to enhance future building designs' efficiency, sustainability, and functionality.

BACKGROUND (PAKISTAN INFRASTRUCTURE AND GREEN BUILDINGS)

Pakistan is rapidly becoming more urbanized, expecting more than 40 million additional people to reside in urban areas by 2025 due to better living standards and the availability of more job opportunities in urban areas. Pakistan has consistently faced an energy crisis due to high demand during peak summer months and inadequate electricity supply. Many regions in the country experience temperatures exceeding 40 degrees Celsius during summers which leads to extensive use of air conditioners and other cooling appliances increasing the energy demand of the country in summer. This requires the country to prioritize demand-side management and energy cost-saving design practices.

Efforts are needed to improve building design, internal conditions (heating and cooling), energy consumption, and energy efficiency and to reduce the overall environmental impact, which is where green buildings come in. Green building design offers a lot of benefits from an architectural and design perspective. Architects and designers focus on energy efficiency by incorporating features such as well-insulated walls, natural ventilation, and efficient heating, ventilation, and cooling systems (HVAC), which not only reduce utility costs but also lower the building's environmental footprint. These designs also emphasize occupant health and well-being, utilizing low-VOC (Volatile Organic Compound) materials and proper indoor air quality measures to create comfortable and healthy indoor environments. Additionally, green building designs often draw inspiration from nature, leading to aesthetically pleasing structures that harmonize with their surroundings and mitigate the urban heat island effect.

Implementing green architecture in Pakistan will lead to many different areas which the country can benefit from such as energy conservation through energy-efficient building design features and the incorporation of renewable energy systems into the building design to reduce the use of non-renewable sources of energy that leads to a reduction in the carbon footprint of the building. Analysis of the current situation is required to better understand the challenges and opportunities in green buildings from a design perspective in Pakistan.

2. PRESENT SITUATION

Pakistan has a rich culture and traditional infrastructure such as traditional mosques, forts, and shah gardens. This document however focuses on three major types of buildings that currently exist in the country:

- **Residential Buildings:** Residential buildings in Pakistan vary from modern urban apartments to traditional rural houses with courtyards. These prioritize comfort and privacy, with diverse room types and materials ranging from brick and mud to concrete and steel.
- **Public Buildings:** Public buildings in Pakistan, such as government offices, schools, hospitals, religious structures, and transportation hubs, often reflect cultural and historical contexts, accommodating large crowds with spacious interiors and accessibility features.
- **Commercial Complexes:** Commercial buildings, including offices, retail stores, malls, hotels, restaurants, and warehouses, have architectural styles that reflect branding, with modern designs in urban areas and traditional elements in older structures.

The building sector is responsible for most of the energy consumption in Pakistan, with the residential sector currently being the largest in energy consumption consuming about 49.2%, and the commercial sector consuming about 7% of the total electricity produced in the Country. With a constantly increasing population and urbanization rate, demand for this sector is expected to rise even further. Therefore, it is important to introduce energy-efficient design techniques that can overcome the increase in the energy consumption of buildings in Pakistan.

BUILDING CODES AND LEGISLATION

The government of Pakistan has acknowledged the significance of sustainable building design and has taken measures to encourage its adoption. An illustration of this commitment is the establishment of the Pakistan Green Building Council (PGBC) in 2012, dedicated to advancing sustainable building design and construction practices in the country. As an esteemed member of the World Green Building Council, the PGBC strives to foster a sustainable built environment in Pakistan by advocating for green building approaches. Additionally, the Pakistan Engineering Council's (PEC) 2021 building codes emphasize key architectural considerations, including ventilation, lighting, and roof drainage. These guidelines stress the significance of natural ventilation in occupied spaces, with provisions for accessible windows, doors, louvers, or other openings to the outdoors. When air infiltration rates are low, compliance with the International Mechanical Code is required. The NEECA National Energy Conservation Code 2023 also mentions specific guidelines on sustainable building design practices, such as Green roofing, Window-to-Wall Ratio, Orientation, and integration of Renewable energy, while focusing on the energy saving that these design features can bring. Adequate lighting, both natural and artificial, is mandated to ensure safety and comfort, achieved through strategic design and illumination systems. Biophilic design elements such as green roofs are essential for rainwater management and must adhere to specified standards to safeguard the building's structural integrity and longevity. These comprehensive regulations prioritize the creation of healthier, more functional, and sustainable building environments while enhancing occupant well-being.

Pakistan is lacking in the implementation of these building codes and regulations. Reasons include lawlessness, lack of awareness of the general public on the benefits of green design and workforce on building codes related to design, green design technology unavailability in the country, and financial issues that lead to low or no investment in energy-efficient design features such as integration of renewable energy.

Green building design offers a lot of benefits in terms of cost saving, energy efficiency, and environmental benefits by only incorporating a few changes into the building design, orientation, and architecture. In terms of energy saving, the building sector offers a potential of 30%, which is why Pakistan needs to shift towards green building design by addressing all the gaps that are present in the construction sector. A detailed analysis of the green building design aspect in Pakistan is necessary to utilize the energy and cost savings potential that the building sector has to offer.

3. ARCHITECT ANALYSIS

Architects are responsible for planning and implementing building design during the construction phase of a building. This section analyses building design in Pakistan from an architectural point of view.

ARCHITECTURAL DESIGN REVIEWS

Architecture plays an important role in the energy efficiency, building aesthetics, and health of the inhabitants through a focus on certain areas such as building orientation, window-to-wall ratio, and energy-efficient building features. The current building design practices in Pakistan will be discussed in the architectural design reviews segment along with suggestions for improvement in design practices.

EVALUATION OF BUILDING DESIGN CONCEPT

Building design in Pakistan is intertwined with the architecture of the broader Indian subcontinent. The major architectural styles popular in the past were Temple, Indo-Islamic, Mughal, and Indo-Saracenic architecture, all of which have many regional varieties. Urban areas of Pakistan are moving towards modern architecture that focuses more on the aesthetics of the building and rural areas have the traditional building style that focuses on the use of natural materials and design elements such as mud, clay bricks, and openings for passive energy use in a building.

Residential building design practices in Pakistan are rather purely traditional or purely modern which can be seen from the study conducted in Lahore, where the two building styles (Figure 2 and Figure 3) were compared to observe the overall design. After comparing both buildings, it was seen that neither traditional nor modern house designs in Lahore are inherently better than the other. Each has its merits based on environmental considerations, for example, traditional houses involve more nature-based elements that help in reducing GHG emissions and providing a healthy environment, and on the other hand, modern buildings focus on the inclusion of renewable energy sources into the building design which reduces their reliance on fossil fuel-based energy.

However, a balanced approach that combines traditional and modern elements, such as the use of eco-friendly design features, utilization of passive energy for lighting and heating purposes, inclusion of renewable energy design systems, and good aesthetics can create a rich house design, preserving heritage while improving energy efficiency, improving heating and cooling mechanisms, and providing good environmental benefits.

Figure 27 - Traditional House

Figure 28 - Modern House

Commercial buildings in Pakistan majorly follow modern architecture neglecting sustainable design features into the building. However, some examples exist, such as the

Telenor 345 Head office (Figure 4 and Figure 5) located in Islamabad, which is a good example of green architecture. The building has natural airflow through the use of meshes, the orientation of the building is such as to reduce the overall energy consumption and use natural light as much as possible. The design is also highly energy efficient with active chilled beams, LED lights, thermal insulation, and occupancy sensors. The Telenor 345 Head Office was found to have achieved **up to 13% of energy cost savings** and 11% of its energy consumption was shifted to solar energy.

Figure 29 - Telenor 345 Head Office, Islamabad, Pakistan

Figure 30 - Drone view of Telenor 345 Head Office

Green architectural practices can play an important role in energy conservation and GHG emissions reduction. The cost-saving potential of green building design features can be assessed from the study focused on residential buildings in Pakistan. The analysis of conventional buildings shows that a major heat loss of 29.3 kWh/m^2 and 18.3 kWh/m^2 takes place across external walls and roofs respectively while a loss of 5.2 kWh/m^2 was observed through windows. Commutatively, the annual heating demand of conventional buildings was calculated to be 44.2 kWh/m^2 but for energy-efficient buildings, with design features such as building orientation, window-to-wall ratio, nature-based solution, and renewable energy, the losses were significantly reduced consequently leading to 1/10th of annual energy demand. For **annual heating, a 32 % energy improvement** was observed while for **cooling, a 38% energy improvement** was observed.

The analysis of the building design concept in Pakistan shows that building design practices are different in urban and rural areas and green architectural practices are not very common in the country but the potential savings can be seen from the analysis and should be utilized. There are some good examples such as the Telenor 345 Head Office, which can be set as a best practices example to follow in residential areas as well. There is still a need for improvement in different areas of green design in Pakistan, which needs to be addressed.

Areas of Improvement

The following possible options were identified which Pakistan can implement to make good progress in green architecture:

1. Balanced Approach to Traditional and Modern Design: Traditional designs in Pakistan focus fully on natural lighting, passive heating, and cooling, which leads to energy efficiency, but the aesthetics and incorporation of technology in the building are overlooked. On the other hand, modern buildings focus more on aesthetics and the latest technology, and other factors such as passive energy use and the incorporation of nature-based elements are overlooked. Building design features such as natural lighting and airflow, integrating modern technology such as renewable energy along with nature-based solutions, and overall good aesthetics can be used together for a green building design in Pakistan. This design practice is not only for residential buildings, it can be implemented for commercial, and public buildings as well.

2. Awareness of the Public: The local community in Pakistan does not pay much attention to building design aspects during the planning or construction phase of a building which is due to a lack of awareness of the benefits of green building design. The government can take initiatives for capacity building of the general public as well as the workforce including training sessions and workshops on the negative impacts and benefits of using green design features.

3. Implementation of Building Codes: Building codes exist in Pakistan such as PEC Building Codes 2021 and NEECA National Energy Conservation Code 2023, which contain detailed segments on the architecture and design-related aspects of buildings but they lack implementation which is where Pakistan is struggling to move towards green buildings.

The government should ensure enforcement of these codes through dedicated departments, capacity building should be done for the stakeholders involved.

BUILDING ORIENTATION AND WINDOW-TO-WALL RATIO (WWR)

Building orientation and window-to-wall ratio (WWR) play a vital role in the overall energy use of the building as they can provide options for passive heating in winter, and use of wind in summer, and increasing the window-to-wall ratio decreases the lighting demand of the building.

ASSESSMENT OF ORIENTATION'S IMPACT ON BUILDING PERFORMANCE

Concepts like building orientation are often overlooked during the construction of residential public or commercial buildings in Pakistan due to a lack of awareness of the architect and the general public. According to NEECA National Energy Conservation Building Code 2023, a compact building shape and appropriate building orientation can reduce the energy consumption for heating and cooling systems by up to 50% to 80% depending on the geographical conditions where the building is located. The identification of such an improvement in building codes is not enough unless these codes are disseminated widely and backed with information on the long-term economic benefits for dwellers. Along with this, the government's role in the early adoption of these practices is pivotal.

The concept of building orientation in residential, public, and commercial buildings in Pakistan is not very common but there are some examples in Pakistan where building orientation was considered during design. A study was done for a public building (Mosque) in Pakistan, where Faran mosque located in Karachi was analyzed from the building orientation perspective and it was found that the overall design and orientation facilitated the building wind flow and use of natural light which improved the energy efficiency of the building by reducing the use of appliances for cooling and heating. Sprinklers were also used in the building which were placed in the windward direction to maintain a cool temperature in summers. Using passive sunlight and natural wind flow reduces the overall energy use and improves the building's air quality as well in all seasons.

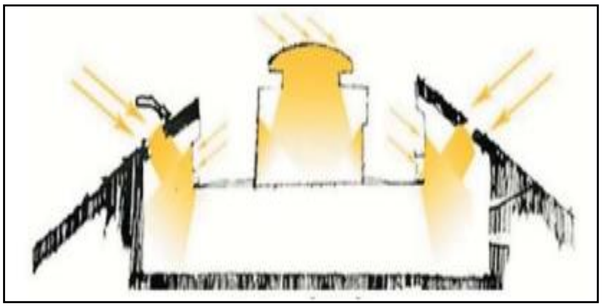


Figure 31 - Section showing light paths into the mosque[6]

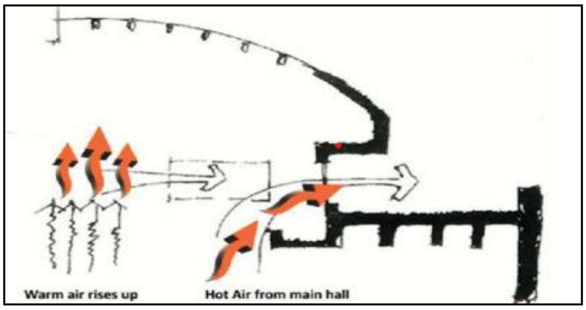
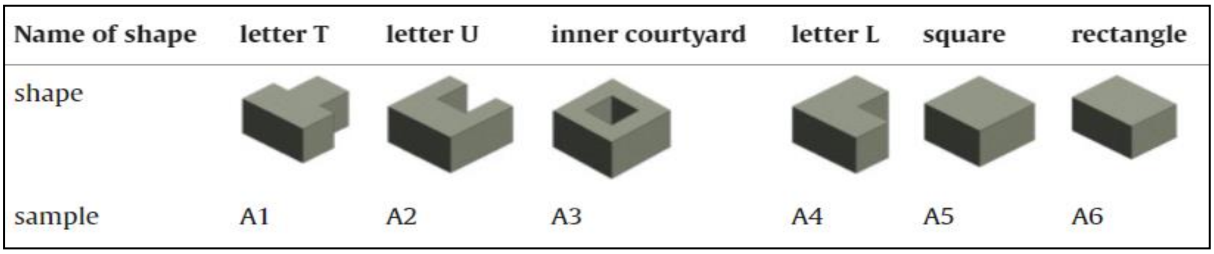


Figure 32 - Wind flow inside the mosque[6]

Pakistan can also take the concept of building orientation from the best practices in other parts of the world. In Iraq, a study was conducted using BIM (Building Information Modelling) in which different types of building shapes and orientations were simulated using an application called Revit, which showed that the T-shape model is the least consuming energy model at a rotation angle of 285˚, as its energy consumption amounted to 40,495 kWh for 964$ per year. The U-shape model is one of the most energy-consuming at the angle of rotation is 270˚, where its energy consumption amounted to 73,880 kWh at a cost of 1758$per year, which equals almost 56% difference in the overall energy cost of both models, keeping other properties such as area and capacity the same.



Name of shape	letter T	letter U	inner courtyard	letter L	square	rectangle
shape						
sample	A1	A2	A3	A4	A5	A6

Figure 33. Shapes of Models

Building orientation plays a key role in the energy cost-savings of a building. A study done in Egypt shows that a building oriented with a south facade can save energy costs up to 26% over a building with a western facade. According to the Bonneville Power Administration and the City of San Jose, California, homes re-oriented toward the Sun without any additional solar features save between 10% and 20% in cold regions and some can **save up to 40% in hot regions**. Another study in Jamaica shows that correctly oriented buildings can save up to **30-40% of their electricity**.

Further, the cost savings will calculated by using the annual utility expenses in Pakistan. The utility expenses in Pakistan vary from season to season. The average household electricity bills in Pakistan based on an evaluation for the year 2022 are as low as 2000-3000/- PKR in winter and in the Summer season, as electricity consumption increases, the electricity bills can go up to 7,000/- PKR. It was analyzed that an average of 30% cost savings in summers and 15% in winters, can be achieved from building orientation alone. The following is a calculation of the total cost savings that can be achieved through the use of proper orientation in buildings in Pakistan:

Table 25 - Cost Savings due to building orientation in an Average Household in Pakistan

Season	Average Household Electricity Cost (PKR)	Percentage Savings (%)	Cost after Orientation Correction (PKR)	Cost Savings (PKR)
Winter	3000	15	2550	450
Summers	7000	30	4900	2100

The calculation shows that a maximum energy cost savings can be **2,100/- PKR per month in Summer** and **450/- PKR per month in winter** in an average household thus energy cost savings can be achieved by orienting the building properly. The cost-saving opportunity should be utilized in Pakistan to relieve the economic stress of utilities of the homeowners.

The Government acknowledges the importance of building orientation in a building design, which is why building codes contain guidelines on building orientation. According to the NEECA Energy Conservation Building Code 2023, the longer axis of any commercial, residential, or public building should not face east or west as they receive constant sunlight at a low angle all over the year and summers can be very difficult for the inhabitants of the building.

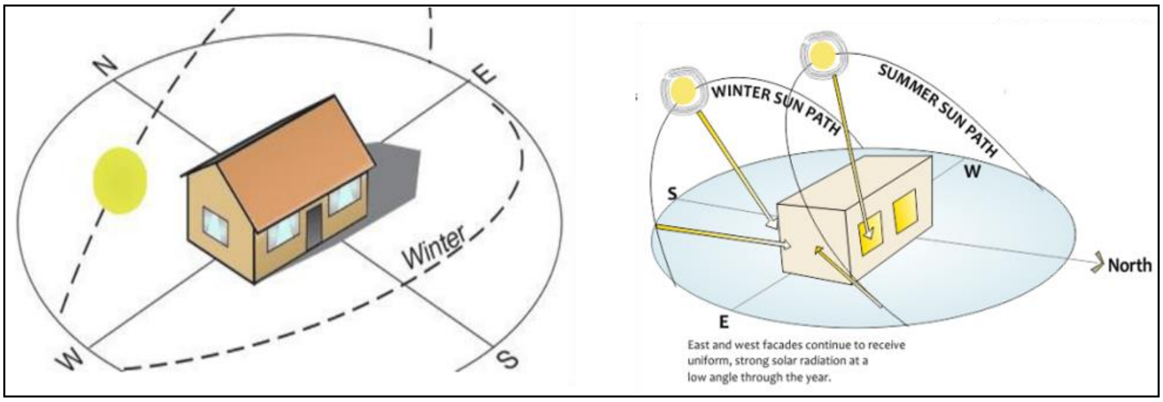


Figure 34 – Longer side of the building should be towards north and south (NEECA)

Overall, it can be seen that Pakistan is lacking in building design from the perspective of building orientation which can reduce energy costs by up to 30% in summers and winters, and maintain healthy internal conditions with good air flow. Building codes do exist in this area but they have improper implementation which can be ensured to cater to this issue.

Areas of Improvement

1. Best Practices as an Example: Faran Mosque in Karachi, as explained in section 3.2.1, is a very sound example of how the building should be oriented to utilize passive sunlight and maintain good airflow during hot seasons. Practices like this need to be promoted and discussed frequently in Pakistan by organizing training programs for the public and professionals, collaborating with universities for workshops and seminars for youth, and carrying out demonstration projects to make the engineers, architects, laborers, and the public aware of these factors.

2. Climate-Responsive Design: Architects should be encouraged by providing incentives, recognition, training programs, and regulatory support to adopt climate-responsive design strategies, such as the use of sun shades, overhangs, and windbreaks, to harness sunlight for passive heating in winter while minimizing heat gain in summer. These features can significantly contribute to overall sustainability.

3. Promote the Use of Simulation Tools: The case studies used in the analysis involved the use of a simulation tool such as Revit for analyzing the impacts of the building orientation on energy cost savings. The use of such software should be normalized and architects and engineers should be proficient in using this kind of software, which can help them build and design better.

4. Lack of implementation in Building Codes: A Detailed Energy conservation building Code exists as mentioned earlier on how the building shall be oriented to improve energy efficiency but it lacks implementation at the local level due to low awareness of the general public and labor. If the NEECA Energy Building Code 2023 guidelines are followed, it can decrease the energy demand and cater for a large portion of the energy shortage by only improving the building orientation. The government should ensure the implementation of building codes to make Pakistan shift towards green design.

ANALYSIS OF WINDOW-TO-WALL AREA RATIO ON ENERGY PERFORMANCE OF THE BUILDING

Around 50% of the energy that buildings lose goes through their windows. The best WWR is the amount of window space that uses the least energy over the entire year for cooling, heating, and lighting. The window-to-wall area ratio (WWR) is a critical factor in building design, especially in the context of achieving optimal daylighting and energy efficiency in

Pakistan. The baseline WWR in residential buildings in Pakistan showing an average **WWR of 20%** as used in a study is given below:

Table 26 - Baseline Window-to-Wall Ratios in Residential Buildings in Pakistan

Walls	Baseline Windows Area
East Wall	0%
West Wall	17.50%
North Wall	22.30%
South Wall	27%

The high cost of electricity is a major issue in Pakistan and the demand for artificial cooling systems is increasing in Pakistan, which was analyzed in an example where in commercial complexes in Lahore, a study was conducted due to the increase in the demand for cooling appliances. It was analyzed by using a simulation software called "COMFEN" that WWR and heat gain are in a linear relation with each other and an average WWR of 20-30% showed a reduced amount of heat gain while keeping the required amount of passive lighting to the building of the commercial buildings. A public sector building i.e., PAK Secretariat, was analyzed for the impacts of WWR on energy savings and it showed a **286.7 kWh in annual energy savings** when the WWR was reduced from **38% to 33%**. The cost of the energy savings comes out to be **12,328/- PKR per year**, which is not a huge cost saving but it can be improved by further improving the WWR.

Further, energy cost saving through the optimization of the window-to-wall ratio can also be seen from the example where BIM was used to optimize the WWR from an average of 40-45% to **an average WWR of 25-30%**. The study shows that there was a decrease in the mean energy cost from the **cost of 229 kWh/m^2/year to the cost of 160**

kWh/m²/year for the residential building, which equals a **reduction of 30%** in the energy costs.

The energy cost savings of a building due to the optimization of the WWR from 28% to 14% were found to be **9.4% to 13.3% in cold regions** and **34.3% to 44.2% in hot regions** due to a major reduction in the use of air conditioning systems. An average of these cost-saving ranges can be used to calculate the cost savings in an average household in Pakistan by using the average utility expense in a building. The following is a calculation of energy cost savings in the average household in Pakistan:

Table 27 - Cost Savings Due to WWR in an Average Household in Pakistan

Season	Average Household Electricity Cost (PKR)	Percentage Cost Savings (%)	Cost after optimizing WWR (PKR)	Cost Savings (PKR)
Winter	3000	11.5	2655	345
Summer	7000	39.5	4250	2750

It can be seen that in winter, an energy **cost saving of 345/- PKR per month** can be achieved, and on the other hand, a substantial **cost saving of 2,750/- PKR per month** can be achieved by optimizing the WWR of a building. These benefits are recognized by the Government of Pakistan, which is why building codes contain guidelines on these design elements. The Energy Conservation Building Code 2023 contains a detailed section on the WWR by the Solar Heat Gain and Solar Glazing Coefficients but it lacks implementation due to the low awareness of the public and professionals and also low or no use of simulation software by architects or engineers in the planning phase of the building.

Hence WWR can have a good impact on the energy performance of a building while also ensuring the effective use of passive sunlight and air flow into the building. WWR has a linear relation with the heat gain of a building leading to an increased use of cooling appliances in the summer. However, It can lead to cost savings of up to 2,750/- PKR per month in summer, and 345/- PKR per month in winter for the average household electricity expense in Pakistan. Pakistan needs to utilize the savings potential for this aspect of building design and make it normal practice in the building sector. The government has already focused on this aspect which is shown by the building codes.

Areas of Improvement

1. Promote the Use of Simulation Tools: The study mentioned earlier involved the use of a simulation tool called COMFEN for analyzing the impacts of the window-to-wall ratio on heat gain. The use of such software should be normalized and architects and engineers should be proficient in using this kind of software, which can help them build and design better.

2. Awareness of the Public: The residential building WWR baseline is around the optimum WWR of 20-30%, but commercial buildings are not catering to this issue which shows that the architects and the local public still do not have any awareness of the importance and benefits of WWR on energy conservation and energy cost-saving of a building. The government can ensure awareness by doing media campaigns and providing technical and regulatory support for including WWR in building design.

3. Strengthen the implementation of Building Codes: Building codes do exist regarding window-to-wall ratio linking it with other factors. As Pakistan is a country with intense weather conditions, these building design features should be implemented on a priority basis to enhance energy efficiency and improve the overall health of the inhabitants of the buildings. The government can provide, capacity-building training to the public as well as labor, technical support, and guidance in design aspects, and certifications for building design related to WWR.

NATURE-BASED SOLUTIONS AND ARCHITECTURAL BEAUTY

Nature-based solutions incorporate biophilic elements in the building design to solve problems of increase in energy consumption, health and well-being, and emission reductions in a building. These solutions help sustainably tackle various issues, making the world more eco-friendly, resilient, and better for people, while also opening up opportunities for businesses and innovation such as for the production of green roofing systems and living walls inside buildings that reduce emissions and create a healthy environment.

ASSESSMENT OF BIOPHILIC DESIGN ELEMENTS

Biophilic design recognizes the inherent human need for nature together with sustainable and universal design strategies to create environments that truly enhance life. In urban and rural areas of Pakistan, residential buildings include certain biophilic elements such as gardens, lawns, pot plants, and in some cases, trees as well but commercial complexes do not focus that much on biophilic design elements.

In contrast, commercial buildings in Pakistan do not focus on introducing nature into the building design. Most commercial buildings and modern residential houses focus more on the inclusion of the latest technology and ignore the importance of biophilic design elements in buildings lacking the use of natural elements.

However, there are some initiatives such as the inauguration of Forest Town as a biophilic city by Green Woods Developments in Pakistan (Islamabad), whose concept was taken from a biophilic city named Tengah located in Singapore. It is a great step in addressing this issue aiming to transform urban living through eco-sustainability and biophilic principles with the mission to re-establish a profound connection between real estate and the natural world.

Figure 35 - Forest town Concept (Tengah, Singapore)

These types of initiatives boost resilience by reducing the urban heat island effect, the risk of flooding, and improving the air quality, and enhancing residents' quality of life by maintaining good air quality. They also help in blending heritage with modern sustainable design, creating attractive spaces that showcase Pakistan's culture and attract both residents and tourists.

The importance of the introduction of biophilic elements can best be calculated by reviewing the cost savings through the inclusion of a green roofing system in a household. A study shows that the energy consumption for their base case was 169 kWh/m^2, while the energy consumption due to the application of green roofing on the entire roof surface came out to be 110 kWh/m^2 and the **energy savings were found to be 35%**, which can save a lot in terms of energy cost.

Comparing this with Pakistan, the energy cost-saving potential of a green roofing system installed in a household in Pakistan can be calculated as follows:

Table 28 - Cost Savings due to green roofing system in an Average Household in Pakistan

Season	Average Household Electricity Cost (PKR)	Percentage Saving (%)	Cost after Green Roofing System (PKR)	Cost Savings (PKR)
Winter	3000	35	1950	1050
Summer	7000	35	4550	2450

Energy cost savings due to the installation of green roofing systems can be up to **2,450/- PKR per month for summers** and in **winters it can be up to 1,050/- PKR per month**. The installation cost of such systems can be high but the return on investment can cover the initial cost of the system, which shows that the installation of green roofs in a building is economically feasible.

However, biophilic elements such as green roofing systems are very uncommon practices in Pakistan the fact that NEECA National Energy Conservation Building Code 2023 mentions that 50% of horizontal exposed roof slabs of Buildings shall have a green roofing system, to manage water run-off from rooftops, to control internal temperatures within the top floors, and to reduce the energy consumption and carbon footprint of the building but these guidelines need to be implemented to get positive results. Pakistan lacks the implementation of building codes on the inclusion of biophilic design elements.

The analysis of nature-based solutions in a building design shows promising energy cost-saving potential such as **2,450/- PKR per month for summers** and **1,050/- PKR per month for winters**, and the government has also advised the inclusion of biophilic elements such as green roofing systems through the NEECA National Energy Conservation Building Code 2023 but there is a lack of implementation of buildings codes, and lack of awareness among the public, and professionals also.

Areas of Improvement

1. Promoting green features in building design: Commercial buildings in Pakistan mainly focus on the materials, windows, and other features for energy conservation but the introduction of several green and natural elements such as living walls, indoor plants, biophilic arts, lawns, gardens, and courtyards for a better indoor environment, natural cooling, energy conservation and reducing the carbon footprint is required. People who are living in apartments or do not have space for lawns can opt for living walls and small plant pots inside their buildings. This can be done by raising awareness among the public and educating them about the economic and health benefits of such systems.

2. Lack of Awareness of the Architects and Labor: The labor and design experts lack awareness and knowledge on the benefits of incorporating biophilic elements into the building design. Biophilic elements ensure well-being, emissions reduction, and good aesthetics in a building. Relevant individuals must be educated and trained to implement these features in the buildings. Relevant professionals should be given training on the inclusion of nature-based solutions in building design in Pakistan.

3. Review and Implementation of Building Codes: NEECA Energy Conservation Building Code 2023 contains a whole segment on the introduction of green roofing systems into the building design to reduce the overall carbon footprint as well as to improve the energy efficiency of the building. Building codes should also be reviewed to contain guidelines on the use of natural elements in courtyards, lawns, gardens, etc. to improve the carbon footprint and energy ever further. To ensure implementation, the Government can provide, training programs to professionals as well as to youth, certifications, and campaigns on the health benefits and emissions reduction caused by to inclusion of biophilic elements.

ENERGY PERFORMANCE AND USE IN ARCHITECTURE

At present, buildings account for roughly 40% of the total energy consumed globally and the construction sector consumes 50% of the total energy of Pakistan. If this energy consumption trend persists while factoring in the expected increase in population, and with limited new sources of fossil fuels, all the natural resources of Pakistan could be exhausted within a short period. The field of construction holds a significant potential of 30% for lessening its environmental footprint by integrating energy-efficient technologies into the planning, building, and maintenance of both new and existing structures.

INTEGRATION OF RENEWABLE ENERGY IN THE DESIGN

Renewable energy technology can play a vital role in optimizing energy efficiency and reducing the carbon footprint of the building. In Pakistan, Solar PV systems are becoming more common in practice in modern residential houses and large commercial complexes in urban areas. In contrast, houses in rural areas do not focus much on technology because of the high installation cost of the systems.

Commercial buildings in Pakistan focus a lot on the integration of renewable energy sources to fulfill their energy demands. One of the examples of a commercial building with solar energy integration is the Telenor 345 Head Office in Islamabad, whose 11% of the total energy consumption is fulfilled by solar energy. An array of PV Solar cells is installed on the roof of the building used to convert the solar energy into electrical energy.

Figure 36 - PV Solar Panels, Telenor 345 Head Office

The cost of solar systems is very high but the return on investment and payback period make it quite cost-effective, which can be seen from the study where the payback period for household solar systems of 5kW was calculated to be **3.98, 2.33, 3.99 & 6.78 years** in Sindh, Balochistan, Punjab and KPK, respectively. Other than that, there is a reduction in the carbon footprint of the building due to the solar systems as according to the Lawrence Berkeley National Laboratory, an acre of solar panels producing zero-emissions electricity saves between **121 to 138 metric tons, of carbon dioxide** per year. Solar systems are used commonly in Pakistan but there is still a lack of other renewable energy technology use in Pakistan.

The integration of other types of renewable energy systems is also an option in a building design, a recent UK study part funded by the Carbon Trust study shows that small wind turbines can be used on top of high-rise buildings with an estimated potential **annual carbon dioxide savings to be in the range 0.75- 2.2 Mt CO_2 per year**. The biomass energy system can also be integrated as explained in this example where biomass boilers were used for heating purposes. Biomass offers substantial advantages, including a significant reduction in CO2 emissions when compared to fossil fuels, resulting in emissions reductions of up to **95.25% for single-family units and 91.18% for multi-family units**. Additionally, the use of biomass enhances energy ratings, and leads to substantial economic savings, with **potential cost reductions of up to 70%** when compared to gasoil, which shows the benefits of using other renewable energy sources in Pakistan.

Figure 37 - The Swift Turbine[19]

Figure 38 - Biomass Boiler

The government has already advised about the integration of solar systems as a renewable energy resource for buildings in the NEECA National Energy Conservation Code 2023, which contains a chapter on the design and integration of Renewable energy systems into buildings. However, the code only focuses on solar energy as a renewable source of energy for generating power. It states that the solar system should be designed at a minimum of 10 kW for 1000 units (kWh) for average monthly consumption. Average consumption must be based on the technical analysis of the solar capacity potential of the building by considering the surrounding buildings and their shades on the concerned building. Other options such as wind energy and biomass energy can also be used as renewable energy sources for buildings but there are no guidelines for them in the building codes of Pakistan.

The analysis of renewable energy sources in building design shows the importance of integrating renewable energy systems such as solar systems, wind energy systems, and biomass boilers in buildings. Buildings in Pakistan have shown the integration of solar systems in their design to fulfill their energy needs. Other renewable energy sources can also be used in the building design to utilize their cost-saving and emissions-reduction potential.

Areas of Improvement

1. Diversification of Renewable Sources: There are various renewable energy sources used in different parts of the world but in Pakistan, the focus is mainly on solar energy. There's a need to explore and integrate a wider variety, especially in regions with high potential for wind energy, and biomass energy. The best practices from other countries can be utilized in this regard.

2. Awareness and Education among Builders and Public: There should be increased awareness and education about the benefits of renewable energy technologies among builders, architects, and the general public because if people are not aware of the benefits of using renewable energy and the negative impacts of using fossil fuel-based energy, they will not be willing to integrating this type of technology into buildings. The government should provide capacity-building training to the relevant professionals and general public, certifications should be introduced, and technical and regulatory support should also be ensured.

3. Financial Incentives: Government incentives and subsidies should be expanded to make renewable energy systems more affordable and attractive for building owners as renewable energy technology comes with high installation costs, which can put a lot of financial pressure on the homeowner. Incentives such as tax reductions, low-interest loans, and grants can be provided to homeowners to integrate renewable energy systems in their buildings.

4. Implementation and improvement of Building Codes: Building codes do exist on renewable energy but they focus only on solar energy integration. Also, the building codes are not followed with regularity in Pakistan, which needs to be addressed. Federal and provincial governments can play a crucial role by assuring the implementation of regulations ₩to promote the widespread use of renewable energy sources in buildings.

COST ANALYSIS OF BUILDING DESIGN FEATURES

The existing building selected for the case study is the double-story Automotive Centre of the University of Engineering and Technology Lahore (UET Lahore). It has a total area of 6903.6 m2 (74312.16 ft2).

Figure 39 - Automotive Centre of University of Engineering and Technology Lahore

Further details of the building have been provided in Table 5.

Table 29 - Detailed Information on Building

Parameter	Value/Description
Building Orientation	Long Axis facing North-South
Number of *stories*	2
Total Area	6903.6 m2
Total Volume	10666 m3
Total Area of Exposed Walls	640 m2
Total Windows Area	368.6 m2
Window-to-Wall Ratio	0.58

Floor Height	9.15 m (30 ft.)
Indoor Design Temp.	260 C
Operating Schedule	8 am- 8 pm (260 Days)
Occupancies	250 persons
Infiltration Rate	0.25 EACH
Lighting Level	400 lux
Appliances (Computer)	80 (Heat Output 160W/PC)

BASELINE DESIGN

The materials under consideration include brick plaster for wall finishes, single-glazed aluminum frames for windows, brick tiles for roofing, exterior paving for the flooring, and hollow-core plywood for the doors.

Applying Retrofitting Techniques

The following techniques are applied to convert a normal/ conventional building into a green one.

- Replacement of Single Glazed Windows with Double Glazed
- Modification of Window-to-Wall Ratio
- Application of Insulation
    - Selection of the most efficient insulation
    - Selection of optimum insulation thickness
- Application of Energy-Efficient Lighting

Assuming that all the previously single-glazed windows in the building are replaced with brown-tinted double-glazed windows while maintaining other parameters unchanged. This is considered because double-glazed windows' benefits reduce energy consumption and enhance indoor comfort levels. It's worth noting that substantial energy savings can be achieved through envelope insulation and energy-efficient lighting.

Additionally, the notably large WWR is optimized to fall within the range of 0.33 to 0.37, by the recommendations set forth by the Building Energy Codes of Pakistan. Furthermore, the existing 40W fluorescent tube lights are assumed to be replaced with 25W LED lights of the same luminous intensity.

REPLACEMENT OF SINGLE-GLAZED WINDOWS WITH DOUBLE-GLAZED

Replacement of single-glazed windows with brown-tinted double-glazed ones, while maintaining all other factors unchanged, can result in a 4.17% reduction in annual thermal loads.

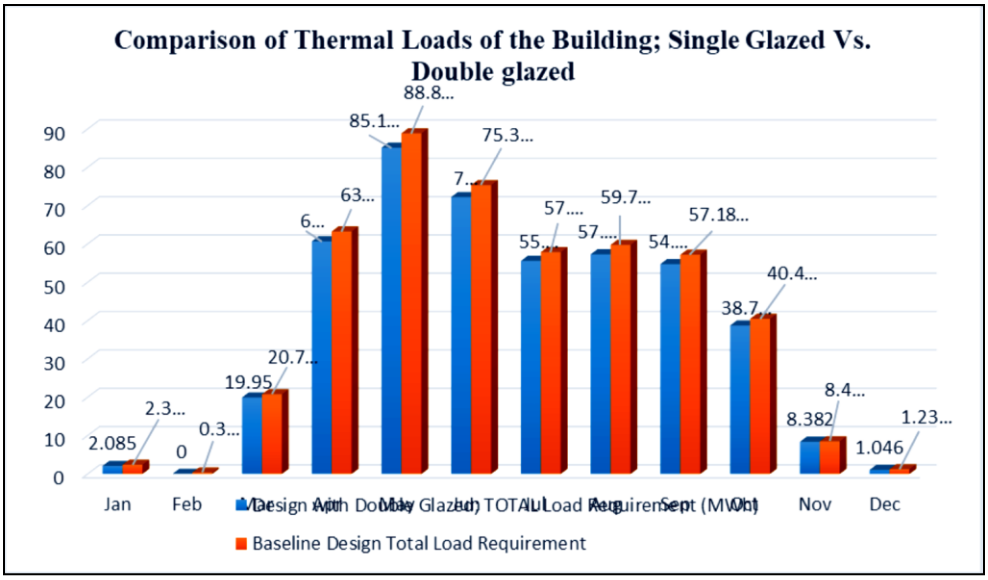


Figure 40 - Comparison of Thermal Loads for Single Glazed and Double Glazed Window

- Annual Load with Single Glazed Windows = 476.024 MWh
- Annual Load with Brown Tinted Double Glazed Windows = 456.150 MWh
- Load Saving = 4.1683%

MODIFICATION OF WINDOW-TO-WALL RATIO

In alignment with the guidelines stipulated by the Building Energy Codes of Pakistan, we have undertaken the reduction of the total window area from 368.6 m2 to 237 m2, accompanied by the implementation of shading measures on the remaining windows. This intervention has revealed an optimal window-to-wall ratio of 0.37, a configuration that minimizes thermal loads.

Subsequently, when comparing the total thermal loads post-optimization with the baseline design, our findings indicate a notable decrease in energy consumption, specifically amounting to 1.96%.

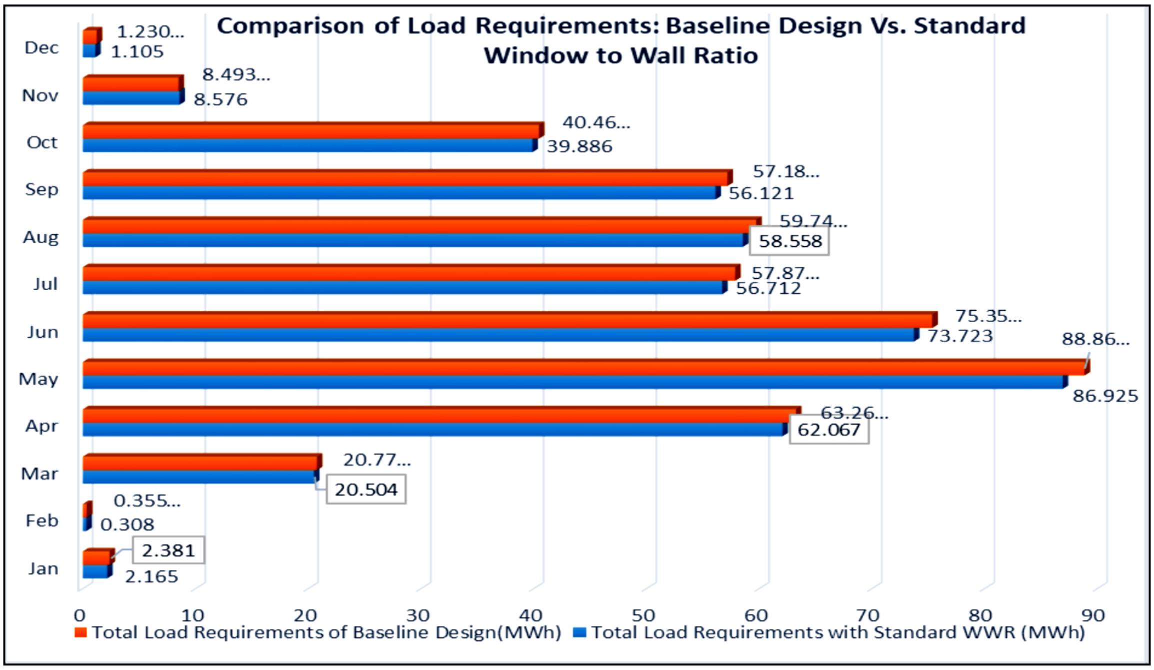


Figure 41 - Baseline Design (Actual) vs Standard Window-to-Wall Ratio for Green Building

- Annual Load with WWR of 0.58 (existing) = 476.024 MWh
- Annual Load with WWR of 0.37 (after retrofitting) = 466.651 MWh
- Load Saving = 1.962%

APPLICATION OF INSULATION

Roof Insulation

The roofing system has been insulated to minimize heat gains and reduce the cooling load of the building. To achieve this objective, the optimal insulating material has been selected, employing four types: cellulose, polystyrene, polyurethane foam, and rock wool. For the sake of comparison, a uniform insulation thickness of 2 inches has been applied on both the exterior and interior sides of the roof.

Findings indicate that polystyrene foam (high density) stands out as the most effective insulating material. However, it's important to note that due to its high flammability, it necessitates an additional layer of fireproof coating material. Typically, this involves the application of a fireproofing chemical known as Hexabromocyclododecane.

On the other hand, rock wool lacks additives that confer fire resistance, making it less suitable for use in extremely hot conditions, though it is inherently non-combustible whereas polyurethane foam employs CFC gas as a blowing agent, which contributes to ozone layer depletion.

Table 30. Insulations and their U values

Type of Insulation	U value (W/m2. K)	Density (kg/m3)	Specific Heat (J/kg. K)	Conductivity (W/m. K)
Cellulose	0.38	43	1,380	0.042
Polystyrene Foam	0.08	46	1,130	0.008
Polyurethane Foam	0.37	60	1,757	0.042
Rock Wool	0.31	200	710	0.034

Table 31. Total Load and Load Saving Using Each Insulation

Month	**Total Load (MWh)**			
	Cellulose	**Polystyrene Foam**	**Polyurethane Foam**	**Rock Wool**
Jan	0.36	0.309	0.358	0.343
Feb	0.003	0.959	0.003	0.002
Mar	15.29	15.011	15.288	15.21
Apr	45	43.91	44.8	44.551
May	62.17	60.884	62.17	61.81
Jun	52.8	51.714	52.8	52.497
Jul	42.275	41.524	42.275	42.065
Aug	44.301	43.557	44.301	44.093
Sep	42.075	41.347	42.075	41.871
Oct	29.953	29.442	29.953	29.809
Nov	7.933	7.837	7.933	7.906
Dec	0.361	0.367	0.361	0.122
Grand Total	342.317	336.861	342.317	340.279
Percentage Load Saving	28.132%	29.293%	28.132%	28.50%

Cellulosic insulation is the most eco-friendly insulating material, fire resistant and suitable thus it is finalized.

Optimizing Insulation Thickness

Analysis for optimizing insulation thickness has been conducted, involving the variation of insulation thickness from 0.25 inches to 8 inches in increments of 0.25 inches. It encompassed the evaluation of both annual load savings and the associated costs of insulating materials, with the final selection of the optimum thickness predicated upon cost considerations.

The graph given below (Figure 17) reveals a noteworthy surge in annual load savings, peaking at 10%, up to a thickness of 4 inches. Subsequently, the rate of increase in load savings diminishes significantly, causing a mere 0.6% increase up to 8 inches. This latter trend entails an increase in insulation costs. Consequently, 4 inches of thickness is selected as the optimized insulation thickness.

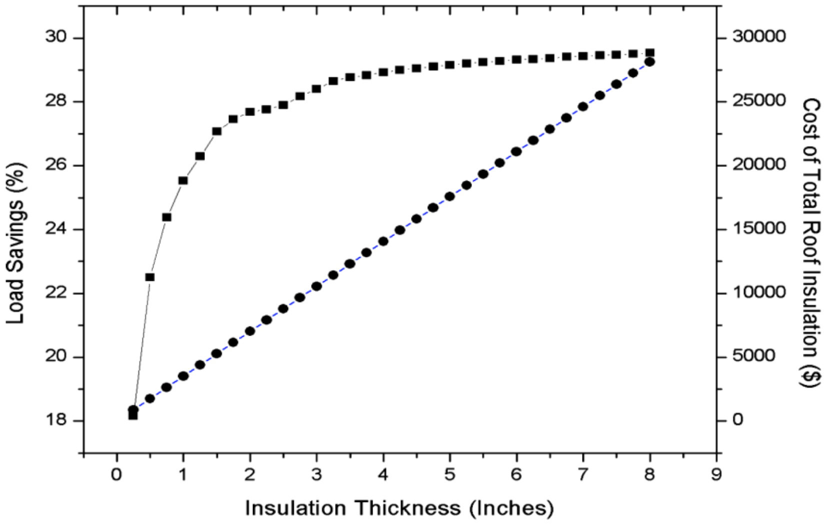


Figure 42 - Annual Load Saving and Insulation Cost Varying

APPLICATION OF ENERGY-EFFICIENT LIGHTING

The fluorescent tube lights used in the conventional building (40W) when replaced with 25W LED lamps to make it green (same luminous intensity), give a total 1.91% load saving.

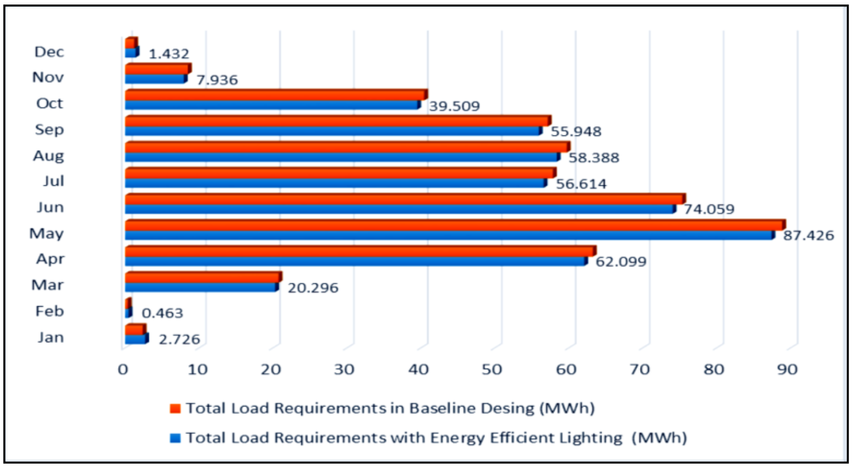


Figure 43. Thermal Loads by using energy-efficient lighting compared with the actual baseline design

OVERALL HEATING AND COOLING LOAD SAVINGS BY ALL TECHNIQUES

The effects of all the considered retrofits on the reduction of cooling and heating load requirements of the building are given below.

Table 32 - Overall Heating and Cooling Load Savings

Component	**Composition After Retrofitting**	**Parameter**	**Actual Value**	**After Retrofitting**
Walls	Ceramic Tiles 0.5", Cement	U value of Walls	1.882 W/m2. K	1.882 W/m2. K

	Plaster 3/8″, Brick Masonry 9″, Paint Coat 1/4″			
Windows	Glass Standard 5/8″, Air Gap 1″, Glass Standard 5/8″	U value of Windows	6.065 W/m2. K	2 W/m2. K (Double Glazed)
Roof	Paint Coat 1/4″, Cellulosic Insulation 4″, Cement Plaster 3/8″, Roof Tile 1″, Cement Plaster 3/8″, Cellulosic Insulation 4″, Paint Coat 1/4″		4.921 W/m2. K	0.115 W/m2. K (Insulated)
Window to Wall ratio	Standard	WWR	0.58	0.37
Roof Insulation	Cellulosic Insulation	Insulating Material	No Insulation	4 Inch Cellulosic Insulation
Lights	L.E.D. Lights	Lights Power Rating	40 W	24 W

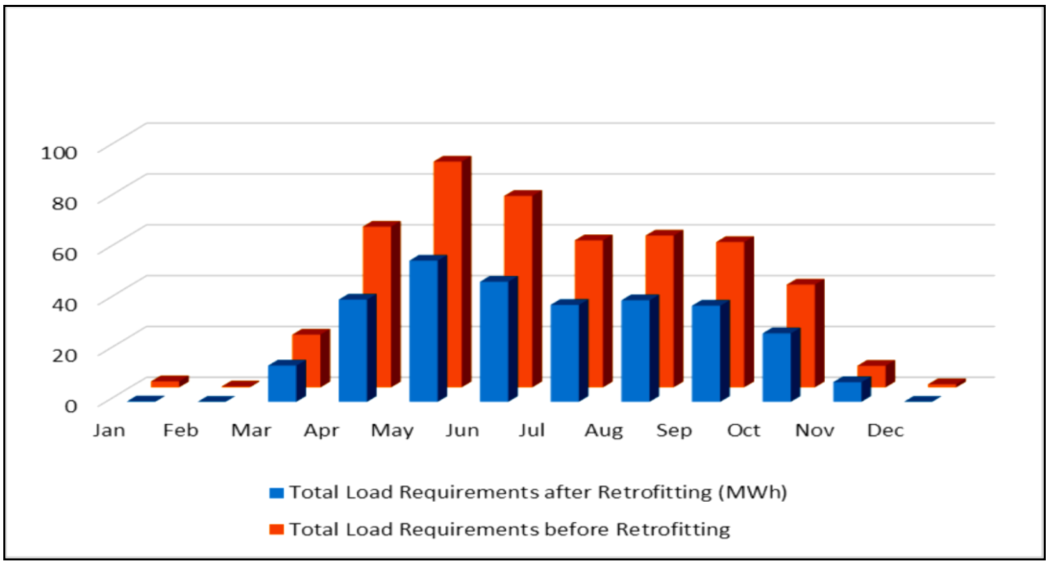


Figure 44. Load Requirements Before and After Retrofitting

OVERALL COST OF FEATURES

The cost of retrofitting techniques and electricity has been calculated and is given below. The table given below summarises the unit cost (Table 9).

Table 33. Uni Costs for Retrofitting and Electricity

Attribute	Unit Price ($)
Electricity price per kWh for commercial connections (inc' GST)	0.153
Cost of cellulose Insulation per square foot	0.408
Double glazed windows	5.1
23 W LED bulbs (Osaka Lightings)	3.1314
The price of a Cement bag of 50 kg	4.3044

The electricity cost is based on Lahore Electric Supply Company's general supply Tariff (2018) for commercial connections while the cost of cellulose insulation per square foot and that of windows per square foot are calculated with the help of quotes available online.

Note: The 2% inflation rate is adjusted to convert the cost in 2018 into 2023

Table 34. Costs and Savings of Green Building

Retrofitting Technique	Details of Cost	Unit Price ($)	Total Area to be retrofitted (ft²) or Number of Parts/pieces Required	The total cost of the technique ($)	Annual Load Saving (kWh)	Energy Efficiency	Estimated Price of electricity per (kWh)	Annual Electricity Saving (kWh)	Annual saving in terms of electricity ($)
Cellulosic Insulation		0.408	50209.3365	20485.409	167506	3	0.153	55835.33	8542.805
Double Glazed Windows		5.1	2551	13010.1	19841	3	0.153	6613.667	1011.891
Energy Efficient Lighting (Thermal Load Saving)		3.13140	120	375.768 0	9083	3	0.153	3027.667	463.2331

Energy Efficient Lighting (Direct Electricity Saving)							0.153	5920	905.76
Modification in Window to Wall Ratio and Shading	Bricks cost per piece	0.0816	5000	408	9339	3	0.153	3113	476.289
	50 kg Cement bag	4.3044	20	86.088					
	Estimated Labor cost			1958.4					
Total Cost/Saving				**36323.765**	205769			74509.67	**11399.98**

PAYBACK PERIOD

- Payback Period = Total cost of retrofitting for converting into green building / Total annual saving
- Payback Period = 36323.765/ 11399.98
- Payback Period = 3.18 years
- Payback Period = 3 years 2 months

The cost analysis of different design features used in a building shows that the overall initial cost of incorporating green design is high but the payback period is **3 years and 2 months**, which makes green architecture an economically feasible alternative.

DEMAND AND REFLECTION OF GREEN ARCHITECTURE

Limited adoption of environmentally friendly and energy-efficient building designs in Pakistan is primarily caused by low awareness of innovative building design features such as simulation software, window-to-wall ratio, nature-based solutions, and renewable energy systems among the general public and professionals, resulting in low demand for green buildings nationwide. Nevertheless, numerous advantages and opportunities make the adoption of green buildings environmentally friendly and cost-effective for Pakistan. The graphical representation of the analysis of the value chain and the challenges and opportunities that exist in the value chain of green building design in Pakistan are illustrated below in Figure 20.

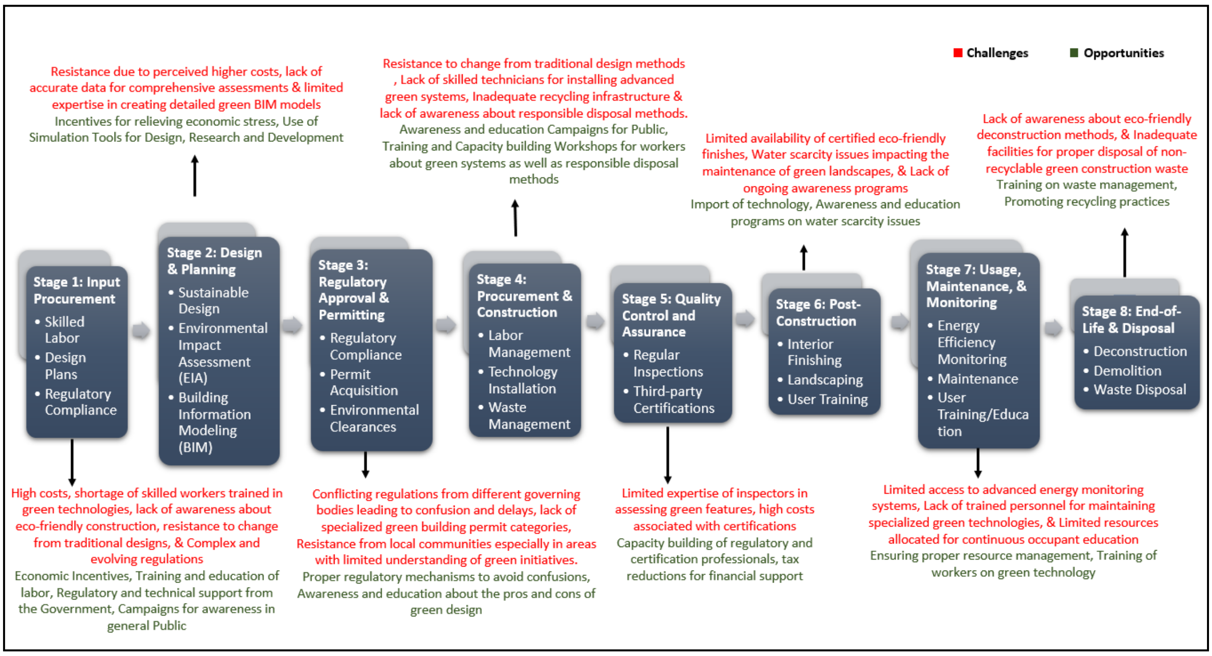


Figure 45 - Challenges and Opportunities in the Design Stages of green buildings in Pakistan Value chain

CHALLENGES IN IMPLEMENTING GREEN ARCHITECTURE

Pakistan is a developing country and lacks sustainable green building design in its construction sector. The reasons for the low demand for green architecture are as follows:

1. Lack of Awareness of Workforce and Public

In Pakistan, there is a significant lack of awareness among architects, owners, builders, and the general public about the benefits of green building practices. Many individuals may not fully understand the advantages of sustainable architecture or may be unaware of the available eco-friendly design options such as WWR, building orientation, biophilic design, or renewable energy integration. Also, many individuals have a strong preference for traditional practices and aesthetics, making it challenging to introduce new green building design concepts.

2. Weak Enforcement of Green building codes and policies

Building codes such as the PEC Building Code 2021 and the NEECA National Energy Conservation Code 2023 have detailed sections on guidelines about building design principles such as Orientation, WWR, Green roofing systems, and solar system integration but these guidelines are not being followed in the country. There are no proper mechanisms for ensuring the implementation of these building codes.

3. Economic Constraints

Economic considerations play a crucial role in the construction industry. Green building design features and technologies can be more expensive upfront compared to conventional options such as renewable energy, and green roofs. In a country like Pakistan, where cost-effectiveness is a significant concern, the higher initial costs of green design can deter potential investors.

4. Limited Access to Technology

The availability of green building design technologies such as wind energy systems, biomass boilers, Green roofing systems, and other biophilic design elements such as living walls are either limited or not present in most regions of Pakistan. The lack of easy access to these materials leads builders to opt for conventional alternatives.

5. Lack of Skilled Professionals

Pakistan faces a shortage of professionals with expertise in sustainable building design strategies. Without a sufficient number of architects, designers, and builders who understand green construction principles, the effective implementation of eco-friendly designs becomes difficult. The skilled professionals also lack knowledge on the use of simulation software such as Revit, COMFEN, and, other BIM modeling software, which has become mandatory to understand the applicable design strategies in a building.

STRENGTHS OF EXISTING BUILDING DESIGN IN PAKISTAN

The existing infrastructure in Pakistan has the following strengths which can be utilized and channeled for implementing green buildings and promoting green architecture in Pakistan.

1. Cultural Heritage and Architectural Diversity

Pakistan's rich cultural and architectural heritage, showcased by landmarks like the Badshahi Mosque and Lahore Fort, can serve as a wellspring of inspiration for contemporary building design. The nation's diverse regional influences have given rise to an array of architectural styles, offering architects a unique palette to create culturally resonant and visually captivating structures.

2. Craftsmanship and Resilient Practices

Pakistan possesses a longstanding heritage of proficient craftsmanship within the domain of architectural design. These skills can be strategically used to formulate building designs that are not only energy-efficient but also ecologically sustainable. Furthermore, traditional construction techniques prioritize resilience in the face of natural disasters, incorporating earthquake-resistant designs and locally sourced materials, which can be utilized during the use of green building design.

3. Adaptability and Community Engagement

Local builders and designers in Pakistan possess a remarkable ability to work with available resources while adapting designs to suit the local climate and cultural preferences, which can be beneficial for green architecture. In many cases, involving the community in building projects fosters a sense of ownership and ensures harmonious integration with the surroundings.

4. Geographical Advantages and Investment Opportunities

Situated at a crucial crossroads of trade routes, Pakistan's strategic geographical location holds immense potential for the development of modern infrastructure and transportation networks. This, in turn, can attract substantial domestic and foreign investment, fuelling the nation's growth.

5. Natural Integration and Technological Innovation

Pakistan's breathtaking natural landscapes provide a unique opportunity to seamlessly integrate nature into architectural designs, resulting in visually appealing and sustainable buildings. Moreover, as technology continues to advance, Pakistan has the chance to incorporate cutting-edge innovations in construction materials, renewable energy solutions, and smart building technologies into its architectural repertoire.

6. Educated Professionals in Modern Infrastructure

The country benefits from a pool of highly educated professionals in the fields of architecture, engineering, and related disciplines. These experts can be trained to shift towards sustainable design strategies.

OPPORTUNITIES IN ADOPTING GREEN ARCHITECTURE IN PAKISTAN

The following opportunities exist in Pakistan's construction sector which can be utilized by shifting toward sustainable and green architecture:

1. Addressing the Energy Shortage in a Nation Struggling with Frequent Power Outages

Pakistan faces a growing energy crisis, with buildings consuming about 50% of Pakistan’s energy. To address this, Pakistan can embrace green building practices, like building orientation, optimal WWR, biophilic design elements, and green roofs, to reduce energy use and improve comfort, which can lead to energy cost savings of up to 30-40% on average. This aligns with sustainable development goals, such as Goal 7 (Affordable and Clean Energy), Goal 13 (Climate Action), and Goal 11 (Sustainable Cities and Communities). Given ample sunlight, integrating solar panels and other renewable energy sources into buildings can also promote renewable energy and reduce greenhouse gas emissions, further supporting sustainable development goals.

2. Cost Savings in Operations

Integrating sustainable building design practices into a building can offer a vast amount of energy cost-saving potential from different aspects such as **WWR saving up to 12-40% of energy cost**, **orientation saving up to 10-40% of energy cost, green roofing systems saving up to 35% of energy cost**, and renewable energy integration which can shift the whole energy consumption to renewable sources., Given the circumstances, the potential for substantial growth offers a positive outlook for the green building industry to thrive, promising sustained rental income in the long run. This growth aligns with Goal 11 (Sustainable Cities and Communities) by ensuring accessible and sustainable housing for all.

3. Enhanced Quality of Life

Traditional building design methods in Pakistan often result in cramped living spaces with limited ventilation and poor indoor air quality for occupants. In contrast, green buildings prioritize fresh and healthy indoor air quality as a fundamental design element. Green buildings achieve improved indoor air quality by utilizing good orientation, nature-based solutions, and windows for heating and cooling. Consequently, green building practices offer a distinct advantage over conventional design techniques by creating a better and healthier lifestyle for occupants.

4. Promoting Sustainable Design Practices

Transitioning from these conventional design practices to energy-efficient alternatives holds the potential not only to conserve energy but also to curtail greenhouse gas emissions wind energy systems can save emissions up to **0.75- 2.2 Mt CO_2 per year** and the use of biomass boilers can save **95% to 99%** emissions as compared to fossil fuel-based energy. Additionally, the use of sustainable design practices aligns with Pakistan's goal of promoting responsible consumption and production, a crucial aspect of the Sustainable Development Goals (SDGs).

5. Utilizing the labor in an effective way

Pakistan boasts a substantial labor force of 68.75 million individuals. This surplus of labor resources can lend support to the adoption of green building practices. Leveraging this circumstance presents an opening to promote the use of affordable labor for the integration of green building practices. This aligns with Goal 8 (Decent Work and Economic Growth) of the SDGs by creating employment opportunities.

6. Integration of Cultural design and modern technology

Building designs can be enhanced by integrating cultural elements and architectural heritage specific to Pakistan. This not only preserves cultural identity but also creates a sense of place in modern designs. By promoting a connection between modern architecture and cultural roots, sustainable design practices can contribute to Goal 11 (Sustainable Cities and Communities) by fostering community cohesion.

4. CONCLUSION AND WAY FORWARD

The building sectors such as the residential and commercial contribute most to the energy consumption in Pakistan. The analysis of building design in Pakistan shows a lack of sustainable design practices in the residential, commercial, and public sectors due to lack of awareness of architects and the public, lack of technology, and lack of implementation of building codes being the major reasons. The NEECA National Energy Conservation Code 2023 contains detailed guidelines on building orientation, WWR, green roofing systems, and renewable energy use. Integrating sustainable building design practices into a building can offer a substantial amount of energy cost-saving potential from different aspects such as WWR saving up to 12-40% of energy cost, orientation saving up to 10-40% of energy cost, green roofing systems saving up to 35% of energy cost, and renewable energy integration, which can shift the whole energy consumption to renewable sources. The cost analysis showed that by transitioning conventional buildings into green buildings from a design perspective payback can be received in about 3 years from energy savings. This demonstrates that embracing green building practices is cost-effective and environmentally friendly. There exist enormous strengths and opportunities in the construction sector that can be used to assist in the shift towards greener and sustainable design practices in Pakistan.

Looking ahead to the future of green buildings in Pakistan, there are both challenges and opportunities to consider. Pakistan faces energy shortages and environmental concerns. Green buildings emerge as a promising solution to address these issues and promote economic growth, social well-being, and ecological balance. By incorporating energy-efficient technologies and innovative design methods, green buildings can transform Pakistan's construction sector.

However, there are some hurdles to adopting green building practices. These include concerns about high initial costs, economic realities, and the need to raise awareness among all stakeholders. It's important to review and improve the green building principles outlined in building codes and policies. In essence, a promising future awaits green buildings in Pakistan through collaboration, the sharing of knowledge, and an environment that supports green buildings and sustainable building design practices. By envisioning a future where buildings harmonize with nature and enhance people's well-being, Pakistan can pave the way for resilience, sustainability, and overall vitality.

Appendix 6. Analysis of Situation and Opportunities in Building Construction Material

1. INTRODUCTION

PURPOSE OF THE REVIEW AND ANALYSIS

The report evaluates the structural integrity of the existing infrastructure in Pakistan, with a focus on the materials used and their impacts. This document however focuses on three major types of buildings that currently exist in the country

- **Residential Buildings:** In Pakistan residential/domestic buildings range from modern apartments to traditional houses with courtyards. These buildings use various construction materials such as brick, mud, concrete, and steel.
- **Commercial Buildings:** Commercial buildings mainly consist of offices, retail stores, malls, hotels, restaurants, and warehouses. These buildings employ a variety of construction materials including steel, concrete, wood, aluminum, and glass, to ensure durability and functionality.
- **Public Buildings:** Public buildings in Pakistan are of various types such as government offices, schools, hospital buildings, religious places, and transportation hubs. These buildings accommodate large crowds with accessibility features.

The evaluation has considered various aspects of the building's structural integrity and has identified the structural enhancements necessary for the transition from conventional buildings to green buildings. This includes an assessment of conventional materials used in the construction of the building sector and the potential of green materials that can replace the current materials. Moreover, it compares the cost of the buildings calculates the energy savings that can be obtained by using sustainable materials, and computes the payback period for the transition of conventional buildings into green buildings. Along with addressing the critical issue of the supply chain for green construction materials, the report recommends measures to promote green construction practices within Pakistan.

BACKGROUND

The construction industry is experiencing a significant boom and is estimated to grow by 35% as compared to the previous decade. The global construction market is expected to expand from US$4.5 in 2021 trillion to US$15.2 trillion in 2030, with China, India, US, and Indonesia accounting for 58.3% of the forecasted growth. According to the World Bank, the construction industry is the largest global consumer of raw materials with the construction environment accounting for 25% to 40% of the world's total GHG emissions.

Construction materials used in Pakistan are mostly conventional such as steel, cement, glass, bricks, and wood. These are not always economical, environmentally friendly, and health-conscious. However, by using sustainable alternatives many of these drawbacks can be mitigated. Cement is commonly used in Pakistan but cement production is an energy-intensive process that leads to substantial expenses replacing it with fly ash cement can offer a more cost-effective and environmentally friendly alternative. Glass can be really expensive when it is used in large and intricate designs but it can be substituted by insulated glass that is cost-effective in long term due to energy efficiency. Traditional bricks are affordable but less sustainable thus fly ash bricks can be a sustainable alternative.

Furthermore, these construction materials result in carbon emissions for instance steel is a widely favored metal selection for constructing buildings in Pakistan but its production is associated with significant carbon emissions. By choosing sustainable alternatives such as bamboo or recycled steel, environmental impact can be significantly reduced. In Pakistan, traditional glass is a commonly utilized building material. However, it keeps the building warm in summer and thus requires more cooling resulting in carbon emissions. By using low emissivity windows or insulated glass units, buildings keep cool in summer and warm in winter hence the energy consumed by the Heating, Ventilation, and Air Conditioning (HVAC) system resulting in reduced carbon emissions. Similarly, replacing conventional bricks with fly ash bricks conserves natural resources and minimizes the environmental footprint.

Moreover, sustainable materials such as rammed earth or bamboo do not emit harmful chemicals contributing to a healthier indoor environment. Likewise, fly ash cement is durable and safe benefiting the safety of residents. Bamboo and low-VOC paint ensure better indoor air quality, and green roofs and galvanized sheet roofing offer improved insulation and provide a better indoor environment resulting in health benefits for occupants.

However, it is difficult to meet the ever-growing demand for buildings by adopting only sustainable materials and construction methods. Hence, there is a need for optimum utilization of available energy resources and raw materials to produce simple, energy-efficient, environment-friendly, and sustainable building alternatives and techniques to satisfy the increasing demand for buildings.

2. PAKISTAN GREEN BUILDING SCENARIO

Currently, Pakistan lacks the adaptation of sustainable materials in the building construction sector, primarily because of the high initial costs, the lack of awareness regarding the benefits of using these materials, and the absence of a dedicated supply chain. According to Green Building Information Gateway (GBIG), Pakistan contains 17 LEED-certified green buildings with 13 registered with the US Green Building Council and 1 with an achiever award, making a list of 31 total green buildings in the country. This number is quite low compared to other developing countries; where India has 323 certified LEED buildings and Turkey reported 518 certified green buildings.

Additionally, in Pakistan, the green building approach suffers from market barriers, for instance, there is a lack of government intervention in the market and inadequate tax incentives for green building materials. Besides, Pakistan's construction industry lacks training for sustainable material usage resulting in lesser awareness about the benefits of using these materials at the micro level. Also, the supply chain for sustainable materials is weak in Pakistan, consequently increasing the costs of materials. Although some green and recyclable materials such as fly ash bricks, bamboo, and recycled steel are gaining popularity in building construction but are in a nascent state. Hence, the phenomenon of using green building materials is very novel and not widely practiced in Pakistan.

BUILDING CODES AND FRAMEWORKS IN PAKISTAN

The latest **Building Code of Pakistan (2021)** provides a minimum benchmark to ensure seismic resilient building design based for all new buildings. It has comprehensive guidelines on traditional constructional materials (concrete, steel, wood, and glass), but these guidelines are mainly focused on the structural strength aspects of these materials to make the structure robust against **seismic threats** in the future. Furthermore, it lacks guidelines about material usage in buildings from the point of view of energy savings in buildings.

On the other hand, The Energy Efficiency of Buildings section is not included in **Building Code 2021**. as they were covered in Building Code of Pakistan-Energy Provisions 2011. However, Energy Provisions 2011 is no longer used in Pakistan and has been replaced by **the Energy Conservation Building Code 2023 (Pakistan) (ECBC-2023).** The codes focusing on energy-efficient building materials are being prioritized because energy demand in the country has enhanced substantially. To further increase the future adaptation of sustainable materials reducing electricity consumption and carbon footprints should be included in future provisions of the building code because it will provide a legal framework for the adaptation of sustainable materials in the construction of buildings.

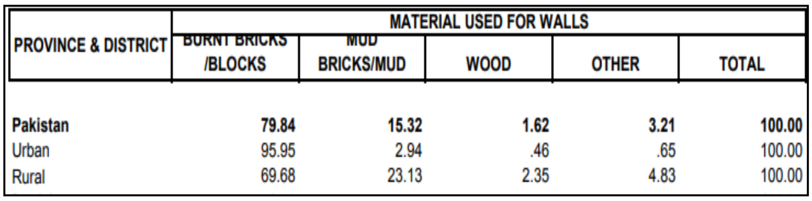
Moreover, SWITCH-Asia-EU – EU, in collaboration with the Ministry of Climate Change (MoCC), Pakistan Engineering Council (PEC), UN-Habitat, and the International Code Council (ICC), has successfully developed the **Green Building Code Provisions**. These provisions are based on the 2018 International Green Construction Code (IgCC-2018), ASHRAE 90.2 2018, and various research projects (Arif 2022/NRPU 9626) conducted in Pakistan. Chapter 5 of this green building code discusses **materials** and **resources** that need to be incorporated into buildings. This document was prepared for the Naya Pakistan Housing scheme and addresses the need for transition to green materials and provides suggestions for incorporating sustainable materials employing recycling waste, replacing hazardous materials, and usage of insulation to reduce energy requirements. Although it does not provide comprehensive guidelines to transit completely on these materials it can be used as initial guidelines for incorporating sustainable materials in new housing schemes.

Buildings in Pakistan can adopt green materials and strategies that comply with the Energy Conservation Building Code 2023. The code was developed to improve energy efficiency in buildings. ECBC provides minimum requirements for energy-efficient designs and construction of buildings and includes international best practices appropriate to Pakistan's environment. This document can be utilized as a useful framework for encouraging the adaptation of green materials. It covers materials that can be replaced and used instead of conventional materials in the construction phase and the materials that can help in opting energy energy-efficient designs to enhance the operational phase of buildings.

3. CONSTRUCTION MATERIALS PRACTICES IN PAKISTAN

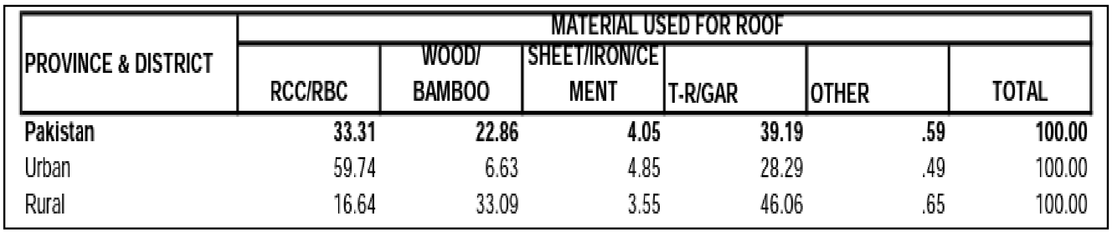
In Pakistan construction industry primarily relies on a variety of materials. The energy conservation pattern exhibited by these materials is still lacking as compared to other countries because hardly any appropriate measure has been taken for heating, cooling, leakage, or orientation.

The figures given below represent the distribution of construction material according to the material used for walls.



PROVINCE & DISTRICT	MATERIAL USED FOR WALLS				
	BURNT BRICKS /BLOCKS	MUD BRICKS/MUD	WOOD	OTHER	TOTAL
Pakistan	**79.84**	**15.32**	**1.62**	**3.21**	**100.00**
Urban	95.95	2.94	.46	.65	100.00
Rural	69.68	23.13	2.35	4.83	100.00

Figure 46: Housing Units in Pakistan by Construction Material (Source: Pakistan BUREAU of Statistics 2019-20)

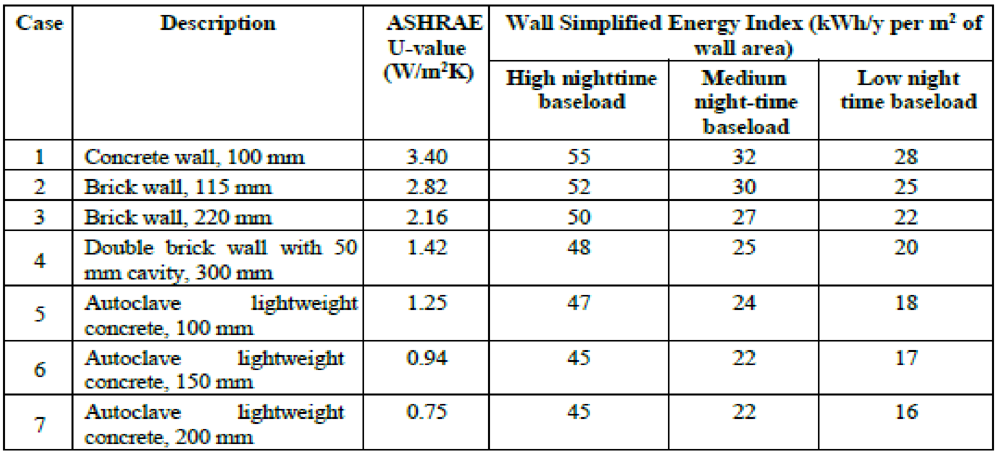


PROVINCE & DISTRICT	MATERIAL USED FOR ROOF					
	RCC/RBC	WOOD/ BAMBOO	SHEET/IRON/CEMENT	T-R/GAR	OTHER	TOTAL
Pakistan	**33.31**	**22.86**	**4.05**	**39.19**	**.59**	**100.00**
Urban	59.74	6.63	4.85	28.29	.49	100.00
Rural	16.64	33.09	3.55	46.06	.65	100.00

Figure 47: Percentage Usage by Material Used in Roofs (Source: Pakistan BUREAU of Statistics 2019-20)

The statistics show intensive usage of concrete and bricks in urban construction while the usage of bamboo and gar is quite prevalent in rural areas. With increasing urbanization, the utilization of bricks and concrete is expected to mount up in urban areas, the higher consumption of this material will consequent in the heat island effect due to the adoption of concrete, and needs to be mitigated by using sustainable materials. Although bamboo and gar are used in higher percentages in rural areas with increasing urbanization fewer people prefer them so the adoption of these and other sustainable materials should be enhanced in both urban and rural areas. In addition, modern techniques should be used to make them resilient and aesthetically appealing

Furthermore, Pakistan lies in a temperate climate zone and according to **Energy Conservation Building Code 2023**, in a temperate climate zone, using appropriate building materials with insulating properties can substantially decrease energy consumption. Hence it is essential to identify the varying energy-saving potential of wall materials with different coefficients of heat transfer (U-values). The estimated values are provided below in Figure 3, these values are based on an energy simulation study outlined in the report of **Building Sector Energy Efficiency Project-2021 (BSEEP)**.



Case	Description	ASHRAE U-value (W/m^2K)	Wall Simplified Energy Index (kWh/y per m^2 of wall area)		
			High nighttime baseload	Medium night-time baseload	Low night time baseload
1	Concrete wall, 100 mm	3.40	55	32	28
2	Brick wall, 115 mm	2.82	52	30	25
3	Brick wall, 220 mm	2.16	50	27	22
4	Double brick wall with 50 mm cavity, 300 mm	1.42	48	25	20
5	Autoclave lightweight concrete, 100 mm	1.25	47	24	18
6	Autoclave lightweight concrete, 150 mm	0.94	45	22	17
7	Autoclave lightweight concrete, 200 mm	0.75	45	22	16

Figure 48: Estimated Electricity Reduction for Wall Materials (Source: Public Works Department Malaysia-2021)

The model considered in the above study was designed using a square building without external shades, with a service core located in the building's center. The high, medium, and low night-time baseloads are associated with night baseloads of 50%, 35%, and 10% of the daytime peak load, respectively. It shows that by reducing the wall material's U-value, the simplified energy index can be decreased. Additionally, the U value of lightweight concrete walls is lower thus energy saving potential increases with reducing concrete in the wall.

Materials that have been traditionally used in Pakistan's construction industry are discussed below along with their impacts.

1. Brick

Clay brick has high energy consumption in the operational phase of buildings because of its low insulation properties. Clay bricks however can be replaced with ash blocks that are

3 times costlier and considerably decrease the requirement of cooling resulting in reduced size of the air conditioning system. Hence ash blocks can be an effective substitute for clay bricks.

2. Cement

Cement is a widely used construction material in Pakistan which has multiple negative impacts on the building's operational phase. Cement-based buildings often have high thermal mass, tending to take a long time to heat up or cool down. This results in increased energy consumption, especially in regions with extreme temperature variations. Although the majority of carbon emissions associated with cement occur during its manufacturing, there is still an ongoing carbon footprint during the operational phase due to the energy required for the HVAC system. Alternatively, fly ash cement is an efficient material to reduce the use of cement. Blocks of cement from fly ash have high insulation and a lower carbon footprint which mitigates the negative impacts of cement.

3. Concrete

The use of concrete is problematic in buildings as it adds to the heat-island effect by absorbing the warmth of the sun and trapping gases from car exhausts and air-conditioner units installed in a building. Concrete is widely used in both urban and rural buildings in Pakistan hence energy energy-efficient alternative blends or materials can help to reduce these negative effects. Rammed Earth is a viable alternative that has high insulative properties and high durability against earthquakes.

4. Steel

Steel-framed buildings often require more energy for heating and cooling compared to well-insulated structures. Steel has high thermal conductivity, which results in significant heat loss or gain, depending on the climate. Moreover, steel structures can corrode over time, especially in humid or coastal environments such as Sindh and Balochistan. The corrosion leads to maintenance requirements, including repainting or even structural repairs, which can be costly and resource-intensive. A sustainable alternative for Pakistan can be a galvanized steel sheet that has high heat resistance and low operational cost making it a more appealing choice.

5. Wood

Pakistan has limited forest cover, encompassing less than 6 % of its total land area. The usage of wood in the building further results in **deforestation** causing loss of carbon sink, reduced biodiversity air quality degradation, and soil erosion. Thus, it is an urgent requirement to replace wood with an alternative material. In addition, wood treatments, finishes, or adhesives emit volatile organic compounds (VOCs), which can affect indoor air quality and occupant health. According to **Energy Conservation Building Code 2023**, wood framing exhibits a lower R-value, allowing heat to conduct more easily compared to insulated regions which increases the energy demand of buildings to cool them. To replace wood works in a building bamboo should be used in Pakistan because of its higher insulation and renewability factor.

6. Traditional Roofing Materials (Asphalt and Metal Tiles)

Asphalt and metal tiles are some of the materials used in the roofing of buildings in Pakistan. They do not provide adequate insulation, leading to higher energy consumption for cooling or heating buildings. Hence, to reduce energy consumption, sustainable insulation materials such as galvanized sheets and bamboo can be viable options for roofing.

7. Non-insulated Glass Windows

Non-insulated windows are less energy-efficient, leading to higher energy consumption for heating and cooling. Unlike insulated glass doors and windows, they do not resist heat. Their insulation ability is not resistant enough to protect the room or building from hot weather. This allows heat to enter more than it would from an insulated glass. In summer or regions where temperatures can be extreme, this can result in significant energy wastage. In Pakistan due to its cost-effectiveness, it's preferred over the other options but it is not suitable in long-term scenarios because energy losses from its usage result ultimately in higher costs. Alternative double-glazing windows with low emissivity are a viable sustainable alternative that can be used instead of non-insulated windows.

Pakistan continues to grow and modernize, and a strategic shift toward sustainable construction materials is a pressing necessity. The shortcomings in the traditional materials seek the intervention of sustainable alternatives to enhance the overall energy efficiency of the buildings and move towards greener buildings. The construction industry in Pakistan stands at a pivotal state where the adoption of sustainable materials can bring a multitude of benefits. Not only it will address environmental concerns but it will significantly contribute to energy efficiency financial benefits and a resilient future .

4. SUSTAINABLE CONSTRUCTION MATERIALS FOR GREEN BUILDINGS IN PAKISTAN

A large number of viable alternative building technologies have been developed and disseminated over two and half decades. The materials are currently used at a micro-scale in Pakistan but their increased adoption is necessary for a sustainable future.

Table 35: Traditional Materials and Available Sustainable Alternatives In Pakistan

Traditional Materials	Sustainable Alternatives
Clay Bricks	Fly Ash Brick
Traditional Paint	Low VOC Paint
Insulated Glass Window	Low Emissivity Window /Insulated Glass Units
Concrete	Rammed Earth/ Bamboo
Cement	Fly Ash Cement
Wood	Bamboo/PVC flooring
Traditional Roofing Material	Green Roofs/Bamboo/Galvanized Sheet

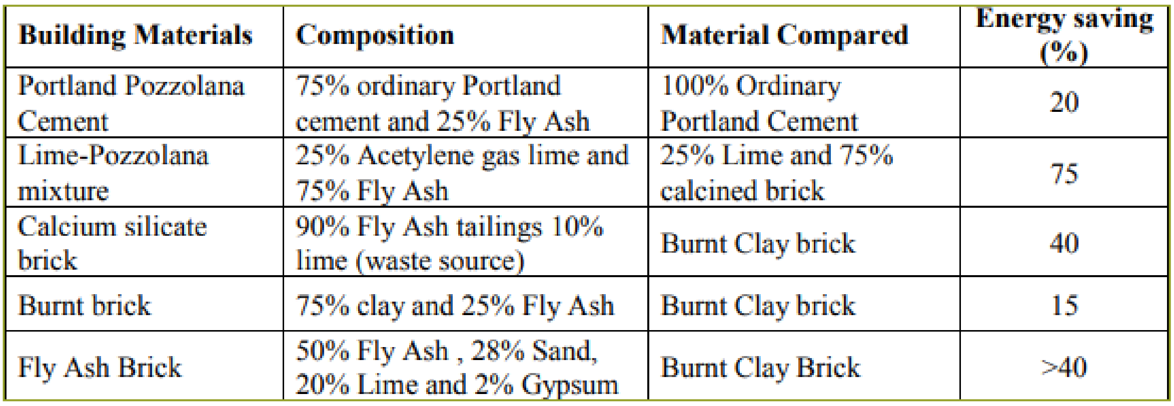
A comprehensive detail of these alternative materials and some additional green building materials is discussed below:

1) Fly Ash Bricks

Fly ash bricks are made from waste materials produced by coal-fired power plants. They are strong, durable, and environmentally friendly, as they help reduce waste by recycling ash and save energy through high insulative properties. Furthermore, fly ash bricks have excellent insulation properties resulting in less HVAC energy consumption.

Fly ash bricks are a sustainable building material because they have a lower carbon footprint compared to traditional clay bricks. They are also cheaper than traditional bricks, making them an affordable option for construction in Pakistan.

Figure 49: Fly Ash Bricks



Building Materials	Composition	Material Compared	Energy saving (%)
Portland Pozzolana Cement	75% ordinary Portland cement and 25% Fly Ash	100% Ordinary Portland Cement	20
Lime-Pozzolana mixture	25% Acetylene gas lime and 75% Fly Ash	25% Lime and 75% calcined brick	75
Calcium silicate brick	90% Fly Ash tailings 10% lime (waste source)	Burnt Clay brick	40
Burnt brick	75% clay and 25% Fly Ash	Burnt Clay brick	15
Fly Ash Brick	50% Fly Ash , 28% Sand, 20% Lime and 2% Gypsum	Burnt Clay Brick	>40

Figure 50: Energy Savings using Fly Ash

Moreover, according to the guidelines of **Green Building Code Provisions by MoCC Pakistan,** recycled materials shall be utilized in green housing projects to promote a circular economy and divert material from landfills. The recycled material needs to be a specified percentage of the total material, preferably by cost. Thus, using fly ash bricks is aligned with the provisions.

2) Insulative Material

The heat gain in hot climates can be fairly reduced by well-planned insulation of walls resulting in less (HVAC) and annual energy costs. The kind of insulative material that is available in Pakistan and can be used to lower energy conservation are insulated glass and cellulose insulation.

- **Insulated Glass**

Insulated glass unit (IGU), more commonly known as double glazing, consists of two or three glass window panes separated by a vacuum or gas-filled space to reduce heat transfer across a part of the building envelope. It is a very effective way to reduce air-to-heat transfer through the glazing. When used in conjunction with low-emissivity and/or reflective coatings, IGU performs even better for conserving energy and complying with international standards.

Double glazing greatly reduces the amount of heat transmitted through a building's windows, by **20-25 %** and perhaps as much as **50 %**. This means that less energy will be needed to heat or cool the building, saving the cost to the owner as well as reducing the building's carbon footprint.

However, the **Energy Conservation Building Code 2023** has provided guidelines that glazing shall be used very carefully a balance between natural light, ventilation, and heat gain should be maintained properly. The windows must be appropriately shaded and insulated to minimize the heat exchange. These insulated glasses are highly valuable for the compliance of **ECBC.**

- **Cellulose insulation**

This material is endorsed by the **ECBC (2023)** to be used as insulation material in roofs. One of its significant uses in Pakistan is for thermal insulation. The low thermal conductivity of cellulose foam makes it an excellent choice for insulation purposes.

A comparative evaluation between various sustainable materials has been done and the total load savings by each material is shown below.96

Table 36: Total Load and Load Saving Using Each Insulation[89]

Month	**Total Load (MWh)**			
	Cellulose	**Polystyrene Foam**	**Polyurethane Foam**	**Rock Wool**
Jan	0.36	0.309	0.358	0.343

Feb	0.003	0.959	0.003	0.002
Mar	15.29	15.011	15.288	15.21
Apr	45	43.91	44.8	44.551
May	62.17	60.884	62.17	61.81
Jun	52.8	51.714	52.8	52.497
Jul	42.275	41.524	42.275	42.065
Aug	44.301	43.557	44.301	44.093
Sep	42.075	41.347	42.075	41.871
Oct	29.953	29.442	29.953	29.809
Nov	7.933	7.837	7.933	7.906
Dec	0.361	0.367	0.361	0.122
Grand Total	342.317	336.861	342.317	340.279
Percentage Load Saving	**28.132%**	**29.293%**	**28.132%**	**28.50%**

Findings indicate that polystyrene foam (high density) stands out as the most effective insulating material. However, it's important to note that due to its high flammability, it necessitates an additional layer of fireproof coating material. Typically, this involves the application of a fireproofing chemical known as Hexabromocyclododecane.

On the other hand, rock wool lacks additives that confer fire resistance, making it less suitable for use in extremely hot conditions, though it is inherently non-combustible.

Whereas polyurethane foam employs CFC gas as a blowing agent which contributes to ozone layer depletion.

Cellulosic insulation is found to be the most eco-friendly, fire-resistant, and suitable insulating material. Using cellulose insulation helps to keep spaces comfortable and energy-efficient, contributing to a more sustainable environment. This is beneficial, especially for Pakistan, where energy conservation and temperature control are important, whether it's for houses, commercial buildings, or public facilities. **오류! 책갈피가 정의되어 있지 않습니다.**

3) Cool Brick

There is a new material being experimented on in Pakistan, propelled by the Muscatese Evaporative cooling window, which joins a fired vessel loaded up with water and a wood screen. A 3D-printed porous clay block is set in mortar, every block retains water like a wipe and enables air to go through the divider. As air passes through the 3D printed block the water that is present in the tiny scale pores of the clay dissipates, bringing cool air into an inside domain and reducing the temperature using the guideline of evaporative cooling. In Pakistan, the cool brick will provide thermal comfort within the structure without using any mechanical cooling device resulting in less HVAC energy consumption.. The assessment of 3D-printed green walls shows that they lower the AC load by **11.20%** in summer and **9.12%** yearly.

4) Low VOC Paint

In Pakistan, paint serves the dual purpose of protecting walls and adding decorative appeal to buildings. The paints used in Pakistan release **harmful chemicals** called VOCs into the indoor air, leading to air pollution indoors. According to **Green Building Code Provisions**, the use of paints and coatings having a high content of VOCs, such as formaldehyde, should be prohibited to ensure healthy indoor air.

To address this issue, paint manufacturers in Pakistan, are now producing low-VOC paints. Notably, in Pakistan, water-based paints are a preferable choice since they contain **three**

times fewer VOCs compared to oil-based paints. Moreover, lighter-colored paints and those with a flat finish tend to have lower VOC levels, making them a better option for indoor spaces, and contributing to better indoor air quality and health.

5) Low Emissivity Windows

The **Energy Conservation Building Code 2023** of Pakistan emphasizes using windows that are properly shaded and insulated and have R values under advisable limits. Regular, uncoated glass in Pakistan has a high emissivity value of **0.91**, which means it allows a lot of heat to escape from buildings, making it less energy-efficient.

To address this issue, low-emissivity (Low-E) glass can be utilized. This glass has a nearly invisible coating on one side that reflects heat away in summer and back into the room in winter, it helps in maintaining indoor temperature making buildings more comfortable and energy-efficient in hot weather.

Windows manufactured with Low-E coatings typically cost about 10% to 15% more than regular windows, but they reduce energy loss by as much as **30% to 50%**.

- **Single vs Double-Glazed Window**

Replacement of single-glazed windows with brown-tinted double-glazed ones, while maintaining all other factors unchanged can result in a 4.17% reduction in annual thermal loads.

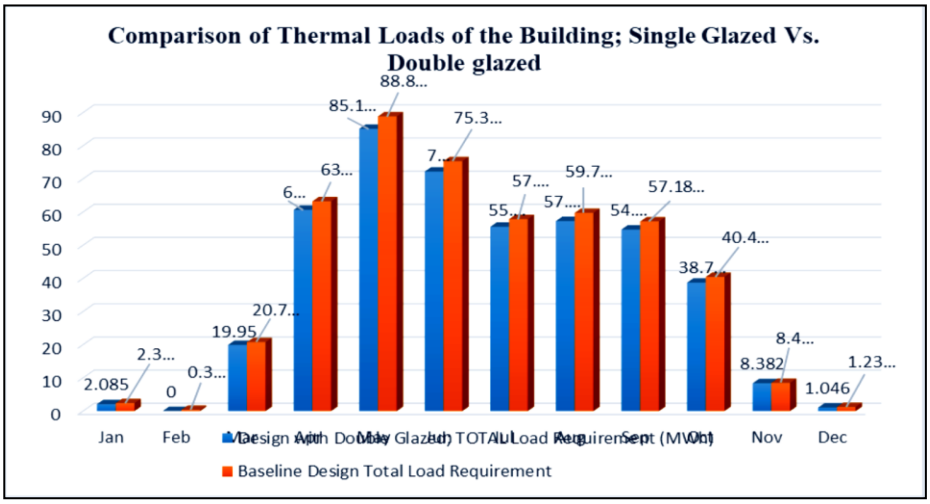
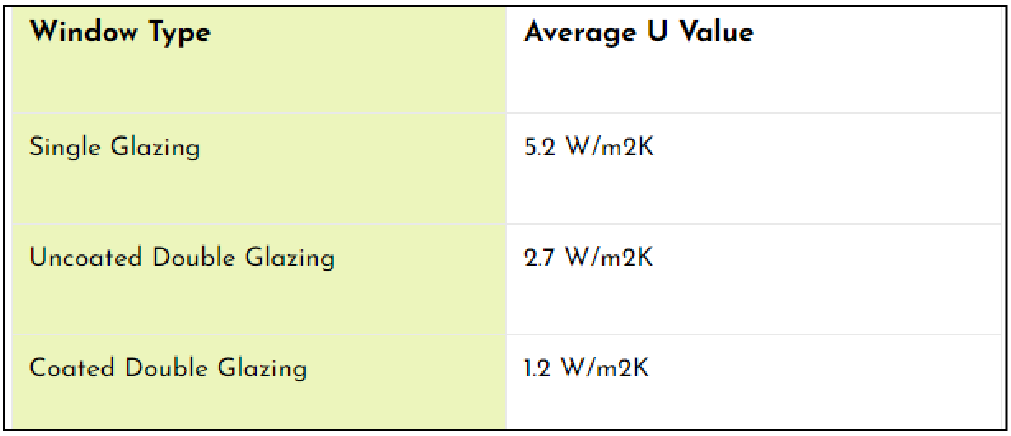


Figure 51: Comparison of Thermal Loads for Single Glazed and Double Glazed Window

- Annual Load with Single Glazed Windows = 476.024 MWh
- Annual Load with Brown Tinted Double Glazed Windows = 456.150 MWh

- Load Saving = **4.1683%**

Table 37: Comparison of U values between Different Categories of Glazing Glass



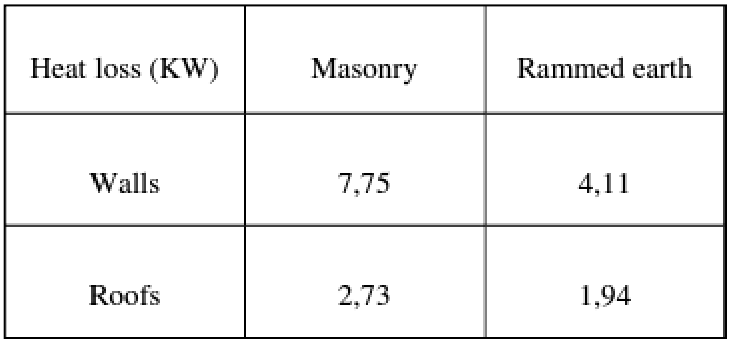
Window Type	Average U Value
Single Glazing	5.2 W/m2K
Uncoated Double Glazing	2.7 W/m2K
Coated Double Glazing	1.2 W/m2K

The lower the U value, the better the thermal performance of the glass. Hence, the lower U value of double-glazing glass as shown in the above table validates better thermal performance that increases energy saving potential.

6) Rammed Earth

It is a sustainable building material that is made by compressing layers of earth, gravel, and other locally available materials. Rammed-earth buildings are highly durable and can withstand **earthquakes**, **fires,** and other natural disasters. They have excellent **insulation properties**, which can help reduce the need for heating and cooling systems. The maximum average energy saving in a study indicates a saving **of 2192.27 kWh/annual** from houses built on Rammed Earth.

Table 38: Heat Losses Comparision of Masonry and Rammed Earth[107]



Heat loss (KW)	Masonry	Rammed earth
Walls	7,75	4,11
Roofs	2,73	1,94

The added benefit is that this will reduce the carbon output by around **1 tonne per year**, primarily from heating and cooling.

Figure 52: Rammed Earth Structure in Pakistan

7) Bamboo

Building Code Of Pakistan (2021) has provided the framework for wood usage concerning preservative treatment, fire safety, ASTM standards, and other compliance regulations, but in practice, wood is being used without proper adherence to these regulations, However, it lacks the direction of wood usage considering resource depletion and that should be an integral part of the codes in future to conserve the natural wood sources.

The **Green Building Code Provisions** developed by MoCC and Switch Asia suggest that 5 % of the building materials used, based on cost, shall be biobased products (**IGCC 2018**). Moreover, it should be composed of solid wood, engineered wood, bamboo, wool, cotton, cork, agricultural fibers, or other biobased materials with at least 50 % biobased content.

The use of Bamboo in Pakistan as an alternative to woodwork is gaining popularity because hardwood and bamboo are the only renewable flooring options available. Bamboo has the benefit of being rapidly renewable and minimizing CO_2 emissions and generates up to **35% more oxygen** than equivalent stands of trees. A study conducted for energy efficiency concluded that the use of bamboo instead of the conventional reinforced concrete structure would reduce energy consumption by **3% to 5%** and reduce **CO_2 emissions by 7% to 20%.** The analysis of results demonstrates that bamboo residential buildings are more carbon-efficient in cold climates.

Figure 53: Utilization of Bamboo in Navy Housing Scheme Zamzama Karachi

8) Galvanised Sheet

Galvanized steel sheets also come with a corrugated pattern. **For heat resistance**, these sheets are dipped and coated with zinc. As compared to **stainless steel**, a galvanized steel sheet is low in price, requires **less maintenance work**, and can be used for a longer period. All these qualities make it one of the best types of heat-resistant roofing sheets in Pakistan.

They can also be used as additional coatings with heat and waterproofing chemicals, exhibit amazing quality of **damage control,** and are widely known for their robustness. This makes the galvanized steel one of the best roofing materials in Pakistan.

Hence along with traditional materials used in buildings, these options are viable considering the market demand, awareness, and other factors that influence their role in the building construction.

5. COST EVALUATION OF CONVENTIONAL AND SUSTAINABLE CONSTRUCTION MATERIALS

This analysis is focused on comparing the cost if the traditional construction material is replaced with sustainable material. For this purpose, the commercial office building is chosen such that a G+3 rectangular building is considered for a conventional building and a G+4 "L" shaped building is considered for a green building model. Moreover, AutoCAD 2021 and SketchUp were used for rendering the design of the building models, and STACK (take-off and cost estimation) was used for quantity and cost estimation. The models for both buildings are given below:

Figure 54: Conventional Building

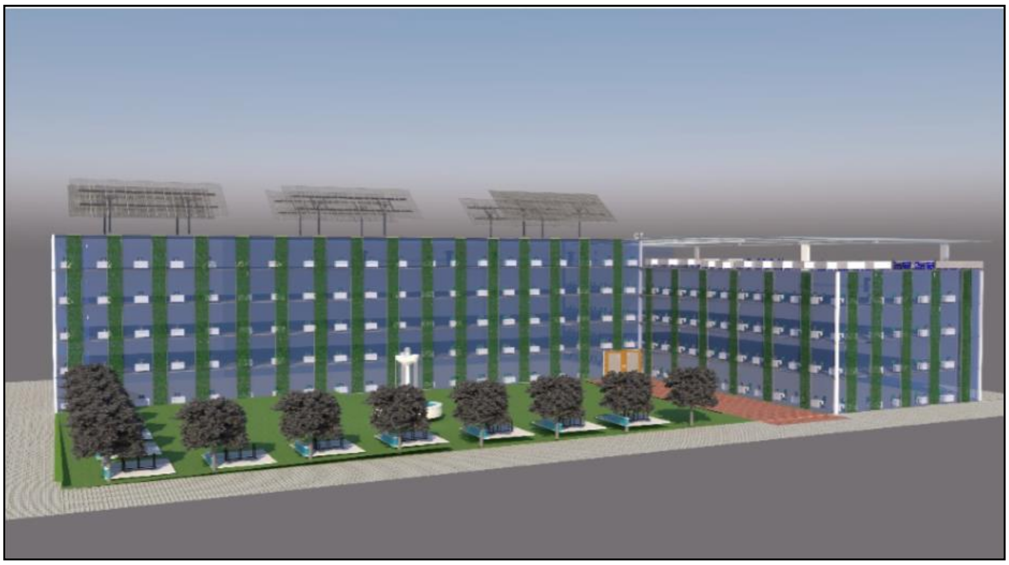
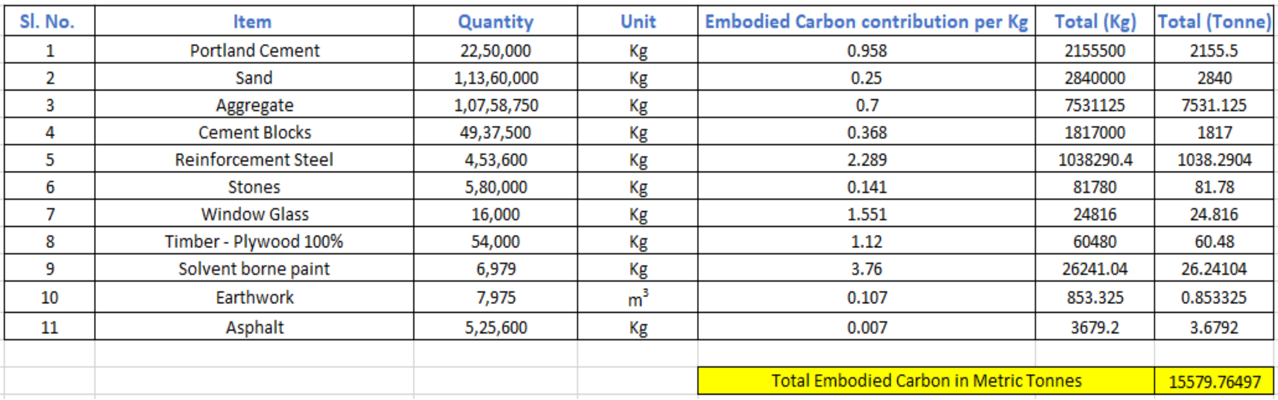


Figure 55: Green Building

CONSTRUCTION MATERIAL

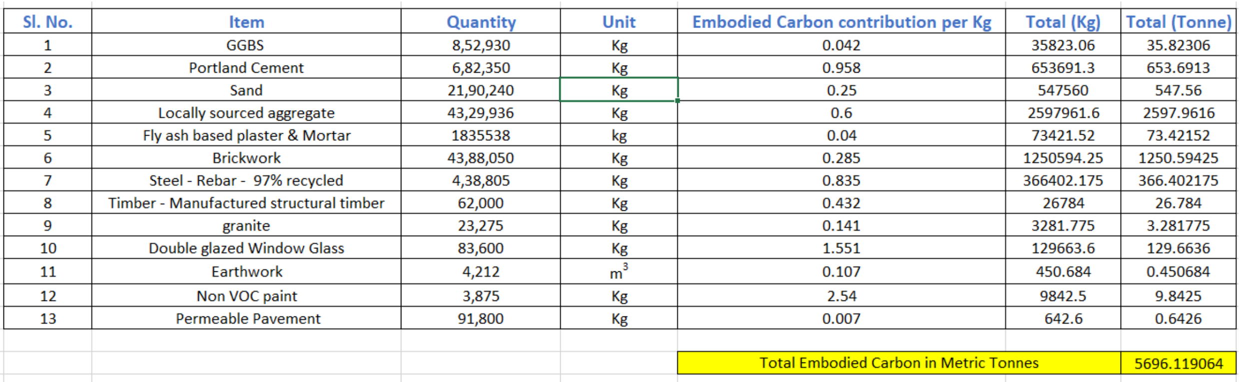
The material used for the construction of both buildings is given below:

Table 39: Construction Material Used in Conventional Building



Sl. No.	Item	Quantity	Unit	Embodied Carbon contribution per Kg	Total (Kg)	Total (Tonne)
1	Portland Cement	22,50,000	Kg	0.958	2155500	2155.5
2	Sand	1,13,60,000	Kg	0.25	2840000	2840
3	Aggregate	1,07,58,750	Kg	0.7	7531125	7531.125
4	Cement Blocks	49,37,500	Kg	0.368	1817000	1817
5	Reinforcement Steel	4,53,600	Kg	2.289	1038290.4	1038.2904
6	Stones	5,80,000	Kg	0.141	81780	81.78
7	Window Glass	16,000	Kg	1.551	24816	24.816
8	Timber - Plywood 100%	54,000	Kg	1.12	60480	60.48
9	Solvent borne paint	6,979	Kg	3.76	26241.04	26.24104
10	Earthwork	7,975	m^3	0.107	853.325	0.853325
11	Asphalt	5,25,600	Kg	0.007	3679.2	3.6792
				Total Embodied Carbon in Metric Tonnes		15579.76497

Table 40: Construction Material Used in Green Building



Sl. No.	Item	Quantity	Unit	Embodied Carbon contribution per Kg	Total (Kg)	Total (Tonne)
1	GGBS	8,52,930	Kg	0.042	35823.06	35.82306
2	Portland Cement	6,82,350	Kg	0.958	653691.3	653.6913
3	Sand	21,90,240	Kg	0.25	547560	547.56
4	Locally sourced aggregate	43,29,936	Kg	0.6	2597961.6	2597.9616
5	Fly ash based plaster & Mortar	1835538	kg	0.04	73421.52	73.42152
6	Brickwork	43,88,050	Kg	0.285	1250594.25	1250.59425
7	Steel - Rebar - 97% recycled	4,38,805	Kg	0.835	366402.175	366.402175
8	Timber - Manufactured structural timber	62,000	Kg	0.432	26784	26.784
9	granite	23,275	Kg	0.141	3281.775	3.281775
10	Double glazed Window Glass	83,600	Kg	1.551	129663.6	129.6636
11	Earthwork	4,212	m^3	0.107	450.684	0.450684
12	Non VOC paint	3,875	Kg	2.54	9842.5	9.8425
13	Permeable Pavement	91,800	Kg	0.007	642.6	0.6426
				Total Embodied Carbon in Metric Tonnes		5696.119064

- Total Embodied Carbon for Conventional Building 15,580 $MTCO_2e$
- Total Embodied Carbon for Green Building 5,696 $MTCO_2e$
- Reduction in Embodied Carbon = **9,884 $MTCO_2e$**

For the above calculations, only using green/sustainable material, 9,884 $MTCO_2e$ can be reduced in the provided case before the implementation of any other green building controls, technologies, or building equipment.

COSTS OF BUILDING CONSTRUCTION MATERIALS

The estimated cost for construction materials for conventional and sustainable buildings is given below:

1) Conventional Building

Table 41: Conventional Building Construction Material Cost

Item	Quantity	Unit	Estimated Price ($)
Portland Cement	2,250,000	Kg	195,430
Sand	11,360,000	Kg	91,623
Aggregate	10,758,750	Kg	80,098
Cement Blocks	4,937,500	Kg	127,433
Reinforcement Steel	453,600	Kg	225,136
Stones	580,000	Kg	44,980
Glass	16,000	Kg	14,766
Timber	54,000	Kg	457
Paint	6,979	Kg	8,327
Earthwork Excavation	7,975	m'	138,538
Asphalt	525,600	Kg	163,045
Grand Total			**1,089,833**

The costs given above are only focused on the construction material in a fully functional green building other costs can be for:

- Electrical Wiring

- Water Supply & Sanitation
- Labour Charges
- Scaffolding, Shuttering, etc.
- Consultation and miscellaneous work
- Contingencies

2) Sustainable Building

Table 42: Green Building Construction Material Cost

Item	Quantity	Unit	Estimated Price ($)
GGBS	852,930	Kg	10,583.385
Portland Cement	682,350	Kg	59,280.504
Sand	2,190,240	Kg	17,665.032
Locally sourced aggregate	4,329,936	Kg	37,605.120
Fly ash-based plaster and mortar	849	m'	22,123.943
Brickwork	4,388,050	Kg	52,691.713
Recycled Steel	438,805	Kg	435,584.829
Reclaimed hardwood	62,000	Kg	456.202
Linoleum	23,275	Kg	19,917.753
Window Glass	83,600	Kg	390,860.465
Earthwork Excavation	4,212	m'	73,169.079

Non-VOC Paint	3,875	Kg	6,840.679
Permeable Pavement	91,800	Kg	178,679.070
Grand Total			**1305,457.773**

The costs given above are only focused on the construction material in a fully functional green building other costs can be for:

- Solar Power System
- Rainwater Harvesting System
- Electrical Wiring
- Water Supply & Sanitation
- Labour Charges
- Scaffolding, Shuttering, etc.
- Consultation and miscellaneous work
- Contingencies

Note: The cost of building materials is adjusted considering the year when costs were recorded (2022) and the present scenario (2023).

ELECTRICITY CONSUMPTION

Electricity consumption and saving comparison of a conventional and green building are given below:

Table 43: Electricity Consumption

Building Type	**Duration**	**kWh**	**$**
Conventional Type	1 Year	1,672,200	255,847

Green Type	1 Year	929,000	142,137

- 1 kWh= Assumed $ 0.15 for commercial electricity unit
- Saving/ year = 255,847-142,137
- Saving/ year = **$ 113,710 / year**

Note: In green buildings, electricity can be generated using renewable energy technologies. However, this analysis is only focused on construction material thus it has not been considered.

PAYBACK PERIOD

The payback period for converting conventional buildings into green buildings is calculated and provided below.

- Cost Difference = Grand Total for Sustainable Building - Grand Total for Conventional Building
- Cost Difference = 1,305,458 - 1,089,833
- Cost Difference= $ 215,625
- Payback Period= 1.89 Years
- Payback Period**= Approximately 2 Years**

Note: The payback period is only focused on building construction materials, it does not include any design advancements, technology installation, rainwater harvesting system, or any other costs.

6. MARKET DEMAND FOR GREEN CONSTRUCTION MATERIALS

The construction industry in Pakistan has traditionally been a significant contributor to the country's GDP and employment. However, the rapid urbanization and industrialization taking place in Pakistan have raised concerns about environmental sustainability. This has led to an increasing demand for green construction materials, which are characterized by their environmentally friendly attributes.

One of the primary drivers of the demand for green construction materials in Pakistan is the rising awareness of environmental issues. As the country faces the adverse effects of climate change, there is a growing recognition of the need to reduce carbon emissions, minimize resource depletion, and curb pollution. Green construction materials are seen as a practical solution to address these concerns.

Another factor fueling the demand for green construction materials is the need for sustainable infrastructure development. Major government initiatives like the **Naya Pakistan Housing Scheme** and the **Ravi Riverfront Urban Development Project** have the potential to reshape Pakistan's urban landscape. To ensure the long-term sustainability of these projects, there is a requirement for materials that are not only durable but also environmentally responsible.

REFLECTIONS ON SUSTAINABLE MATERIAL ADOPTION CHALLENGES

Despite the increasing demand, the availability of green construction materials in Pakistan remains limited. The construction industry in the country largely relies on conventional materials that may not meet modern sustainability standards. Several key observations can be made regarding the current state of green construction materials in Pakistan.

Limited Product Variety

Green construction materials such as bricks manufactured from zig-zag technology, green cement, and other eco-friendly products are relatively scarce in Pakistan. The market lacks diversity in terms of sustainable construction materials, hindering the construction industry's ability to adopt green practices.

Lack Of Awareness and Education

A significant challenge lies in the lack of awareness and education regarding the benefits of green construction materials. Builders, developers, and consumers often have limited knowledge about these materials and their advantages, which can slow down their adoption.

Cost Considerations

Green construction materials, while environmentally friendly, may be perceived as more expensive than traditional options. This cost differential can discourage builders and developers from choosing sustainable materials, particularly in price-sensitive markets.

Regulatory Framework

The absence of comprehensive regulations and standards for green construction materials poses a barrier to their widespread use. Clear guidelines and certifications could encourage the adoption of these materials by ensuring their quality and performance.

RECOMMENDED MEASURES

To overcome the challenges in promoting green construction in Pakistan following measures are recommended.

- **Active collaboration of government with renowned green building certification bodies** like EDGE, LEED, NESPAK, NEECA-Pakistan, etc. These organizations can provide expertise and guidance in implementing green building practices in construction projects. Furthermore, builders and developers should be encouraged to seek green certifications for their projects, which can serve as a benchmark for sustainability.
- Offer **tax incentives** for builders and developers who embrace green construction practices. These incentives can include reduced income taxes, property tax reductions, or deductions for investments in green technologies. **Fee concessions** should be

provided for green building map approvals and permits to incentivize eco-conscious construction.

- **Encourage the banking industry** in Pakistan to establish green banking divisions or departments that specifically cater to the financing needs of green construction projects. Low-interest rates and financial incentives should be available for builders and developers engaged in green and affordable housing projects.
- Launch **public awareness campaigns** to educate builders, developers, and the general public about the benefits of green construction materials and practices. **Training and workshops** should be offered on green building techniques to professionals in the construction industry.
- Develop and implement **clear and comprehensive regulations** and standards for green construction in Pakistan. These standards should cover building materials, energy efficiency, waste management, and water conservation.
- Encourage **public-private partnerships** in the construction sector to promote the use of green materials and technologies. These partnerships can lead to innovative solutions and shared resources.
- Invest in **research and development efforts** to develop locally sourced green construction materials and technologies that are cost-effective and eco-friendly.
- Promote **innovation and entrepreneurship** in the green construction sector.
- Establish a system for **monitoring and evaluating** the environmental performance of green construction projects to ensure compliance with sustainability standards. Regular reports should be published on the environmental impact and benefits of green construction initiatives
- To assess the environmental impact of construction materials thoroughly, **a life cycle assessment (LCA)** should be adopted. This assessment evaluates materials from extraction to disposal, helping make informed choices. Finally, **certification and labeling systems** like LEED (Leadership in Energy and Environmental Design) or Green Building Councils can assure material sustainability.

7. MATERIAL SUPPLY CHAIN ANALYSIS

Based on materials availability and its perception in the market, the supply chain of materials in a country influences its adaptation in a sector greatly. In this section green building material supply chain existence in Pakistan, the challenges it faces, and recommendations for the future are discussed comprehensively.

ANALYSIS OF EXISTING MATERIAL SUPPLY

The concept of a green construction material is a transformative idea in Pakistan's construction industry. The supply chain of green construction materials encompasses various key components, starting with the responsible sourcing of eco-friendly raw materials or recycled materials. Manufacturing processes prioritize environmental sustainability, aiming to reduce energy consumption and emissions. Efficient distribution and logistics networks are crucial to ensure a steady supply of green construction materials across Pakistan, while appropriate storage facilities maintain material quality. Effective waste management and recycling strategies are vital to reusing the material and minimizing environmental impact.

Currently, Pakistan lacks a dedicated supply chain for green construction materials. The existing supply chain primarily caters to conventional construction materials, which are readily available and widely used. Green construction materials, on the other hand, are relatively scarce and often require specialized sourcing. An infographic that shows different stakeholders present at various stages of the value chain existing in the green buildings in Pakistan is shown below:

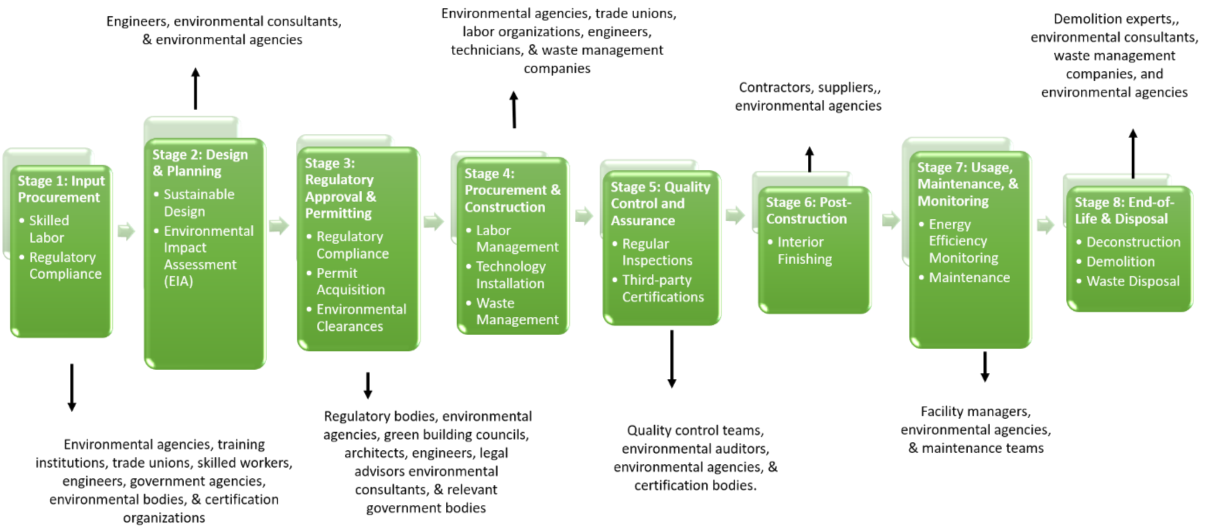


Figure 56: Value Chain Analysis of Green Buildings in Pakistan

SUPPLY CHAIN CHALLENGES AND RECOMMENDATIONS

The establishment of a sustainable supply chain for green construction materials in Pakistan faces a set of challenges that need careful consideration and strategic solutions. The major supply chain challenges and their recommendations are briefly discussed in the infographic below:

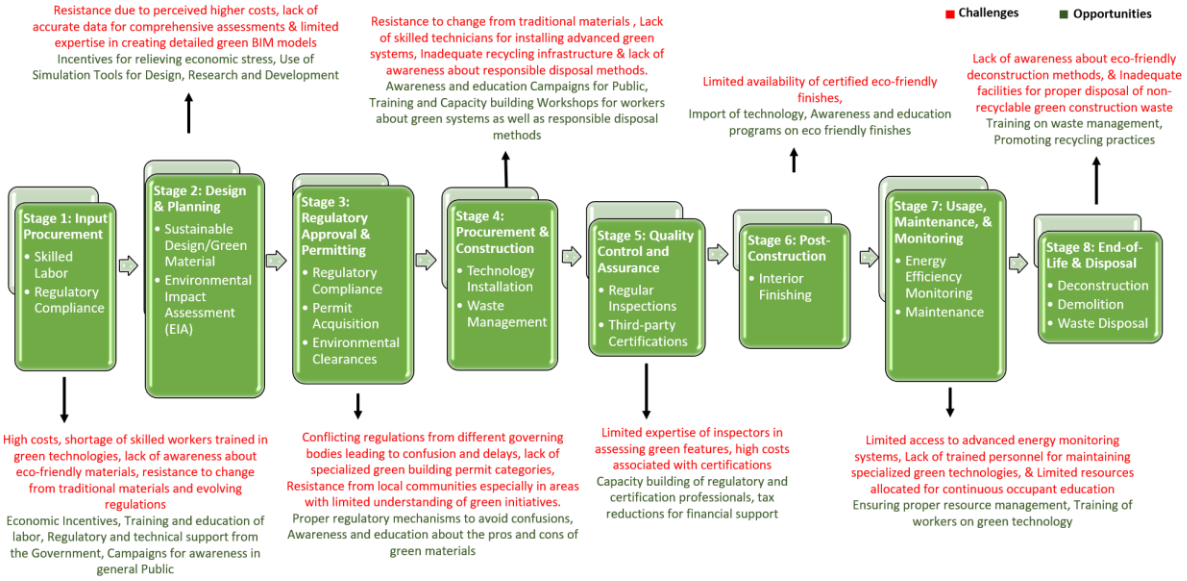


Figure 57: Challenges and Opportunities in the Value Chain of Green Buildings in Pakistan

One of the most pressing challenges is **generating consumer demand** due to a **lack of awareness** among contractors, owners, and other key stakeholders about the advantages of green construction materials. This challenge is surged by **regulatory and policy gaps** related to green construction materials and practices. There is absence of clear standards and regulations that are creating uncertainty in the industry. According to some websites **PEC has published the Green Building Code of Pakistan-2023** but these are not available on the official website. It is utterly important to publish these codes officially and make them mandatory to create the demand for green construction in Pakistan. In addition, relative stakeholders should be made aware of these codes or any other relevant policy and in case of non-compliance actions should be taken against them.

Another critical challenge is the **insufficient recycling** of waste materials generated during construction activities. In Pakistan, mainly plastic and glass are segregated from waste, not construction materials. As well as Pakistan currently lacks recycling infrastructure for construction waste and materials, leading to increased environmental impact and missed opportunities for resource reuse. Therefore, it is highly recommended to develop efficient recycling mechanisms for construction materials and use such recycled materials for making green construction materials following the second-tier supply chain concept.

Moreover, some green construction materials already exist in Pakistan but there is **no dedicated supply chain** for them which limits the utilization of these materials. Establishing an effective supply chain for green construction materials should consider a carefully structured approach. The initial step can be **conducting an inventory assessment** of available materials while **identifying local sources** like bamboo forests and straw bales. Parallelly **education and training programs** should be implemented for local stakeholders, including suppliers and builders, to raise awareness about sustainable construction practices. In addition, **supplier network development** should be prioritized which can involve collaborating with existing suppliers in respective areas or supporting community-based cooperatives to ensure a consistent supply. However, **quality control measures** must be in place to maintain material standards. Local communities should be involved in material sourcing and promoting sustainable practices and regulations for environmental, labor, and safety standards should be adhered to. Once the supply chain is created it is recommended to **continuously monitor and evaluate the supply chain's performance**.

Figure 58. Recommendation for Generating Supply Chain in Pakistan

Furthermore, the **limited availability of new and innovative sustainable construction materials** in Pakistan poses a significant hurdle to the widespread adoption of green construction practices. To address this scarcity, **investments and public-private partnerships** can play essential to diversifying the range of sustainable materials, making them more accessible and appealing to builders and contractors.

Lack of skills and training represent another challenge, as construction professionals need specialized knowledge and expertise to effectively work with green construction materials. Educational programs and training are suggested to equip the workforce with the capabilities required to implement green practices successfully.

Indeed, high costs remain a concern, as green construction materials often come with **higher initial** costs **compared to conventional materials**. This cost differential can deter stakeholders from embracing sustainable materials and practices. To overcome this obstacle, policymakers should consider implementing incentives such as **tax benefits and subsidies** to help offset initial costs and encourage the use of green materials.

8. CONCLUSION

The report highlights the drawbacks of conventional materials used in Pakistan, such as clay bricks, cement, concrete, steel, wood, and non-insulated glass windows, and suggests specific sustainable alternatives to mitigate these drawbacks. The construction industry in Pakistan is at a critical phase, with significant opportunities to transition toward more sustainable and green building practices. By addressing the barriers to the adoption of sustainable materials, updating building codes, and promoting awareness, Pakistan can reduce its environmental footprint, improve energy efficiency, and create healthier living and working environments for its citizens. This transition is not only essential for addressing the environmental challenges but also for ensuring the long-term sustainability of the construction sector in the country.

The adoption of sustainable alternative building materials in Pakistan offers the potential to reduce energy consumption, improve indoor air quality, and contribute to environmental sustainability. While there may be higher initial costs, the long-term benefits and savings make these materials a valuable choice for the construction industry. Encouraging green building practices and compliance with building energy frameworks, such as the Energy Conservation Building Code 2023, are critical steps toward a more sustainable future in Pakistan's construction sector.

Appendix 7. Analysis for economic revitalization and training

1. INTRODUCTION

The amount of built-up area in Pakistan varies widely by region and is influenced by factors such as population density, economic development, and land use policies. The Building Sector is responsible for a significant amount of greenhouse gas (GHG) emissions. According to the International Energy Agency (IEA), it is responsible for approximately 28% of global and energy-related GHG emissions and almost 25% of the total emissions in Pakistan.' Reducing the GHG emissions of buildings is an important part of the efforts of the United Nations (UN) to mitigate climate change and achieve global emissions reduction targets. This can be attained through a combination of energy efficiency measures, the use of renewable energy sources, and the adoption of low-carbon building materials and design methods.

The building sector is responsible for most of the energy consumption in Pakistan, with the residential sector currently being the largest in energy consumption consuming about 49.2%, and the commercial sector consuming about 7% of the total electricity produced in the country. Thus, it can be a major energy and cost savings opportunity if a building is developed with the use of sustainable construction materials, design features, and energy-efficient appliances. Green building through the use of sustainable structure, design, and energy-efficient appliances offers a major saving potential of up to 30% but an economic analysis is important to understand the complexities involved in using these materials, design features, and appliances.

Furthermore, green buildings typically have a higher upfront cost compared to conventional buildings but they offer benefits that built-to-code projects lack. These benefits include cost savings from reduced energy and water use, less waste production, diminished environmental and emissions costs, lower operations and maintenance costs, and enhanced occupant productivity and health. These values range from being predictable (energy and water savings can be recorded over time) to relatively uncertain (productivity/health benefits are somewhat subjective.

This report encompasses a comprehensive cost-benefit analysis and human resource analysis of green buildings in Pakistan, concurrently addressing identified gaps to provide mitigation measures and training modules for economic revitalization.

2. COST-BENEFIT ANALYSIS

The adoption of green materials, design features, and energy-efficient appliances is uncommon in construction practices in Pakistan. This situation is due to a lack of awareness among professionals and the general public, limited access to requisite technology and materials, and higher associated costs. The following section presents a cost-benefit analysis for evaluating the suitability of green buildings. This assessment will help determine whether green buildings represent an advantageous and practical choice for adoption in Pakistan's construction industry.

COST-BENEFIT ANALYSIS OF GREEN BUILDING MATERIALS, DESIGN, AND ENERGY-EFFICIENT APPLIANCES

Cost-benefit analysis of green buildings in Pakistan is carried out for domestic, commercial and industrial buildings. In addition, savings for building materials, design features, and energy-efficient appliances are calculated for these buildings separately.

DOMESTIC SECTOR

In Pakistan, the per capita annual consumption of electricity is 399 kWh in domestic sector. Keeping an average household of 7 persons, give the aggregate consumption as 2793 kWh/Annum. So, the monthly consumption of a house having 7 persons is 233 kWh. Keeping given NEECA electricity rates following calculations have been done.

Table 44 - Electricity Cost in Absence of Green Building Practices

S. No	Units consumed (kWh)	Unit Price	With a 17% tax	Unit consumed by household	Household Monthly Bill (RS)	Yearly bill (Rs)
1	201-300	22.14	25.9038	232.75	6,029.109	72,349.31
2	301-400	25.33	29.6361	360	10,668.996	128,028
3	401-500	27.74	32.4558	420	13,631.436	163,577.2
4	501-600	29.16	34.1172	580	19,787.976	237,455.7
5	601-700	30.3	35.451	650	23,043.15	276,517.8
6	Above 700 units	35.22	41.2074	750	30,905.55	370,866.6

Economic analysis was conducted comparing electricity consumption between conventional and green building approaches using Table 1 as baseline data for residential buildings. For this purpose, a residential building of the area of construction; 25` X 50` (5.5 Marlas) was used. The cost-benefit analysis was conducted in terms of the use of:

i. Building Materials
ii. Building Design features
iii. Energy-efficient appliances

COST-BENEFIT ANALYSIS OF GREEN BUILDING MATERIALS

Green building materials such as fly ash bricks, low VOC (Volatile Organic Compound) paint, low-e windows, rammed earth, and bamboo was analyzed in the structural review document which showed that sustainable building materials such as the use of Fly Ash Bricks instead of conventional bricks can **save up to 40%,** bamboo can offer **savings up to 3-5%**, and cellulose insulation can **save up to 28%** of the energy cost of the building. Also, it showed an increase in the overall cost by 18% but reduced CO_2 emissions by 63%. Additionally, it led to energy-cost savings of $113,710 which **equals 30% of the total energy-cost savings.** The payback period for building using green construction materials was calculated to be almost 2 years.

Below (Table 2) is the analysis of the example residential building in terms of the use of green building materials. The costs are taken based on the local market price in Pakistan, and calculations are done where direct cost for green materials is not available. ' Their average electricity units consumed are taken based on the Table 1 calculations.

Table 45 - Use of Energy-Efficient Building Material

	Use of Fly Ash Bricks	Use of Cellulose Insulation in Roof	Combined Use of both Materials (Fly Ash Bricks, Cellulose Insulation)
Electricity Units Range	**201-300**		
No. of Electricity Units Consumed/Month	**232.75**		
Yearly Bill	**72,349.31**		
Percentage Savings (Avg.)	40	28	68
Yearly Benefit of Building Material	28,939.6	20,257.80	49,197.4
Cost of Installation/Retrofitting	3,50,000	36,354	386,354
BCR (Ratio)	4.13	13.9	2.54
ROI (%)	8.2	55	12.73

Payback Period (years)	12.09	1.79	7.8
Life Span	50 years	25 years	20 years

The benefit-cost ratio (BCR) is 4.13, 13.9, and 2.54 for using fly-ash bricks, cellulose insulation, and using the two together, respectively, showing a highly beneficial investment. Moreover, the return on investment and payback period are showing satisfactory results. As a rule of thumb, if the ROI value is greater than 7%, it's considered a good investment. It is thus concluded that the use of energy-efficient materials is a good option in monetary as well as energy-saving terms. The payback period is 12.09, 1.79, and 7.8 years for the use of fly ash bricks, cellulose insulation, and a combination of the two.

COST-BENEFIT ANALYSIS OF BUILDING DESIGN FEATURES

The cost of green building design features such as WWR, building orientation, green roofing systems, and renewable energy systems, was analyzed in the architectural review document and it showed that WWR can offer up to **12-39% savings** in different climates, Building Orientation can save up to **15-30% of energy cost**, and the case study of several building design parameters such as WWR, Glazing, Insulation, Biophilic design, and building orientation in building design offered a cost saving of up to $113,999 which equals to almost **30% of the building energy consumption**. It showed a payback period of 3 years and 2 months.

Below (Table 3) is the analysis of the example residential building (25’ x 50’) in terms of the use of green building design features. The cost of installation is calculated by using the local market price of Windows, glazing, and insulation in Pakistan, and calculations are done where direct costs are not given. Their average electricity units consumed are taken based on the Table 1 calculations. The details of the analysis are given in the table 3 below:

Table 46 - Use of Energy-Efficient Building Design Features

	Building with Optimum WWR	**Overall saving through Green Design (WWR, Glazing, Orientation, Insulation)**
Electricity Units Range	**201-300**	
No. of Electricity Units Consumed	**232.75**	
Yearly Bill	72,349.31	

Percentage Savings (Avg) %	25	45
Yearly Benefit of Building Design Features	18,087.32	32,556
Cost of Installation/Retrofitting	1,80,000	2,20,000
BCR (Ratio)	1.51	2.96
ROI (%)	10	15
Payback Period (years)	9.9	6.7
Life Span	15 years	20 years

The benefit-cost ratio (BCR) is 1.51, and 2.96 for using installing optimum WWR and integrating other factors alongside also, respectively, which shows a beneficial investment. Moreover, the Return on investment and Payback periods are showing satisfactory results. As a rule of thumb, if the ROI value is greater than 7%, it's considered a good investment. It is thus concluded that the use of energy-efficient design features is a good option in monetary and energy-saving terms. The payback period for the use of WWR is 9.9 years, and for multiple energy-efficient building design features is approximately 6.7 years, which has differed from the architectural review document due to the difference in size of the buildings.

COST-BENEFIT ANALYSIS OF ENERGY-EFFICIENT APPLIANCES

The energy expert analysis on green buildings shows the use of insulated walls, roofs, and energy-efficient appliances i.e., LED bulbs, inverter AC, energy-saving fans, etc., save 29% of the energy consumption of a building. Also, the solar PV system delivers annual savings of approximately US$ **16,096.50 or PKR 4,819,950** by reducing the consumption of grid electricity. The payback period for **Solar PV systems is about 3 years**, and for **energy-efficient appliances, it is about 1-2 years**.

Below (Table 4) is the analysis of the example residential building (25’ x 50’) in terms of the use of energy-efficient appliances. The cost of installation is calculated by using the local market price of LEDs, and fluorescent bulbs in Pakistan, and calculations are done where direct costs are not given.′ The details of the analysis are given below in the Table 4.

Table 47 - Use of Energy-Efficient Appliances

	Savings by LEDs	**Savings by Fluorescent**
Electricity Units Range	**201-300**	

No. of Electricity Units Consumed/Month	**232.75**	
Yearly Bill	72,349.3	
Percentage Savings (%)	50	75
Yearly benefit of appliances	36,174	54,261
Cost of Installation/ Retrofitting	185,000	196,655
BCR (Ratio)	1.11	0.8
ROI (%)	19.5	27
Pay Back Period (years)	5.11	3.62
Life Span of bulbs/tubes	5.7 years (50,000 hours)	2.5 Years (24,000 - 36,000 hours)

The benefit-cost ratio (BCR) of LEDs is 1.1, which is higher than the 0.8 value for fluorescent tubes, showing that despite the higher savings of fluorescent tubes they are a slightly costly investment when compared to LEDs. However, the return on investment and payback period are showing satisfactory results. As a rule of thumb, if the ROI value is greater than 7%, it's considered a good investment. It is thus concluded that the use of the energy-efficient appliance is a good option in monetary as well as energy-saving terms. The payback period for the use of LEDs is 5.11 years, and for fluorescent tubes is 3.62 years.

The cost-benefit analysis of building materials, design features, and energy-efficient appliances shows that green buildings have more benefits outweigh the associated costs. All these aspects can lead to an overall 30% decrease in the energy consumption of the building, which can help in utilizing the 30% energy-saving potential that the building sector of Pakistan has to offer.

▪ COMMERCIAL SECTOR

In Pakistan, residential buildings electricity unit is usually charged on the basis on units consumed by a household, while on the other hand for the commercial sector NEPRA has defined a load range based on which price of a unit will be charged.

Table 48 - Electricity Cost for Commercial Units in Pakistan 2023

S. No	Load Type	Rate per Unit (kWh)	With 17% tax
1	Less than 5kW load	Rs. 38.80	45.39
2	More than 5kW load	Rs. 40.26	46.84

The cost-benefit analysis was conducted in terms of the use of:

i. Building Materials
ii. Building Design features
iii. Energy-efficient appliances

COST-BENEFIT ANALYSIS OF GREEN BUILDING MATERIALS

The structural review document analyzed the use of green building materials, finding that they could result in significant energy savings, with fly ash bricks saving up to 40% and bamboo offering savings of 3-5%. However, this green approach increased the overall construction cost by 18% while reducing CO2 emissions by 63%.

Below (Table 6) is the analysis of the example commercial building in terms of the use of green building materials. The costs are taken based on the local market price in Pakistan, and calculations are done where direct cost for green materials is not available. Their average electricity units consumed are assumed because of the fact that commercial sector has high variance in number of units consumed by a tall building vs a small commercial shop and similarly for other buildings residing in a commercial sector. For the price of a unit charge building under consideration Is assumed to have load greater than 5 kw.

Table 49 - Use of Energy-Efficient Building Material

	Use of Fly Ash Bricks	Use of Cellulose Insulation in Roof	Combined Use of both Materials (Fly Ash Bricks, Cellulose Insulation)
Load Type	**Less than 5 kW**		
No. of Electricity Units Consumed/Month	**400**		

Yearly Bill	**224,832**		
Percentage Savings (Avg.)	40	28	68
Yearly Benefit of Building Material	89,932	62,952.96	152,884
Cost of Installation/Retrofitting	3,50,000	36,354	386,354
BCR (Ratio)	12.84	43.29	7.91
ROI (%)	25.69	17.36	39.5
Payback Period (years)	3.89	0.57	2.52
Life Span	50 years	25 years	20 years

The benefit-cost ratio (BCR) is 12.84, 43.29, and 7.91 for using fly-ash bricks, cellulose insulation, and using the two together, respectively, showing a highly beneficial investment. Moreover, the return on investment and payback period are showing satisfactory results. As a rule of thumb, if the ROI value is greater than 7%, it's considered a good investment. It is thus concluded that the use of energy-efficient materials is a good option in monetary as well as energy-saving terms. The payback period is 3.89, 0.57, and 2.52 years for the use of fly ash bricks, cellulose insulation, and a combination of the two.

COST-BENEFIT ANALYSIS OF BUILDING DESIGN FEATURES

The analysis in the architectural review document found that incorporating green building design features like WWR and building orientation can result in significant energy savings of up to 12-39% and 15-30%, respectively. The study also demonstrated that these features, along with others, could lead to cost savings of approximately $113,999, equivalent to nearly 30% of the building's energy consumption, with a payback period of 3 years and 2 months.

Below (Table 7) is the analysis of the example commercial building in terms of the use of energy efficient design. The costs are taken based on the local market price in Pakistan, and calculations are done where direct cost for green materials is not available. ’ Their average electricity units consumed are assumed because of the fact that commercial sector has high variance in number of units consumed by a tall building vs a small commercial shop and similarly for other buildings residing in a commercial sector. For the price of a unit charge building under consideration Is assumed to have load greater than 5 kw.

Table 50 - Use of Energy-Efficient Building Design Features

	Building with Optimum WWR	**Overall saving through Green Design (WWR, Glazing, Orientation, Insulation)**
Load Type	**> 5kw**	
No. of Electricity Units Consumed/Month	**400**	
Yearly Bill	**224,832**	
Percentage Savings (Avg) %	25	45
Yearly Benefit of Building Design Features	56,208	101,174
Cost of Installation/Retrofitting	1,80,000	2,20,000
BCR (Ratio)	4.684	11.49
ROI (%)	31.22	45.98
Payback Period (years)	3.2	2.17
Life Span	15 years	20 years

BCR for installing optimal WWR is 4.684, and when combined with other factors, it reaches 11.49, indicating a highly advantageous investment. Additionally, the ROI and Payback periods are delivering favorable results, with an ROI exceeding 7%, signifying a sound investment choice. In conclusion, incorporating energy-efficient design features proves to be a prudent decision both in terms of financial and energy savings. The payback period for optimal WWR utilization is 3.2 years, while the use of multiple energy-efficient building design features results in an approximate payback period of 2.17 years, with variations due to differences in building sizes.

COST-BENEFIT ANALYSIS OF ENERGY-EFFICIENT APPLIANCES

The energy expert's analysis of green buildings highlights that the incorporation of insulated walls, roofs, and energy-efficient appliances such as LED bulbs, inverter ACs, and energy-saving fans can lead to a 29% reduction in a building's energy consumption. Additionally, the installation of a solar PV system can yield annual savings of approximately US$ 16,096.50 or PKR 4,819,950 by decreasing reliance on grid electricity, with a payback period of around 3 years for the solar PV system and 1-2 years for energy-efficient appliances. Table 8 provides a detailed analysis of an example commercial building (load >5kw) in terms of the use of energy-efficient appliances, considering local market prices in Pakistan.

Table 51 - Use of Energy-Efficient Appliances

	Savings by LEDs	**Savings by Fluorescent**
Load Type	**> 5 kw**	
No. of Electricity Units Consumed/Month	**400**	
Yearly Bill	**224,832**	
Percentage Savings (%)	50	75
Yearly benefit of appliances	112,416	168,624
Cost of Installation/ Retrofitting	185,000	196,655
BCR (Ratio)	3.46	2.14
ROI (%)	60.7	85.74
Pay Back Period (years)	1.64	1.16
Life Span of bulbs/tubes	5.7 years (50,000 hours)	2.5 Years (24,000 - 36,000 hours)

BCR of LEDs stands at 3.46, surpassing the 2.14 BCR value for fluorescent tubes, indicating that while fluorescent tubes provide higher savings, they represent a slightly more expensive investment compared to LEDs. Nevertheless, both the return on investment and payback period show positive results with an ROI value exceeding 7% which is generally considered a good investment. Therefore, using energy-efficient appliances is a favorable choice in terms of both financial and energy savings. The payback period for LEDs is 1.64 years, and for fluorescent tubes, it is 1.16 years.

The cost-benefit analysis of building materials, design features, and energy-efficient appliances underscores that green buildings offer more advantages than their associated costs. The combination of these factors can result in an overall 30% reduction in a building's energy consumption, contributing to the realization of the 30% energy-saving potential within the building sector of Pakistan.

INDUSTRIAL SECTOR

Like commercial sector, unit price of electricity and tariff for industrial area is determined based on load they consume.

Table 52 - Electricity Cost For Industrial Units in Pakistan 2023

S NO.	Load Type	Per Unit Price (Peak time)	Per Unit Price(Off Peak)
1	**Up To 25 kW (at 400/230 Volts)**	-	34.33
2	**Exceeding 25-500 kW (at 400 Volts)**	-	33.83
3	**Up to 25 kW**	37.89	32.33
4	**Exceeding 25-500 kW (at 400 Volts)**	37.83	32.12
5	**For All Loads up to 5000 kW (at 11,33 kV)**	37.83	32.03
5	**For All Loads (at 66,132 kV & above)**	37.83	31.93

The cost-benefit analysis was conducted in terms of the use of:

i. Building Materials
ii. Building Design features
iii. Energy-efficient appliances

COST-BENEFIT ANALYSIS OF GREEN BUILDING MATERIALS

The structural review document examined green building materials like fly ash bricks, low VOC paint, low-e windows, rammed earth, and bamboo. The findings revealed significant energy savings potential, with fly ash bricks potentially saving up to 40%, bamboo offering 3-5% savings, and cellulose insulation potentially reducing energy costs by 28%. Despite an 18% increase in overall costs, these materials reduced CO_2 emissions by 63% and led to energy cost savings of $113,710, equivalent to 30% of total energy cost savings.

Below (Table 10) is the analysis of the example Industrial vicinity in terms of the use of green building materials. The costs are taken based on the local market price in Pakistan, and calculations are done where direct cost for green materials is not available. Their average electricity units consumed are assumed because of the fact that industrial sector has high variance in number of units consumed based on the apparatus, technology and machinery used by a particular industrial unit. For the price of a unit charge building under consideration Is assumed as a small factory having load between 25-500 kw.

Table 53 - Use of Energy-Efficient Building Material

	Use of Fly Ash Bricks	**Use of Cellulose Insulation in Roof**	**Combined Use of both Materials (Fly Ash Bricks, Cellulose Insulation)**
Load Type	**25-500 kw**		
No. of Electricity Units Consumed/Month	**15000**		
Yearly Bill	**63,00000**		
Percentage Savings (Avg.)	40	28	68
Yearly Benefit of Building Material	2520,000	1764,000	4284000
Cost of Installation/Retrofitting	3,50,00000	3635400	386,35400.00
BCR (Ratio)	3.6	12.13	2.21
ROI (%)	72	48.5	11.08
Payback Period (years)	13.8	2.06	9.01
Life Span	50 years	25 years	20 years

The benefit-cost ratio (BCR) is 3.6 for fly-ash bricks, 12.13 for cellulose insulation, and 2.21 when using both materials together, signifying a highly advantageous investment. Additionally, the return on investment (ROI) and payback periods yield favorable results, with an ROI exceeding 7%, indicating a sound investment choice. In conclusion, the use of energy-efficient materials proves to be a prudent decision both in terms of financial and energy savings, with payback periods of 13.8 years for fly ash bricks, 2.06 years for cellulose insulation, and 9.01 years for their combined use.

COST-BENEFIT ANALYSIS OF BUILDING DESIGN FEATURES

The architectural review document analyzed green building design features, finding that WWR can save 12-39% in different climates, building orientation can cut energy costs by 15-30%, and a combination of design parameters could result in $113,999 savings, equivalent to 30% of energy consumption.

Below (Table 11) is the analysis of the industrial vicinity (25-500 kw) in terms of the use of green building design features. The cost of installation is calculated by using the local market price of Windows, glazing, and insulation in Pakistan, and calculations are done where direct costs are not given. Their average electricity units consumed are assumed because of the fact that industrial sector has high variance in number of units consumed based on the apparatus, technology and machinery used by a particular industrial unit. For the price of a unit charge building under consideration Is assumed as a small factory having load between 25-500kw

Table 54 - Use of Energy-Efficient Building Design Features

	Building with Optimum WWR	**Overall saving through Green Design (WWR, Glazing, Orientation, Insulation)**
Load Type	**25-500 kw**	
No. of Electricity Units Consumed/Month	**15000**	
Yearly Bill	**63,00000**	
Percentage Savings (Avg) %	25	45
Yearly Benefit of Building Design Features	157,5000	2835,000
Cost of Installation/Retrofitting	1,80,0000	2,20,0000
BCR (Ratio)	13.1	25.7

ROI (%)	8.75	12.8
Payback Period (years)	1.14	0.77
Life Span	15 years	20 years

BCR is 13.1 for optimal WWR and 25.7 when combined with other factors, indicating a beneficial investment. The Return on Investment (ROI) is satisfactory with an ROI above 7%, making energy-efficient design features a financially and energy-saving option. Payback periods are 1.14 years for WWR and approximately 0.77 years for multiple energy-efficient design features.

COST-BENEFIT ANALYSIS OF ENERGY-EFFICIENT APPLIANCES

The energy expert's analysis indicates that utilizing insulated walls, roofs, and energy-efficient appliances can save 29% of a building's energy consumption. Furthermore, a solar PV system can provide annual savings of around US$ 16,096.50 or PKR 4,819,950 by reducing grid electricity consumption.

Below (Table 12) is the analysis of the example of industrial building (25-500 kw) in terms of the use of energy-efficient appliances. The cost of installation is calculated by using the local market price of LEDs, and fluorescent bulbs in Pakistan, and calculations are done where direct costs are not given. The details of the analysis are given below in the Table 4.

Table 55 - Use of Energy-Efficient Appliances

	Savings by LEDs	**Savings by Fluorescent**
Load Type	**25-500 kW**	
No. of Electricity Units Consumed/Month	**15000**	
Yearly Bill	**63,00000**	
Percentage Savings (%)	50	75
Yearly benefit of appliances	3150,000	4725,000
Cost of Installation/ Retrofitting	185,0000	196,6550
BCR (Ratio)	9.7	6.006

ROI (%)	11.7	22.4
Pay Back Period (years)	0.58	0.416
Life Span of bulbs/tubes	5.7 years (50,000 hours)	2.5 Years (24,000 - 36,000 hours)

BCR for LEDs is 9.7, surpassing the 6.006 value for fluorescent tubes, indicating that although fluorescent tubes offer higher savings, they represent a slightly more costly investment compared to LEDs. Nevertheless, the return on investment and payback periods show positive results, with an ROI exceeding 7%, signifying a sound investment choice. In conclusion, the use of energy-efficient appliances proves to be a beneficial choice in both financial and energy-saving terms, with a payback period of 0.58 years for LEDs and 0.416 years for fluorescent tubes. The cost-benefit analysis of building materials, design features, and energy-efficient appliances highlights that green buildings provide more benefits than their associated costs, potentially leading to an overall 30% reduction in a building's energy consumption, contributing to the utilization of Pakistan's 30% energy-saving potential in the building sector.

FACTORS INFLUENCING BUILDING STRUCTURE, DESIGN, AND ENERGY COSTS

Several factors exert influence on building structure, design, and energy costs. These factors are critical in shaping the sustainability and efficiency of structures within the construction industry. The following factors are critical in determining the factors that can introduce a change in the overall energy performance, construction, and energy cost of a building.

ECONOMIC FACTORS

The economic sustainability of construction ensures high economic growth and employment in the construction industry but it is also intrinsically linked to improved project delivery. While there is a perception of high initial costs it is important to consider the concept of whole life value. Whole life value takes into consideration the initial cost; design and procurement cost, cost in use; maintenance operation and dismantling cost, and residual value of the construction material. In the long run, the whole life value of the sustainable construction material should resort to profitability without compromising their positive environmental impact.

The **construction industry in Pakistan** is influenced by a lack of funding availability, high material costs, and high housing demand. Moreover, the shortages in foreign investment, volatile material prices, and increased housing demand in urban areas affect the construction industry. Although government policies encourage energy-efficient practices and safety standards, their implementation remains a concern. Despite these challenges, the industry has grown due to government initiatives and rising real estate demand, contributing significantly to the country's economy.

ENVIRONMENTAL FACTORS

The environmental factors are geared towards preventing harmful effects on the environment. These are realized by minimizing the production of waste, appropriate usage of natural resources, and protecting the environment. Local and recycled building materials have been touted to reduce CO_2 emissions leading to the production of healthier buildings which concomitantly strengthen the economy. Literature has provided evidence that the promotion of prioritization of the use of local and recycled building materials has been advanced in research and development due to the evolution of the low-carbon building movement. Szydlik (2014) added in a study that sustainable buildings maximize resource efficiency, energy efficiency, water conservation systems, and grey water use, enhance indoor environment and quality, and usage of non-toxic materials. This agrees with Reddy (2016) who asserted that selecting sustainable materials is keen to the reduction or minimization of the economic (pricing) of buildings. Energy efficiency reductions in the construction and operation of buildings lead to reduced financial burdens for owners.

Environmental concerns are increasingly significant in **Pakistan's real estate** market, with demand for energy-efficient and eco-friendly properties. Extreme weather conditions, such as hurricanes and earthquakes, can necessitate costly structural reinforcements. To accurately estimate costs, understanding local climate and conditions is vital. To optimize construction expenses in Pakistan, it's essential to consider factors like accessibility, resource availability, and local regulations, and collaborate with local experts and experienced construction companies.

SOCIAL FACTORS

The social factor addresses the needs (culture, living conditions) of people involved in construction activities. According to Patil and Patil (2017), social factors highlight improvements in the quality of human life and the human living environment encompassing intergenerational equity, culture, education, and health. According to Jamilus et al. (2013), social factors provide high customer satisfaction. It stated that the social aspect of sustainability undergoes degradation in the same way as the natural environment. The need for a comfortable housing system is to be met by the usage of sustainable construction materials/products. Social sustainability is to improve the quality of life of individuals. Patil and Patil (2017) asserted that sustainable building materials provide the opportunity for living inhabitants to live in healthy, comfortable conditions throughout the building's full life cycle. The emissions from the various construction materials could end up in health risks such as cancer, asthma, and so on. Othman et al. (2018) in a study posited that long-term exposure to specific building materials may be harmful to the overall health of building occupants. Materials can contain hazardous, irritating, toxic, or odorous elements that can adversely impact human overall health either directly or indirectly.

In **Pakistan**, social factors significantly influence construction projects. These factors encompass accidents, shopping, tourism, and traffic, impacting project schedules, costs, and quality. Transportation efficiency, health, safety, migration, land value, and several other factors also play vital roles in project performance, making it crucial to address these considerations in the context of Pakistani construction.

SOLUTIONS/STRATEGIES

To address the financial aspects and gaps identified in green buildings in Pakistan, the following strategies and solutions can be considered. Below (Figure 1) is the graphical representation of financial solutions for different stages of the value chain of buildings in Pakistan.

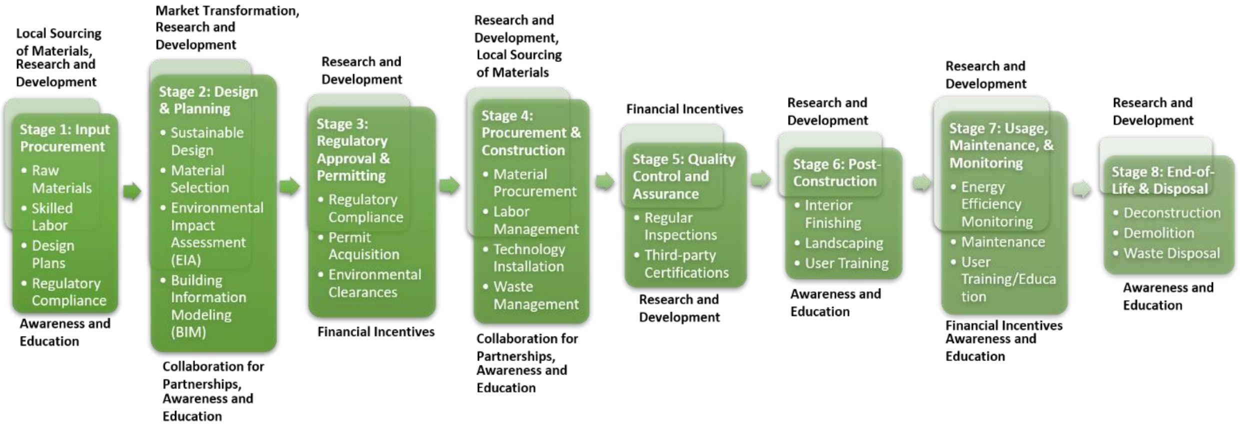


Figure 59 - Financial Solutions of the Design and Construction Phases of Green Buildings in Pakistan

FINANCIAL INCENTIVES AND SUBSIDIES

The government of Pakistan can offer **subsidies or tax incentives** to encourage the use of green building materials and practices. This can help offset the initial higher costs. Also, financial institutions can provide specific **green financing** options, such as lower interest rates or longer repayment terms, for individuals and companies investing in green buildings. Further, the Government can establish a system of **grants or rebates** for green building projects that meet certain sustainability criteria. These incentives can help reduce the upfront costs.

AWARENESS AND EDUCATION OF GOVERNMENT, PROFESSIONALS, AND PUBLIC

Awareness of the Government can ensure investments in sustainable buildings and technology. **Training programs and workshops** for architects, engineers, and builders can be offered to educate them about the benefits and techniques of green construction, which can lead to increased adoption and reduced costs as skilled labor becomes more readily available. Also, doing **public awareness campaigns** to educate homeowners and businesses about the long-term cost savings associated with green buildings can drive demand for such changes in the building sector of Pakistan.

LOCAL SOURCING AND RECYCLING OF MATERIALS

Encouraging the use of **locally sourced building materials**, **design technology,** and **energy-efficient appliances** can reduce transportation costs and support the local economy. Also, promoting the **recycling** of construction waste and the use of recycled materials can reduce costs and minimize environmental impact.

FUNDING FOR RESEARCH AND DEVELOPMENT

The Government should allocate **funding for research and development** in the green building sector to develop innovative and cost-effective green materials and technologies and also, establish a **platform for sharing research findings** and best practices within the industry to facilitate knowledge transfer and cost reduction.

COLLABORATION AND PARTNERSHIPS

Foster **partnerships** between **government agencies, private sector entities,** and **NGOs** to jointly promote and invest in green building initiatives and encourage **collaboration among different sectors** of the construction industry to share resources and knowledge, leading to cost reduction.

MARKET TRANSFORMATION BY PROFESSIONALS

Encourage architects, real estate developers, and homeowners to **create a market demand** for green buildings, which can drive competition and lower prices. This can be achieved if infrastructure professionals promote the use of green materials, design technology, and efficient appliances.

By implementing these strategies and solutions, Pakistan can address the financial aspects and gaps in green buildings, making them more accessible and affordable while reaping long-term economic and environmental benefits.

3. HUMAN RESOURCE ANALYSIS

The construction industry in Pakistan is a significant contributor to the country's economy, and there is a wide range of skills and expertise available among the labor force in the construction sector. Pakistan boasts a substantial labor force of 68.75 million individuals. However, it is difficult to gauge the percentage of labor, who have green building construction knowledge. This concept is relatively new in Pakistan but there is a growing interest in sustainable building practices. In the pursuit of economic revitalization in Pakistan's construction industry through the adoption of green building practices, a careful evaluation of required human resources is essential. This report includes the assessment of skills and expertise available and required in the value chain of the green building structure, design, and energy-efficient appliances in Pakistan.

ASSESSMENT OF THE VALUE CHAIN OF GREEN BUILDINGS IN PAKISTAN

The value chain of green materials involves several individuals including engineers, architects, project managers, electricians, laborers, and several other experts. Analysis of all the relevant individuals is important to identify the gaps in the value chain of green building, design, and energy-efficient appliances.

ASSESSMENT OF MATERIALS AND TECHNOLOGY

The assessment of materials and technology in the building value chain is shown below (Figure 2) and carried out as follows:

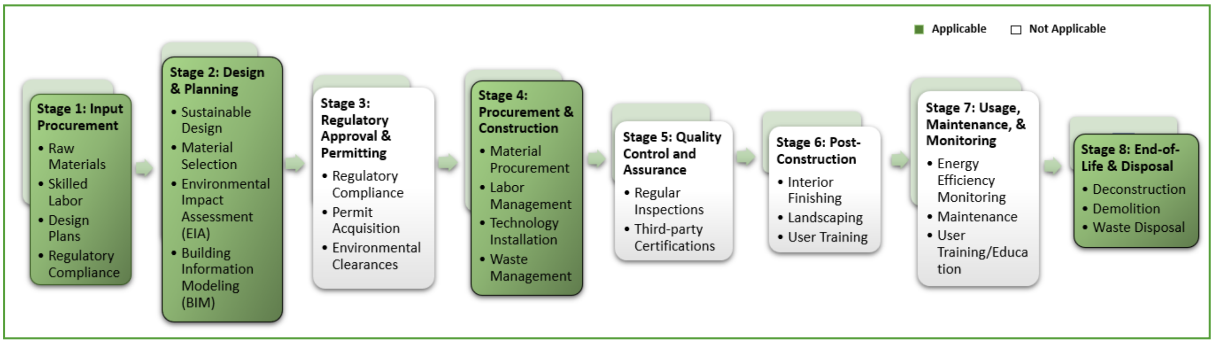


Figure 60 - Materials and Technology in Construction Value Chain

1. Sustainable Materials and Construction Techniques

Several sustainable and green building materials are produced locally in Pakistan but they are not produced in very high quantities due to the low market demand. Most of the sustainable materials to be used in green buildings are given below:

- **Fly Ash Bricks:** Fly ash bricks, made from waste materials, and produced by coal-fired power plants, are strong, durable, and environmentally friendly, as they help reduce waste and save energy. They are cheaper than traditional bricks, making them an affordable option for construction in Pakistan. **Tameerkaro Construction Company and Sitara Chemical Industries** are two of the very few suppliers of fly ash bricks in Pakistan.

- **Cellulose insulation:** Cellulose insulation is used in roofs due to the low thermal conductivity of Cellulose foam making it an excellent choice for insulation purposes. **Duracon Engineering and Lakhwa Chemical Services** are the suppliers of cellulose roof insulation in Pakistan.

- **Insulated Glass (Glazed Glass):** Insulated glass unit (IGU), more commonly known as double glazing, consists of two or three glass window panes separated by a vacuum or gas-filled space to reduce heat transfer across a part of the building envelope. **Al-Haq Glass & Aluminum, Pakistan Sunshine, and the graph** are a few firms that provide single- and double-glazed glass for windows.

- **Cool Bricks:** In Pakistan, a new material called the "cool block" that has been made using a special window called the Muscatese Evaporative cooling window is being tested. This cool block is created by putting water in a ceramic container and placing it next to a wooden screen. It is still in the experimental phase, hence there is **no supply** yet.
- **Bamboo:** Bamboo is a highly sustainable material that grows quickly and can be harvested without damaging the environment. It is strong and durable, making it an ideal construction material. Bamboo is used in building construction in Pakistan primarily for structural support in various

construction applications, including scaffolding, roofing, and as a building material itself. Bamboo is grown in Pakistan on **private farms**, particularly in the Punjab region, and is also supplemented by **imports from other countries** such as China and Bangladesh to meet the demand for construction purposes. **NYJ industries** are the biggest suppliers of bamboo in Pakistan.

- **Straw Bale:** Straw bale construction is gaining popularity in Pakistan due to its affordability and sustainability. Straw bales are made from the leftover stalks of wheat, rice, and other crops, which are often burned or discarded. They are highly insulating, making them an ideal material for construction in hot climates Straw bale buildings are also earthquake-resistant, which is crucial in Pakistan, where earthquakes are common. **Zeta Traders, Shoaib Enterprises, and Syed Usman Corporation** are a few suppliers of straw bales in Pakistan.

- **Low VOC Paints:** In Pakistan, paint serves the dual purpose of protecting walls and adding decorative appeal to homes and buildings. However, some paints can release **harmful chemicals** called VOCs into the indoor air, leading to air pollution indoors, which is where the need for low-VOC paints comes in. Paint manufacturers in Pakistan such as **Brighto, Berger, and Master Paints** are now supplying low-VOC paints.

- **Rammed Earth:** Rammed Earth is made by compressing layers of earth, gravel, and other locally available materials. Rammed-earth buildings are highly durable and can withstand earthquakes, fires, and other natural disasters, while also having excellent insulation properties, which can help reduce the need for heating and cooling systems. The use of rammed earth is **very common in rural areas** of Pakistan, but not very much in urban areas.

- **Stone, Marble & Chips:** Natural stones such as granite, marble, and limestone are used in Pakistan for building purposes. They are commonly used for cladding and flooring. These materials are mostly **available in the local market**. However, imported marbles are also available in the market. Solar Chips or green chips are used, and manufactured locally, and their cost is 20% higher than regular chips. They are used on rooftops to control direct heat from the sun.

- **Energy Efficient Lights** are manufactured in Pakistan. The system of smart and energy-efficient lights, swatches, doorbells, locks, swatches, surveillance cameras, and AI-integrated technologies are **available in the market**. However, the cost is 40-50% more than the locally manufactured products.

- **Water efficient Fixtures** are manufactured in Pakistan and there are several local manufacturers available, meeting the market demand as **Faisal Sanitary, Sonex Sanitary, Master Sanitary, and Super Asia Sanitary.** Most of them are water efficient. However, some of the imported water-efficient, sensor-embedded fixtures such as sensor taps, and sensor toilet flush are available in the market, providing smart solutions to homes.

Most of the building materials are produced locally in Pakistan such as bamboo, rammed earth, and natural stones. However, some building materials such as smart glass/glazed glass, fly ash bricks, insulation, and advanced electrical equipment, are imported from other countries mainly due to the presence of only a few local suppliers. Also, there is a limited number of firms in Pakistan offering expertise in **sustainable materials and construction techniques**. These firms prioritize the use of environmentally friendly materials and practices that align with principles of sustainability and conservation. Firms such as **Banu Mukhtar-Lahore** are at the forefront of this movement, emphasizing the use of eco-friendly materials and methods that align with environmental conservation principles.

2. Sustainable Design & Renewable Energy Technology

Sustainable design, also known as green or eco-friendly design, focuses on minimizing the negative impact of buildings on the environment and maximizing their energy efficiency. It involves incorporating sustainable design features such as WWR, Building Orientation, green roofs, and renewable energy sources. In the Pakistani context, sustainable design is gaining importance due to increasing environmental concerns. There are a few firms such as **Landscape-Karachi, Amir Adnan Associates-Lahore, and Consulting and Design Consortium Pvt. Ltd**., providing sustainable building design services to this industry.

Renewable energy technology focuses on the utilization of natural resources to generate clean and sustainable energy. Few firms are working in this area, that design energy-efficient buildings that incorporate renewable energy technologies, leading to sustainable and environmentally friendly construction projects in Pakistan such as the **Pakistan Council of Renewable Energy & Technology**.

ASSESSMENT OF SKILLS

The assessment of skills in building a value chain is shown below (Figure 3), and carried out as follows:

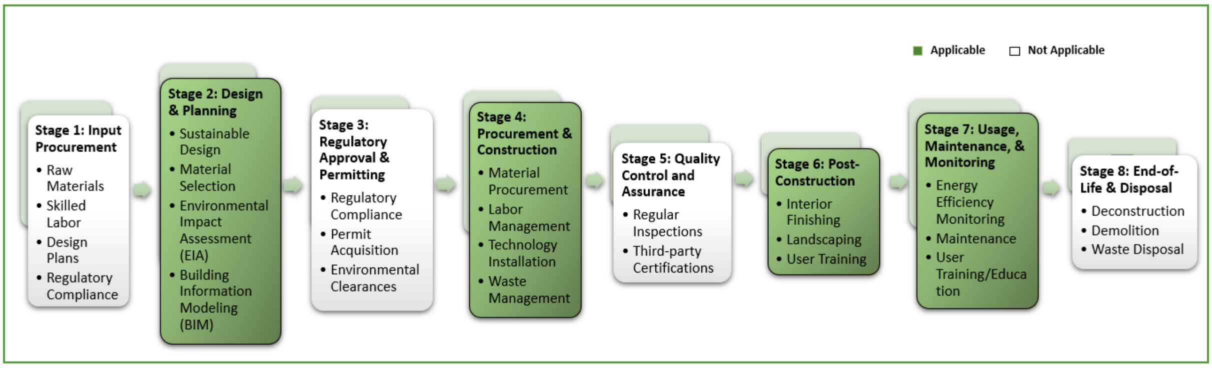


Figure 61 - Skills in Construction Value Chain

1. Architecture & Engineering

In the context of green building structures, architecture and engineering are of utmost importance. Architects and engineers are responsible for making buildings that not only look good but also have a minimal impact on the environment. They ensure that the construction uses sustainable materials and energy-efficient systems. Moreover, they strike a balance between making the building environmentally friendly while still being visually appealing and fitting into the local culture. In simple terms, architects and engineers are crucial for turning regular buildings into eco-friendly and energy-efficient green structures.

Within Pakistan's construction landscape, a multitude of architectural firms and engineers thrive, proficiently versed in various architectural styles and building engineering disciplines. Their expertise extends to the aesthetics, functionality, and cultural context of structures. However, a significant gap persists in the availability of expertise in sustainable and eco-friendly design practices. This shortage of firms dedicated to green design limits the widespread integration of sustainable principles into construction projects.

2. Construction Management

Construction management plays a crucial role in ensuring the successful execution of construction projects. Construction management is of vital importance Professionals in this field are responsible for overseeing all aspects of a project, including scheduling, budgeting, and quality control ensuring that projects are completed on time and within budget while maintaining high standards of quality. Construction management is essential for the efficient allocation of resources, preventing delays, and managing costs effectively. This expertise is vital for the construction industry's growth and success.

Pakistan exhibits self-sufficiency in construction management skills. Substantial growth in construction management services has been observed in recent years. This growth has solidified the nation's self-sufficiency in construction management skills, ensuring the timely, budgeted, and high-quality completion of construction projects.

3. Masonry, Concrete Work, Electrical, HVAC, Plumbing, and Carpentry Skills

Trades skills in masonry, concrete work, electrical, HVAC, plumbing, and carpentry are the backbone of the construction industry in Pakistan, these skills are essential for creating strong and durable structures. Masons and concrete workers lay the foundation and build the structural framework, ensuring stability. Electricians and HVAC technicians install crucial systems for power and climate control. Plumbers set up water supply and drainage systems, while carpenters add the finishing touches. These trade skills are really important to utilize green construction materials to the fullest. If expertise is not available in this domain then the availability of green materials is of no use.

A considerable labor force in Pakistan possesses a high level of proficiency in critical construction trades. These skills encompass masonry, concrete work, electrical work, HVAC installation, plumbing, and carpentry, collectively forming the foundation of construction endeavors. These skilled individuals form the backbone of construction projects, contributing significantly to the creation of sturdy foundations and structures.

ASSESSMENT OF CERTIFICATION AND REGULATORY BODIES

The assessment of certification and regulatory bodies in building the value chain is shown below (Figure 4), and carried out as follows:

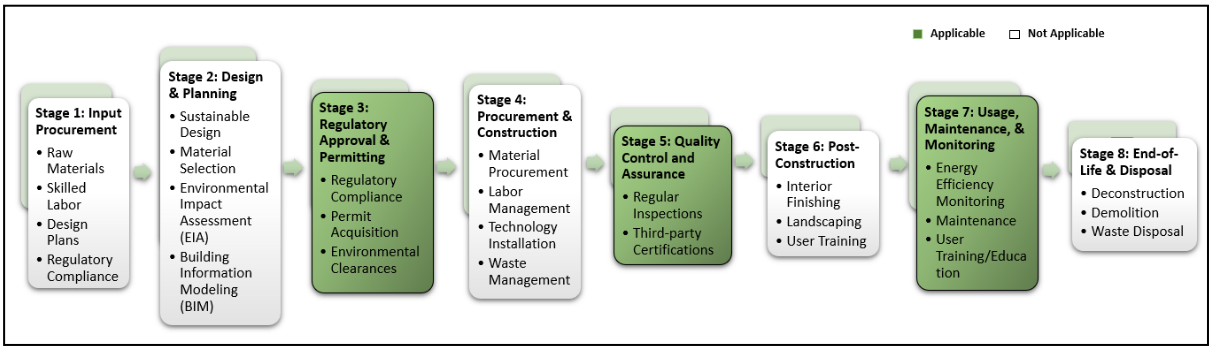


Figure 62 - Regulatory and Certification Bodies in Construction Value Chain

1. Green Building Certification System

Green building certification systems hold particular significance in Pakistan's construction industry, primarily concerning building materials. These systems play a crucial role in advancing sustainability by ensuring that construction projects utilize eco-friendly materials, thus reducing the environmental impact. Green building certification can play a crucial role in advancing sustainable development and reducing the environmental impact of the built environment in Pakistan. It is primarily driven by **LEED certification** and supplemented by local initiatives, such as the **Green Building Certification System (GBCS)** launched by the **Pakistan Green Building Council (PGBC)** and **National Green Building Standards by The Pakistan Engineering Council (PEC).** It promotes sustainable construction practices and recognizes buildings that meet specific environmental criteria. One of the few firms that provides this service to the country is **EDGE green building certification**. EDGE provides a simple and easy-to-use interface that can calculate and evaluate the environmental impact of the building design as well as energy efficiency and water conservation of the building by taking some inputs from the user.

2. Regulatory Bodies for HVAC, Safety, and Water Conservation

The importance of regulatory bodies and standards for HVAC (Heating, Ventilation, and Air Conditioning), safety, and water conservation in the construction industry, particularly in green building projects, cannot be overstated.

HVAC (Heating, Ventilation, and Air Conditioning), building safety, and water conservation standards in Pakistan are established and regulated by various authorities to ensure the well-being of occupants, prevent structural failures, and mitigate potential hazards. Here are the key organizations involved in setting building safety standards in Pakistan:

- **Pakistan Engineering Council (PEC):** The Pakistan Engineering Council is the regulatory body responsible for overseeing the engineering profession in Pakistan. PEC sets and enforces standards related to building design, construction, and safety. It develops the Pakistan Building Code (PBC), which provides guidelines for structural design, fire safety, electrical systems, water conservation, HVAC, and other aspects of building safety.
- **National Engineering Services Pakistan (NESPAK):** NESPAK is a leading engineering consultancy firm in Pakistan that provides expertise in various engineering disciplines,

including building safety. NESPAK works closely with government organizations and local authorities to develop and update building codes and standards. They provide consulting services and ensure compliance with building safety regulations, water conservation, and HVAC.

- **Local Development Authorities**: Local development authorities, such as the Lahore Development Authority (LDA), Karachi Development Authority (KDA), and Capital Development Authority (CDA), oversee building and construction activities within their respective jurisdictions. These authorities enforce building codes, bylaws, and regulations to ensure compliance with given standards.
- **National Disaster Management Authority (NDMA):** The National Disaster Management Authority is responsible for disaster risk reduction and management in Pakistan. NDMA plays a role in establishing guidelines and regulations related to building safety in areas prone to natural disasters, such as earthquakes, floods, and cyclones. They provide recommendations for designing structures to withstand such hazards.
- **Punjab Emergency Service (Rescue 1122):** Rescue 1122 is an emergency service provider in Punjab province. While not primarily responsible for setting safety standards, it plays a crucial role in responding to emergencies and enforcing safety protocols during rescue operations. They provide guidelines for fire safety and emergency evacuation in buildings.

- **International Standards:** Pakistan often adopts international building safety standards and guidelines. These include standards from organizations such as the International Code Council (ICC), the International Organization for Standardization (ISO), and the American Society of Civil Engineers (ASCE). International standards provide references and best practices for various aspects of building safety.

Value chain analysis shows the presence and absence of materials, technology, design features, and energy appliances regarding green buildings. There is a lack of firms supplying green materials, features, and expertise in this area, which is discussed in the identified gaps section as follows.

IDENTIFIED GAPS

While the construction industry in Pakistan exhibits a range of skills, significant gaps and challenges remain:

- **Limited Expertise in Sustainable Practices:** Across multiple segments, there is an overall lack of expertise in sustainable and eco-friendly practices. This gap includes the knowledge and skills needed to implement sustainable design, construction, and operational practices. Addressing this gap is essential for promoting environmentally responsible economic revitalization.
- **Inadequate Specialization in Green Building Certification:** The expertise required for green building certification is not readily available in most segments. Professionals who can navigate certification systems like LEED and ensure compliance with environmental criteria are in short supply. Bridging this gap is crucial to achieving sustainable and energy-efficient construction.

- **Regulatory Compliance Expertise:** The segments generally lack sufficient human resources with expertise in regulatory compliance, particularly related to safety, HVAC standards, and water conservation. Regulatory bodies and standards play a crucial role in ensuring building safety and environmental performance. Addressing this gap is essential for maintaining compliance with building codes and environmental regulations.
- **Limited Human Resources for Sustainable Materials and Techniques:** There is a gap in the availability of human resources knowledgeable in sustainable materials and construction techniques. These professionals are needed to promote the use of eco-friendly materials and construction methods that align with sustainability and conservation principles.
- **Insufficient Skilled Workforce in Specialized Trades:** While there is a skilled labor force in trades like masonry, concrete work, electrical work, HVAC installation, plumbing, and carpentry, there may be gaps in specialized skills required for sustainable and energy-efficient construction practices. Building a skilled workforce in these specialized trades is essential for high-quality and sustainable construction.

RECOMMENDATIONS/SOLUTIONS/STRATEGIES

To address these identified gaps and facilitate economic revitalization through green building construction, a series of strategic recommendations and solutions are proposed:

HUMAN RESOURCE CAPACITY BUILDING

Building the capacity for adopting green buildings involves a comprehensive approach that encompasses both skilled and unskilled manpower. Given some strategies and training activities to consider these can be grouped based on the audience and target sector

Green Building Workshops, Seminars, and Training Initiatives Organize **workshops and seminars** to introduce the concepts of green buildings, green building materials, their benefits, and the environmental impacts of conventional construction. Also, **develop online/onsite courses** or **webinars** that provide an overview of green building principles, practices, and technologies adopted**.** Further, **collaborate** with green building organizations, industry experts, and NGOs to develop and deliver training programs.

Public Awareness

Launch public awareness **campaigns** to educate homeowners, developers, and the general public about the importance of building codes, energy efficiency, and sustainable construction practices. Further, provide easily accessible online resources, guidelines, and toolkits to help stakeholders understand and comply with building codes.

Training for Professionals

Offer **training programs** and workshops for architects, engineers, builders, and local government officials to enhance their understanding of the latest building codes and green building practices and design training programs focused on specific **green building technologies**, such as energy-efficient

HVAC systems, renewable energy integration, rainwater harvesting, etc. Further, introduce **certification programs** for construction and building inspection professionals to ensure they have the necessary expertise to enforce and monitor codes effectively and conduct **workshops on sustainable design** principles, energy-efficient architecture, passive design strategies, and using sustainable materials. Also, teach the design and installation of **rainwater harvesting systems** to reduce water consumption. Also, provide knowledge about reusing grey water for non-potable purposes.

Training for Labor

Educate workers on **waste segregation**, recycling practices, and proper disposal methods on construction sites and provide **practical training sessions** where individuals can work with green building technologies under supervision. Further, train construction workers in techniques for reducing construction waste, efficient resource use, and proper installation of green technologies.

The strategies and training activities proposed for human resource capacity building are essential to promote green building practices in Pakistan. By raising awareness and providing training in green building concepts, public awareness campaigns, and professional development, these initiatives can significantly contribute to the adoption of eco-friendly construction methods. The introduction of certification programs and workshops for professionals ensures the necessary expertise for enforcing green building codes effectively. Ultimately, these actions lay the foundation for a more sustainable and environmentally responsible construction industry in Pakistan.

STRENGTHENING COMPLIANCE AND ENFORCEMENT

Local Capacity

Establish **specialized teams** at the local level tasked with monitoring and enforcing building codes. These teams should consist of trained inspectors, engineers, and other relevant professionals. While also **fostering collaboration** between local authorities, professional associations, and construction industry stakeholders to enhance enforcement efforts.

Technology and Data Management

Develop **digital platforms** for submitting building plans, permit applications, and inspection requests. Implement electronic record-keeping to improve transparency and accessibility of enforcement data. Further, utilize **remote monitoring** technologies, such as drones and satellite imagery, to conduct inspections and verify compliance with building codes.

Review and Continuous Improvement

Establish a **schedule for periodic reviews and updates** of human resource capacity building to ensure they remain aligned with technological advancements, best practices, and changing environmental concerns and **solicit feedback** from industry stakeholders, professionals, and the public to identify challenges, gaps, and areas for improvement in the enforcement process. Also, develop key performance indicators (KPIs) to measure the effectiveness of building code enforcement efforts, including compliance rates, energy savings, and environmental impact.

By developing a robust policy framework, building local capacity, leveraging technology, and fostering collaboration, Pakistan can create a more effective and efficient system for enforcing building codes. Continuous review, stakeholder engagement, and data-driven decision-making will be essential for ensuring the long-term success of these efforts and promoting sustainable and resilient construction practices across the country.

PROCESS FOR IMPLEMENTATION OF GREEN BUILDING CODES AND CERTIFICATION IN PAKISTAN

The implementation and actualization of the Green Building Code can be achieved by following the steps below:

- Establish a **Green Office coordinator** and a team to plan a practical environmental program.
- The detailed plan should have a different stage **assessment strategy**. For example, dividing the building construction into three stages the base structure assessment, the grey structure assessment, and the final building assessment.
- For all chosen indicators for assessment, numeric **objectives**, benchmarks, and monitors are set to fulfill the assessment process.
- The final building assessment, specifically checks the environmental aspects of the building, including energy efficiency, ventilation, waste reduction, recycling, and water conservation aspects.
- Special attention be paid to green issues in **procurements** and the purchase of green smart building materials. Incentives be given to industries manufacturing smart building materials solar chips, ash bricks, PVC, etc.
- **Annual reports** be compiled and set to the regulatory offices for audit purposes and certification purposes.
- **Training and certification** of the Project development offices, and district offices development could be done. Thus, only certified people are allowed to perform different tasks/ jobs in the construction industry.
- Incentives for the construction of green buildings, as **tax relaxations**/ **subsidies** could be given to real estate contractors
- Quick and efficient **e-approval** process be implemented. File approvals or approvals from CDA could be done by adding a separate swift digital platform by the name of Green Dream/ Green Building/ Green Society etc
- For industrialists, who are producing green technology or materials, incentives be given in terms of relaxing the caps and allowing trade by increasing the production units
- Designated **certified firms** or individuals be allowed in the construction industry
- Acquiring licenses for the engineers or contractors could be made compulsory. For certified/licensed engineers and contractors, who have proven themselves by constructing green smart projects, awards and relaxation in license renewals be given
- **Clean development mechanism** (CDM) projects be initiated with the coordination of local industry and foreign partners for long-term sustainability and SDG achievement.

Figure 63 - Process for Implementation of Green Building Codes and Certification in Pakistan

RECOMMENDATIONS FOR TECHNOLOGICAL IMPLEMENTATION OR ADOPTION

The **implementation of technology**, especially in government and policy institutions, is a key focus. Some suggestions to help with this include conducting a thorough assessment of Pakistan's ecological region to determine the availability of raw materials for making **smart building materials**, as Pakistan has abundant natural resources. Additionally, it is important for **academia and research** institutions to better understand the challenges faced by industries. Instead of seeking random ideas, they should conduct research based on **industry needs**. For instance, **research grants** can focus on finding low-cost, smart bricks for construction. Providing incentives and tax exemptions to industries involved in making smart building solutions is another recommended step. Furthermore, **reducing the import** of smart building equipment can support local industry growth and generate employment opportunities.

Educating people, training professionals and workers, enforcing green building rules, and supporting local industries in making materials are key recommendations for green materials in Pakistan. The report also suggests using available resources for smart building materials, promoting research that aligns with industry needs, providing incentives to local industries, and reducing imports of building equipment. These steps can help Pakistan transition to greener and more sustainable construction practices.

4. CONCLUSION AND WAY FORWARD

This report highlighted the significance of adopting green building practices in Pakistan to reduce greenhouse gas emissions, lower energy consumption, and ultimately, enhance the country's economic and environmental sustainability. Green building materials, design features, and energy-efficient appliances offer substantial cost savings, good BCR (Benefit-to-Cost Ratio), and good returns on investment with feasible payback periods. Alongside, there are long-term benefits, with a potential energy reduction of up to 30% in all aspects such as materials, design, and energy-efficient appliances. Also, various factors influence construction costs, including economic, environmental, and social aspects, making green building practices a favorable choice. To facilitate this shift, the report suggests strategies such as financial incentives, awareness and education initiatives, local sourcing, research funding, collaboration, and market transformation by professionals. By implementing these strategies, Pakistan can bridge the financial gaps in green buildings and promote sustainable construction practices, benefiting both the economy and the environment.

Furthermore, Pakistan's construction industry holds significant potential for green building practices. While it possesses a large labor force and some local sources of sustainable materials, there are notable gaps in expertise, green certification, and regulatory compliance. Addressing these gaps through capacity building, awareness programs, and enforcement measures is essential for fostering sustainable construction and economic revitalization. The adoption of technology and support for local industries can further drive progress. Transitioning towards green building practices will not only benefit the environment but also contribute to Pakistan's long-term economic growth and improved quality of life.

Moving forward, Pakistan should take action on the recommendations provided in this report. This includes creating and enforcing green building rules, offering financial incentives, and educating people about green construction. Promoting local materials, supporting research, working together, and making sure everyone follows the rules are equally important. Using technology and cooperation between the government and private sector will be crucial and periodic evaluation and adjustment of strategies will ensure the country remains on a sustainable path. By doing this, Pakistan can benefit from green building practices, leading to better economic growth, a healthier environment, and a better lifestyle for its citizens.

Appendix 8. Review Analysis of the Pakistan Green Building Regime

I. Introduction

1. Pakistan does not possess a formal, unified statutory regime addressing the concept and phenomenon of green buildings. Green buildings are distinguishable from energy efficient buildings in that Green buildings represent the practice of developing structures and employing processes that prioritize environmental responsibility and resource efficiency, which goes beyond the singular dimension of energy efficiency. Compared to the narrower focus of the energy efficiency approach, this approach spans the entire life cycle of a building, from initial site selection to design, construction, operation, maintenance, renovation, and eventual demolition. It expands upon and complements the traditional building design considerations of cost-effectiveness, utility, durability, and occupant comfort.
2. In this regard, green buildings circumscribe not just energy efficiency (the first step to green building), but also other important elements including the promotion of water conservation, indoor environmental quality, the use of sustainable construction materials and the reduction of environmental impact and the preservation of natural surroundings.
3. While green buildings are a relatively new policy imperative in Pakistan, there have been attempts dating back to the late 1980s (with varying degrees of success) to both make building codes more energy-efficient and the construction industry as a whole more environmentally friendly. Below, we survey these efforts from a legislative and regulatory perspective and use the locus of green buildings to assess what the potential path forward may be to make green building practices more mainstream in the Pakistani building / construction industry.
4. To do this, we primarily discuss four areas of legislation and regulation: (1) building control (with a corollary discussion of environment protection standards); (2) the energy efficiency regime; (3) the national standards regime; (4) finance and tax.

II. The Statutory and Regulatory Framework

A. Regulation of Construction & Building Control in Pakistan

Building Control as a Provincial Subject: Development Authorities, DHAs, Cantonments and Private Housing Societies as Regulators

5. The survey of any regulatory landscape necessarily needs to start with in an inquiry of where the power to legislate and administer lies. Pakistan is constitutionally a federal republic in which powers to regulate affairs are divided between the Federal and provincial governments respectively. Especially since the 18th Constitutional Amendment to the 1973 Constitution in 2010, the provinces reserve substantial autonomy to legislate, administer and enforce a number of matters in their respective territories. This includes the environmental protection, building control and the regulation of construction, since the federation retains powers to only legislate in respect of these matters to the extent of the Islamabad Capital Territory, or insofar as they bear relation to a federally controlled project, such as the Naya Pakistan Housing and Development schemes.
6. There are two notable exceptions to this – building control in Cantonment areas across the country, which are governed by the federal Cantonments Act, 1924, and the various Defence Housing Authorities ("**DHA**") across the country which are each governed by a federal law establishing them in each major city in the country. Furthermore, the Federal Government (through the Ministry of Housing and Works) continues to play a role in developing national policies for housing and development (though these policies are again not binding upon the provinces and merely set priorities for the Federal Government to advance), as well as promoting interprovincial coordination.
7. At the provincial level, the provincial legislatures have generally conferred quasi-legislative (regulation and bylaw making) powers and enforcement powers on both development authorities through the legislations that create them, and local governments (such as under those established under provincial statutes like the Punjab Local Government Act, 2022, the Sindh Local Government Act, 2013, the KPK Local Government Act, 2013, and the Balochistan Local Government Act, 2010). Due to primarily political challenges in making local governments functional, a discussion of which is beyond the purview of this Report, building control is primarily enforced and administered by development authorities within the areas of their jurisdiction. Each development authority usually has jurisdiction over an area roughly equal to the size of a district. As stated above, cantonments and DHAs within these areas fall outside the jurisdiction of the development authority and come within the purview of either the Cantonment Board established under the federal Cantonment Act, 1924 to administer that particular cantonment, or the DHA, established under the parent DHA statute. In some circumstances, building control is only indirectly administered through developers of private housing schemes, or not

at all and left to private bodies, such as in the case of cooperative housing society like the Model Town Cooperative Housing Society ("**MCS**") in Lahore.

8. There are also some federal housing projects administered by the Federal Government which are as a result subject to regulation by federal authorities. The most notable of these is the Naya Pakistan Housing Scheme, a low cost housing project announced by the Federal Government in 2020. This scheme is administered by the Naya Pakistan Housing and Development Authority under the Naya Pakistan Housing and Development Authority Act, 2020. Though interest (and momentum) in this scheme has diminished since the ouster of the PTI government that introduced it, the Naya Pakistan Housing Scheme is a example of a development agency developing and attempting to implement green building standards, and is therefore of interest for the purposes of this report. A brief discussion of these green building standards follows further below in the "Regulation of Energy Efficiency Related Standards" section.
9. The location of a residential or commercial building project determines which authority is the concerned building control authority whose rules, regulations and bylaws must be adhered to in order to gain the necessary building permits, site-map approvals, inspection clearances, and completion certificates to successfully navigate its construction.
10. The table below summarizes some notable agencies and authorities in major cities that exercise building control powers, and the building control measures they presently enforce:

Name	**Governing Legislation**	**Power to administer & legislate**	**Building Regulation**
CDA	The Capital Development Authority Ordinance, 1960	Federal	Islamabad Residential Sectors Zoning (Building Control) Regulations, 2020
LDA	The Lahore Development Authority Act, 1975	Provincial (Punjab)	Lahore Development Authority Building and Zoning Regulations 2019 (amended up till 2020)
Cantonment Board Clifton, Karachi	The Cantonments Act, 1924	Federal	The Cantonment Board Clifton Building By-Laws, 2007
SBCA	Sindh Building Control Ordinance, 1979	Provincial (Sindh)	The Karachi Building & Town Planning Regulations, 2002
DHA Islamabad / Rawalpindi	Defence Housing Authority Rawalpindi Act, 2013	Federal	DHA Islamabad/ Rawalpindi By-Laws and Regulations Revised 2022
DHA Lahore	Defence Housing Authority Lahore Order, 2002	Federal	DHA Construction & Development Regulations 2014

Naya Pakistan Housing and Development Authority	Naya Pakistan Housing and Development Authority, 2020	Federal	Standardization of Building Codes Standards and Specifications for Low-Cost (Affordable) Units - 2021

11. The building control regulations surveyed (listed above) show no consistent patterns. While each building control agency administers its regulations through a system of pre-construction approvals, permissions, no objection requirements, building plan approvals and other related measures, the requirements that building plans need to comport to vary. While some reference the Building Code of Pakistan (discussed further below) as the metric along which seismic, structural, and material requirements need to be measured against (in the case of the LDA Building Regulations also requiring compliance with the Building Code's energy related provisions), there is no consistent practice. Some even stipulate compliance with foreign standards, such that structure analysis, design, detailing and loading should be "*in accordance with the requirements of current Uniform Building Code and American Code or British relevant Code or any other Code*."
12. This can probably be accounted for by a lack of any central coordination mechanism between these various authorities in respect of building control requirements, the absence of any central guidance on the provincial or national goals of building control, or even what best current practices may be.
13. Building codes and regulations administered by various building control authorities also provide for standards for the testing of materials. For example, the Cantonment Board Clifton, Karachi requires that "*Regular testing will be carried out of materials such as aggregates, cement, concrete, reinforcing steel and all architectural materials, the quality control and quality assurance criteria laid down in standards of FIDIC, American Standard Testing method (ASTM), OR ACI or UBC and project specifications, quality assurance programme of architect or engineer may also be followed.*" However, the building control authorities in question have scant, if any, mechanism available to either enforce or verify compliance in respect of such requirements and provisions. Some of them, as this example demonstrates, can also be so vague as to essentially become irrelevant or immaterial.

The Building Code and the Engineering Profession

14. The Building Code of Pakistan is a consolidated construction code created and periodically by the Pakistan Engineering Council (the "**PEC**"), the apex statutory body charged with licensure and regulation of the engineering profession. The PEC was created by the Pakistan Engineering Council Act, 1975 which is a Federal law, and is enforced federally (with policy input from the federating units through the Council of Common Interest).
15. The Building Code of Pakistan is by itself a non-binding code detailing the minimum standards engineers ought to follow for the "*construction, alteration, relocation, enlargement, replacement, repair, equipment, use and occupancy, location, maintenance,*

removal and demolition of every building or structure or any appurtenances connected or attached to such buildings or structures." The Building Code of Pakistan 2021 ("**BCP 2021**") is the most recent iteration, having succeeded the Building Code of Pakistan 1986, and is based substantially on the 2021 International Building Code, the 2021 International Performance Code for Buildings and Facilities and the 2021 International Zoning Code. Once construction is complete, a distinct legal framework for post-completion building maintenance is lacking in Pakistan. Building owners have the freedom to decide on maintenance and improvements at their discretion.

Architects as Gatekeepers of Building Design: Untapped Opportunities

16. Besides structural or consultant engineers, who are almost universally required to certify the structural aspects of a building within the jurisdiction of each building authority discussed above, there is an equal, if not more significant role ascribed to architects, who bear the primary responsibility of certifying and submitting a building plan and drawings to the building control authority for approval. Each set of building regulations for each building authority codifies this role, and may even require parties engaging in construction to acquire certification only from architects registered with that particular building authority.
17. The profession of architecture is more broadly regulated under the Pakistan Council of Architects and Town Planners Ordinance 1983 (also a federal statute – the "**PCATPO**")), by the Pakistan Council of Architects & Town Planners ("**PCTAP**"), whose members are appointed by the Federal Government. There are by-laws prepared under the PCATPO which govern the professional ethics and standards of licensed architects and town-planners. Needless to say, green building practices and energy efficiency related standards have scant, if any, mention these by-laws – the only obligation placed on architects is to "*advise on the efficient use of energy in new and existing buildings*."

Environmental Approvals and Building Control

18. In addition (and in supplement) to the broader building control regulatory framework, each province's environment protection statute (such as the Punjab Environmental Protection Act 1997), also provides for the necessity of an environmental impact assessment (EIA) or initial environmental examination (IEE) for the construction of certain projects anywhere in the province from the province's environmental protection agency.
19. Building by-laws and regulations for most building control authorities recognize the need for EIAs and IEEs and make it a prerequisite for obtaining these prior to being granted approval for drawing and site maps to commence construction. It is worth noting however, that EIAs and IEEs are not required for every kind of construction or development, but it does cover a number of important residential and commercial constructions, such as housing schemes, apartment buildings, restaurants, urban development projects, and hotels.

B. Regulation of Energy Efficiency Related Standards

The 1990 Energy Code

20. The discourse on implementation of energy-related provisions in the construction of residential and commercial buildings in Pakistan has its roots in the Building Energy Code of Pakistan, 1990.
21. The Building Energy Code of Pakistan 1990 (the "**1990 Energy Code**") was a set of recommendations prepared by the National Energy Conservation Centre (ENERCON), a department of the Planning & Development Division of the Federal Government for the benefit of the Ministry of Housing & Works. It appeared to be fundamentally motivated by the Government's realization that buildings accounted for 40% of the total electricity consumed in Pakistan, and there was a 14% annual increase in demand by buildings, which warranted a new set of standards aimed at reducing the energy consumption of buildings. While ENERCON indicated that the 1990 Energy Code would form a part of the Building Code of Pakistan 1986 (which was the latest iteration of the national building code at the time – the "**1986 Building Code**"), it was not immediately mandatory to comply with, and ENERCON viewed it as a guidance document, supplemented by a Compliance Handbook, and workshops / seminars with building professionals that would help familiarize the industry with the concept. Once this familiarity was developed, ENERCON suggested that the 1990 Energy Code be made mandatory to comply with.
22. Thematically, the 1990 Code was mostly based on the American Society for Heating, Refrigerating and Air-Conditioning ("**ASHRAE**") standards, setting minimum performance standards for building windows and openings, heating, ventilating and air- conditioning (HVAC) equipment and lighting, ENERCON also made attempts to account for Pakistan's unique weather and climatic conditions by adopting separate standards for each of the five (05) climatic zones identified in the 1986 Building Code.

23. From 2003 to 2012, the Ministry of Housing & Works together with ENERCON ran an Awareness Campaign of Energy Conservation and Environment with the apparent aim of increasing awareness about the 1990 Energy Code. During this time, there were efforts to also update the 1990 Energy Code, but a 2012 effort to commission the National Energy Services Pakistan (NESPAK), was not able to take off, and ENERCON ultimately engaged with the PEC to both update the 1990 Energy Code as well as formally incorporate it into the 1986 Building Code. On 28 March 2013, the Building Code of Pakistan – Energy Provisions 2011 (the "**2011 Energy Provisions**") became both the successor of the 1990 Energy Code and a formal (binding) regulation under the PEC (Conduct & Consulting) By-Laws 1986, which prescribe professional standards for engineers, and which make non-compliance / non-observance of the 2011 Energy Provisions **mandatory** at the risk of misconduct proceedings on grounds of violation of professional engineering work.
24. The 2011 Energy Provisions aim to establish energy efficiency standards for buildings. They are substantially an adaption of the ASHRAE standards 90.1-2004, with the exception of Section 4, which has been tailored to accommodate the energy codes of regional countries and local environmental considerations.
25. The 2011 Energy Provisions delineate the scope, considering building size, construction type, applicable systems, exemption criteria, and priority in case of conflicting provisions. The Provisions encompass the regulation of building components and facilities such as building envelopes, mechanical systems and equipment (including HVAC), service water heating, lighting, and electrical power and motors.
26. The 2011 Energy Provisions only apply to buildings of a certain scale and scope, encompassing buildings and building clusters with a total connected load of 100kW or more, a contract demand of 125 kVA or more, a conditioned area of 900 m^2 or more, or unconditioned buildings with covered areas of 1,200m^2 or more. Furthermore, the Provisions only apply to new buildings and their systems, new portions of existing buildings and their systems (if they exceed the specified area or load limits), new systems and equipment in existing buildings, and an increase in electricity load beyond the aforementioned limits. They do not cover buildings that exclusively use sources other than electricity or fossil fuel, government-notified historically significant and heritage buildings, as well as equipment and building system parts utilized solely for manufacturing processes. They also do not take precedence over relevant safety, health, or environmental codes; they must yield to these provisions.
27. Although the PEC formally has the power to police and enforce the compliance of the 2011 Energy Provisions, as a practical matter it is nearly impossible for it to do so because it has no formal role in the building control process and is not in charge of vetting and providing approval for building plans. At present, the most the PEC can do is initiate misconduct proceedings upon a report that a consultant engineer has failed to comply with the 2011 Energy Provisions.

28. The only institutions that are administratively capable of enforcing the 2011 Provisions or other similar building code related regulations are the concerned building control authorities discussed above. However, the various building control authorities have been slow to formally incorporate the 2011 Energy Provisions, and for that matter even the Building Code of Pakistan, into their building regulations. The table below summarizes references to, and mandates for compliance with, the 2011 Energy Provisions in the regulations of some building control authorities:

Name	**Building Regulation / Bylaws**	**Incorporation of 2011 Energy Provisions?**
Capital Development Authority	Islamabad Residential Sectors Zoning (Building Control) Regulations 2020	No
Lahore Development Authority	Lahore Development Authority Building and Zoning Regulations 2019 (amended up till 2020)	Yes
Sindh Building Control Authority	The Karachi Building & Town Planning Regulations, 2002	Not expressly, but references the BCP more broadly
DHA Islamabad / Rawalpindi	Building By-Laws DHA Islamabad/ Rawalpindi Revised 2022	No
DHA Lahore	DHA Construction & Development Regulations 2014	No

The National Energy Efficiency & Conservation Act 2016

29. By 2014, local and international development agencies began calling for the establishment of a stand-alone energy efficiency and conservation framework at the national/federal level to address the growing energy crisis. In its 2016 report, the Japanese International Cooperation Agency ("**JICA**") documented the growing calls for such a regime and reiterated its need by drawing parallels to the implementation and relative success of such an infrastructure in Japan.
30. One of the many challenges associated with creating such a regime was that, as discussed earlier, several areas which have a direct nexus with the potential mandate or area of concern for an energy efficiency and conservation authority, such as building control, are within the legislative and administrative domain of the provinces <u>exclusively</u>. While this handicap could have been overcome through a mechanism in the Constitution whereby provinces can pass a resolution to "delegate" the power to legislate to the federation in the interest of creating a national legislative framework for an area of importance, (which has been successfully managed in several areas, such as the regulation of pharmaceuticals by the Drug Regulatory Authority of Pakistan), there was no such consideration to do that in this case. Instead, since the regulation of electricity, oil and gas fall within the purview of the Federation, as does interprovincial matters and coordination, the Federal Government relied on the power to regulate these domains to propose a new

National Energy Efficiency and Conservation authority, which would coordinate with the provinces and their designated energy conservation authorities to implement energy efficiency related measures.

31. After two years of circulation and consideration as a bill, on 29th June 2016, the National Energy Efficiency and Conservation Act 2016 ("**NEECA Act**") formally came into force in Pakistan. The NEECA Act does several important things.
32. The NEECA Act empowered the Federal Government to create the Pakistan Energy Efficiency and Conservation Board ("**NEECB**"), an inter-governmental and inter-sectoral forum composed of a minister, secretaries, regulators and industry representatives, whose province of responsibilities include, among other things, policy formulation, collaboration with the National Standards Board to enforce energy efficiency standards, labelling, incentives and fines, and the establishment of organizations to promote its objectives.
33. More importantly, NEECB is charged with the supervision of a new body, also created by the NEECA Act, called the Pakistan Energy Efficiency and Conservation Authority ("**NEECA**"). NEECA steps into the shoes of ENERCON as the focal federal agency for "*initiating, catalyzing, carrying out and coordinating the implementation of all energy conservation programs in all sectors of economy.*"
34. NEECA, having a broad mandate, has a number of powers and functions, including the development and implementation of policies, programs, and projects related to energy efficiency and conservation. The Authority is also responsible for conducting research and development activities, as well as providing technical assistance and training to stakeholders. It is charged with preparing and updating the national energy conservation policy, recommending national energy efficiency standards, establishing accredited laboratories for conducting tests and analysis, undertaking inquiries and investigations into energy conservation issues, carrying out energy audits, directing energy use assessment, and potentially prohibiting manufacture, sale or import of non-energy efficient equipment and appliances. One independent means of achieving this, as provided through the NEECA Act is through NEECA's power to certify and appoint energy auditors, who have the power to make an examination of energy consumption in a project and to prescribe means for its conservation.
35. Most recently, under its prescriptive powers, NEECA has prepared a National Energy Efficiency and Conversation Policy, 2023, which remains on the agenda of the Council of Common Interests (a constitutional body composed of representation from both the federation and the provinces that has oversight of matters with an interprovincial nexus, specifically those listed in Part II of the Federal Legislative List of the Constitution of Pakistan) but has yet to be accorded approval.
36. In addition to the NEECB and NEECA, the Federal and Provincial Governments also have important roles to play under the NEECA Act. The Federal Government has the power to, among other things, set standards and issue directions in writing to any person, officer, authority, or designated consumer for the efficient use of energy and its conservation. These directions may include regulating the norms for process and

energy consumption standards in any industry or building, as well as regulating the energy consumption standards for equipment and appliances. It specifically has the power to prescribe and amend energy conservation building codes, and direct designated consumers to comply with the provisions of energy conservation building codes, to prescribe standards for energy auditors, and to prescribe penalties for energy inefficient apparatus, appliances, equipment, plant and machinery.

37. The Federal Government also has the power to issue energy saving certificates to consumers, and stipulate the standards and regulations in accordance with which they will be granted. The NEECA Act itself envisions one benefit for these certificates – that they can be sold to people whose energy consumption is in excess of the prescribed standards – essentially looking to emulate the concept of markets for carbon credits by proposing a kind of energy efficiency credits market.
38. Provincial governments have powers similar to the Federal Government to require compliance with the energy building codes and are expected to appoint designated departments or agencies to coordinate with NEECA in implementing the terms of the NEECA Act. At present, the Sindh Energy Efficiency and Conservation Agency (SEECA), the Pakhtunkhwa Energy Development Organization (PEDO), the Punjab Energy Efficiency and Conservation Agency (PEECA), and the Baluchistan Energy Department, Government of Baluchistan appear to be in line to fulfil this role, though the ability and willingness to make these agencies functional in this regard can be substantially improved. These designated agencies are intended to have inquiry, investigative and energy audit related powers.
39. The NEECA Act also provides for the possibility of energy conservation tribunals to be notified, but to date, no such tribunals appear to have been notified by the Federal Government.
40. NEECA has already published a national Energy Conservation Building Code in 2023, and the Punjab Energy Efficiency Agency has a nearly identical version of it available on its website as a draft Energy Efficiency & Conservation Building Code of Punjab, 2017. However, a fundamental problem that remains is that ultimately the time for consideration of these codes is during the process of gaining approvals for the construction of a commercial or residential building, which process is still entirely regulated and administered by the various building control authorities, none of whom have yet introduced procedures, requirements or guardrails to ensure that engineers and architects are signing certificates and furnishing building plans after duly considering the requirements of these new codes.
41. Not only that, but it appears that even though the PEC has been involved with (and has indeed been pivotal to) the creation of the national Energy Efficiency Building Code, it has <u>not</u> yet been notified either as a component of the Building Code of Pakistan, or as an update to the 2011 Energy Provisions, with the absence of the latter measure meaning that consulting engineers are not actually required to use it. However, sources in the PEC and NEECA suggest that, as of the date of writing of this report, there are ongoing consultations to formally notify the 2023 Energy Efficiency Code as a successor to the 2011 Energy Provisions.

Other Energy Efficiency and Green Building-related Interventions

42. There have been some initiatives by the Federal Government to encourage the adoption of green building codes and standards, at least to the extent of federally administered projects. The Ministry of Climate Change and Environmental Coordination ("**MoCC**") has taken an important role in this regard. While the MoCC has no direct role in the regulation or enforcement of green building standards, as the Ministry that acts as the focal point of the Federal Government as regards to climate change and environmental degradation and its impacts, it has undertaken a number of steps to encourage the adoption of practices that result in a better national environment and forestall the risks and anticipated consequences of climate change. The Ministry is also actively engaged as part of Pakistan's international carbon emissions reduction obligations. These obligations are directly linked with the construction industry in Pakistan which as discussed earlier, plays a significant role in the carbon production of the country. Most relevantly for the purposes of this report, the MoCC is currently engaged in the Climate Resilient Urban Human Settlements Unit project which seeks to develop and strengthen the capacity of city administrations to assess the emission targets and adopt low-carbon energy-efficient comprehensive action plans to convert their urban-heat islands into "Climate Resilient Cities", towards fulfilling international commitments of the Federal Government. The project involves coordination and collaboration with the Pakistan Urban Planning & Policy Centre at the Ministry of PD&R (Planning, Development& Reforms); along with the UN-Habitat (Pakistan); all provincial urban units; and the Line Departments of P&D; Local Governments; Housing & Urban Development of the Governments of Gilgit & Baltistan and the AJK.

43. According to industry insiders, specifically in the context of green building codes and standards, the MoCC has been coordinating and collaborating other federal entities, such as the PEC and NEECA in order to draft and promulgate green building codes which are applicable throughout Pakistan. While no drafts have been made available for public review, we understand that the Energy Efficient Building Code is being used as the underlying document for purposes of establishing a unified regulatory and enforcement regime.
44. Prior to this, the Federal Government received funding to prepare a green building code for implementation as part of its Five Million Housing Programme, and a group steered by SWITCH-Asia prepared the *Model Green Building Code Provisions for Five Million Housing Programme in Pakistan*. As the name suggests though, these are model building code provisions, and do not have the force of law.

C. The National Standards Regime and Certification Systems

45. Pakistan does not yet have any official accreditations or standards recognized by the government for green buildings. There have been some efforts to introduce product certifications for energy-efficient appliances, most recently under the new energy efficiency and conservation regime introduced by the NEECA Act, such as NEECA's efforts to implement energy efficient certifications for fans, but progress on that front has faced delays and can be improved.

The development of certifications and standards by government agencies

46. There is a federal regime in place for national standards, with a reasonable degree of private sector participation for the purposes of performing assessments on the basis of officially notified standards. For standards and quality control, the Pakistan Standards and Quality Control Authority, established by the Pakistan Standards and Quality Control Authority Act 1996 ("**PSQCA Act 1996**"), has been the main body in charge of, among other things, providing grading and setting quality labelling standards for ingredients, performance, specification, usage, methods and other relevant quality control matters as well as grading the products when requested by manufacturers, or whenever necessary for the purpose of quality improvement. The PSQCA also has the power to prohibit, manufacture, keeping in stock and sale of certain articles that do not conform to Pakistan Standards, as well as to prohibit their export, registration or even use of a name.
47. There is some overlap here since 2016, since NEECA possesses similar powers, but there has been some degree of consensus that since PSQCA has superior resources, pre-existing infrastructure and an established track record in devising and implementing quality standards, it is probably better suited to leading the effort on the creation and adoption of Pakistan Standards for energy efficiency and green labelling with supplementary assistance from NEECA.
48. In fact, the PSQCA has already been collaborating with NEECA to produce Pakistan Standards for energy efficiency of certain products. There is already a Pakistan Standard for "Comfort Fans and Regulators for Household and Similar Purposes." Similarly, we see a clearer division of roles between NEECA and PSQCA's roles through the introduction of the draft National Energy Efficiency Authority (Pakistan Energy Labels) Regulations, through which NEECA proposes to itself take on the authority of registering and implementing Pakistan Energy Labels, but only on the basis of Energy Star Rating prescribed by the PSQCA, and on the basis of Minimum Energy Performance Standards (MEPS) also adopted by the PSQCA and approved by NEECA.
49. Under these Energy Label Regulations, there is also finally an attempt to introduce mandatory requirements for certain household products, such as room air conditioners, motors, fans, house hold refrigerating appliances and LED Lights to be energy efficient, and a prohibitions on manufacturers, assemblers and importers from procuring and selling inefficient appliances, as well as a registration and

certification mechanism, so there is more legal infrastructure in place to push for more energy efficient certification and labelling.

50. Consultations around introducing these regulations continue, but there is no news on their notification.

The development of certifications and standards in the private sector

51. Global recognition according to the LEED certifications granted by the U.S. Green Building Council has also spurred interest internationally in the creation and adoption of private green building codes and certifications. In Pakistan, the Pakistan Green Building Council ("**PGBC**"), which is a not-for-profit organization, is posturing itself as the "*only organization in the country advocating, promoting, developing Pakistan specific green guidelines and certifying sustainable building practices and product.*" The PGBC is a prospective candidate for membership with the World Green Building Council.
52. It appears that PGBC has not yet framed independent guidelines for Pakistan, but it continues to promote or facilitate the acquisition of the LEED and SEED standards administered by the World and U.S. Green Building Council. While there is limited public reporting on the activities of the PGBC, they enjoy the patronage and support of notable industry participants (such as Bani Mukhtar, which is a leading builder and a founding member of the PGBC), and also find mention in the Securities and Exchange Commission of Pakistan ("**SECP**")'s latest Green Bond guidelines, as a body whose standards would be recognized for the purposes of identifying and validating the issuance of bonds for green building projects.

D. <u>Financial and Tax Incentives</u>

53. Currently, there are very limited, if any, tax and fiscal benefits available for energy efficient construction or green buildings.
54. At the federal level, the Federal Board of Revenue ("**FBR**") administers several federal taxes and levies, most notably income tax under the Income Tax Ordinance 2001, sales tax on goods under the Sales Tax Act 1990, federal excise duty under the Federal Excise Act 2006 and customs duties under the Customs Act 1969. The Federal Government has afforded waivers and reductions to custom duties and sales tax on solar panels, but there are no concessions currently available to green building materials. Fiscal and tax-based incentives are a good policy to spur the adoption of new policies or to encourage new sectors. For instance, the Income Tax Ordinance 2001 already contains mechanisms for the grant of tax credits based on the securing of various certifications (e.g. not for profit certification from the Pakistan Centre for Philanthropy, or certifications for I.T service providers by the Pakistan Software Export Board).
55. At the provincial level, each province also administers a series of taxes, the most significant of which are the sales tax on services (collected under each province's own sales tax on services statute by the provincial Revenue Authority) and property

tax, collected by the provincial excise and taxation department, or in the case of Islamabad, by the CDA. Property tax is based on the annual value of properties in areas designated as Rating Areas by the provincial government, with higher rates for rented properties compared to self-occupied ones. No special concessions or exemptions presently exist for green buildings or energy efficient buildings, though reduction / concessionary incentives are granted for other purposes, such as early payment.

56. As the chief regulator of the banking sector, the State Bank of Pakistan can play a massive role in the availability of finance through banks for the purposes of developing green buildings and energy efficiency projects. However, there is a general malaise of low credit availability in Pakistan driven by a number of factors, including but not limited to a risk averse banking sector, high interest rates, onerous security requirements, inefficient mechanisms for recovery in cases of default and other similar factors. While the State Bank of Pakistan has tried as recently as 2021 to improve access to credit to the construction industry generally for the purposes of housing development, these efforts have not yielded much success in terms of improving access to housing finance. No measures of this nature have expressly incorporated energy efficiency or green buildings as a priority.
57. Policy interventions such as the Green Banking Guidelines issued by the State Bank of Pakistan to banks have attempted to increase the accessibility and adoption of green finance and green banking, but these have also had a limited impact. Through the Green Banking Guidelines, the State Bank has sought to do a number of things, including encouraging banks to incorporate environmental and social risk factors into their lending decisions, promoting the adoption of best practices in risk management to mitigate potential negative environmental and social impacts associated with financing activities, promoting financing for environmentally sustainable projects, such as renewable energy, energy efficiency, and other green initiatives and providing incentives for banks to offer favorable terms for loans and financing related to environmentally friendly projects, and encouraging banks to build internal capacities to assess and manage environmental risks. However, these guidelines appear to have a very limited impact in the adoption of green banking and green finance nationally.
58. The SECP has also just recently introduced guidelines for the issuance of green bonds/sukuks by public and private, which expressly recognizes green buildings as a legitimate subject of the use of proceeds from raising green bonds. As the guidelines are brand new as of this Report, no green bonds /sukuks have so far been issued.

III. Analysis of Gaps and Failures

59. Needless to say, the legal infrastructure undergirding the push for energy efficient and green buildings is not optimally geared to achieve that purpose.
60. Pakistan’s chief problem in this regard is fundamental in nature: the degree to which building control is successfully administered varies widely, and the mechanics for it

do not, at present, present a strong likelihood that tying in additional requirements either for green building materials and methods will prompt a visible transformation.

61. There is at least one study that documents the relative weakness of building Bylaws enforcement by various building control authorities in Pakistan. It suggests that between public building control authorities (such as the LDA and local government) and private building control authorities (housing societies such as the Model Town Cooperative Housing Society ("**MCS**") in Lahore), the private authorities generally have stronger enforcement practices than the public ones, with better results in the public sphere by authorities such as the Cantonment Boards. It was found that 100% of house plans were approved by the MCS, while Lahore Cantonment Board also had significant control in its area and more than 85% plans were approved from the authority, while LDA had a mixed trend of approved and not-approved status due to weak enforcement. The local government administration had the weakest enforcement results, with 70% of house plans not being approved by the building control authority.
62. A number of reasons have been proffered to explain this. Fundamentally, it appears to be a resources problem, with the lack of monitoring machinery, and shortage of technical manpower at the municipal level. Local political influence has also been suggested as a hurdle in controlling building violations. By contrast, it is suggested that private building control authorities have better enforcement practices because of the participation of private parties, whose direct participation in the building control authorities (through electoral processes) gives them a direct stake in administration and enforcement, and enables building owners to put pressure on authorities to take prompt action and enforce its own Bylaws in the interest of the common good.
63. Presently, the only consistent mode of enforcement found in the building Bylaws and regulations of building control agencies is the requirement that an architect and/or the consultant engineer provide a certification of the compliance of the building plan with the stipulated building standards (whether this is the Building Code of Pakistan, or the various other foreign standards building control agencies find acceptable). There is, to be clear, little to no follow up or inspection regime in place regarding the accuracy of this certification, nor any post-completion, or random audit mechanism to gauge compliance. This has partial ties to the problem of capacity at the building control authority level, but also exposes a procedural / regulatory defect in enforcement.
64. The problem of capacity and lack of effective enforcement, especially at the level of the development authorities such as LDA, CDA etc. has been repeatedly highlighted through prior work in this area. Development authorities are routine found to not possess the technical and skilled staff necessary to assess compliance with the requirements of energy efficiency codes and green building codes.
65. JICA, for example, underlined in 2016 that while the 2011 Provisions state that the review and approval of the plans and specification by respective sanctioning from the development authorities or municipalities shall be in accordance with the EP-

2011, many of these authorities or municipal corporation lack of technical and skilled staff who can understand the existing policies, proposals and can play their role for the implementation. It found that while development authorities were present in every major city, their role regarding urban planning and development remains unsatisfactory except of a few which managed to achieve targets and planned new strategies to cope with urban planning and housing issues.

66. In addition to capacity problems, JICA also highlighted that there was also an awareness problem among building control agencies, architects, engineers and consumers regarding energy related building standards such as the 2011 Energy Provisions. This is to be expected given the complete absence of any effective compliance and enforcement mechanism in respect of energy efficient building codes and protocols such as the 2011 Energy Provisions. Even where compliance can be assured, existing codes are already required to be updated regularly, (3 years standard), but such updates haven't been forthcoming in the past – though there is some renewed energy to do this owing to the establishment of NEECA. Still, despite the development of the national Energy Efficient Building Code in 2023 (12 years after the 2011 Energy Provisions, and 7 years after the NEECA Act was enacted), it should be borne in mind that outside of NEECA's own framework, neither the PEC nor the building control authorities are presently required to enforce it.
67. In an effort to resolve some of these concerns, NEECA is reported engaging with building authorities to improve incorporation and implementation of energy-efficiency related measures. NEECA has estimated that they hope to have engaged with and onboarded all the various building control authorities by the end of 2024.
68. Outside of the domain of building methodologies, green building codes also rely on the prescription of environmentally friendly and code-compliant construction materials. However, the rating system for manufactured goods in Pakistan is underdeveloped, and at present, domestically manufactured equipment and fixtures such as window frames come with no product specifications (such as airtightness or waterproofing). The lack of a market certificated products is also limiting factor when it comes to the adoption of energy efficient and green building practices.
69. In this regard, while there is measurable (and commendable) progress in improving material and product certification, it has been commented that the technical aspects of programs are relatively straightforward, but the political, governance issues, and budgetary constraints can impede government-led initiatives. There has been emphasis placed on the importance of continuity and support from government leadership for national labelling success. Broader stakeholder engagement, including industry involvement, is crucial for adoption. Limited promotional budgets and the voluntary nature of the labelling had led to a loss of consumer awareness, but with NEECA's 2022 Regulations, there may be an opportunity for more momentum on the front of enforcement.
70. Finally, as discussed above, there are limited fiscal and tax incentives to adopt energy efficient and green building standards, which make the added cost of implementing green building practices even less attractive.

71. As discussed earlier, within the domestic legal framework, the NEECA Act provides for the awarding of energy efficiency certificates to buildings for energy conservation, which are envisioned as a tradeable commodity in the vein of the global carbon credits market – the idea being that if there were energy usage caps for types of buildings, then building owners who fail to remain under such caps could purchase energy efficiency certificates from building owners who use less energy. However, this mechanism currently exists only on paper, and NEECA has neither notified any standards for the assessment or award of energy saving certificates, nor purported to set any mandatory or voluntary energy consumption quotas for buildings that would create the need for parties to sell or purchase energy efficiency certificates.
72. On the topic of the carbon credit market that had its genesis in the Kyoto Protocol and the Glasgow COP26, Pakistan lags behind in effectively tapping into this mechanism. Energy efficient and green buildings could potentially serve as an additional avenue to capitalize on the global carbon credit trading market by enabling housing society developers, constructors or building owners to claim carbon credits for reductions in the emissions resulting from the erection of green buildings. A number of challenges stand in the way of this, most notably the absence of public knowledge of carbon credits, as well as the absence of local carbon credit markets or supporting legislative / regulatory infrastructure. Even so, there is a nascent market for certification agencies in Pakistan that can certify emissions reductions for registration and trading, and private businesses such as SGS offer such services.
73. Taxation is a significant but underutilized policy tool in this regard. In other countries such as the United States, there are various tax credits and concessionary tax rates available to persons building owners as well as equipment and material manufacturers who implement green building and energy efficient measures. The Internal Revenue Service (IRS) of the U.S. Federal Government has provided the guidance regarding tax credits to construct new energy-efficient homes available under the Energy Policy Act of 2005 through IRS Notice 2008-35, which provides guidance for credit for building energy-efficient homes other than manufactured homes, and IRS Notice 2008-36, which provides guidance for credit for building energy-efficient manufactured homes.
74. Similarly, the Tax Relief and Job Creation Act of 2010 modifies and extends the energy-efficient appliance credit for certain dishwashers, clothes washers and refrigerators manufactured after December 31, 2010. Similarly, the commercial building deduction appears in the new section 179D, which was enacted in the Energy Policy Act of 2005. The provision allows deductions for taxpayers who own, or are lessees of, a commercial building and install property as part of the commercial building's interior lighting systems, heating, cooling, ventilation and hot water systems, or building envelope.

75. In Pakistan, tax incentives both at the Federal and provincial levels could potentially spur a revolution in the adoption of green building standards in constructing buildings if appropriate tax credits, tax breaks

IV. Recommendations for a Path Forward

76. To encourage the integration of smart and green city concepts, as well as energy efficiency provisions in urban planning and design, legal frameworks play a pivotal role in shaping and incentivizing sustainable practices. The Federal and provincial governments both need to implement an integrated strategy that both provides incentives and also mandates the maintenance of clearly defined thresholds / standards at the risk of penalty.
77. As discussed in detail above, Pakistan's federal form of government necessarily requires buy-in from the provinces in order for there to be any effective building control, since property, urban planning, development and ancillary matters remain largely within the legislative and administrative control of the provincial governments and legislatures, and then further down, in the hands of local development authorities created mostly under provincial statutes (except for Cantonments, DHAs and federal housing schemes or programs such as the Naya Pakistan Housing Project).
78. Thus both levels of government can look to enacting legislation that mandates or incentivizes the incorporation of energy-efficient technologies and green building standards in urban development projects. Zoning laws, for example, can be revised to prioritize the allocation of land for eco-friendly initiatives and set specific energy efficiency targets for new constructions.
79. Moreover, financial incentives such as tax breaks, grants, or low-interest loans can be introduced to motivate developers and businesses to invest in smart and green technologies. These incentives can be tied to the attainment of specific sustainability goals, ensuring that the benefits of environmentally friendly practices are both economic and ecological. Additionally, stringent building codes and certification programs can be implemented, requiring adherence to energy efficiency standards for obtaining construction permits. By embedding such requirements in legal frameworks, governments create a regulatory environment that fosters innovation and motivates stakeholders to prioritize sustainability in urban development.
80. Furthermore, collaboration between public and private sectors can be encouraged through legal mechanisms, fostering partnerships that leverage resources and expertise to implement smart city solutions. The law can facilitate the creation of public-private partnerships (PPPs) that focus on the development and maintenance of green infrastructure, including energy-efficient buildings and smart grid systems. By doing so, the legal system becomes a catalyst for the widespread adoption of sustainable practices, promoting a holistic approach to urban development that addresses environmental concerns while also meeting the needs of a growing and technologically advancing population. These approaches are discussed below:

Improving the implementation of Green Building Standards

81. As noted previously, in Pakistan, the power of the state to regulate affairs is divided between the Federal and provincial governments. On a Federal level, the NEECA Act provides mechanisms for the enforcement of the provisions of the Act including compliance with energy consumption standards. The Act provisions for the appointment of inspectors, by the designated provincial agency, for the purposes of enforcement. The inspectors may enter into a premises to undertake inspection of any equipment for compliance with the energy consumption standards or other such matters as may be authorized. According to our information, no such inspectors have been appointed by any of the provincial agencies.
82. Furthermore, under the NEECA Act, there exists a provision which allows for NEECA to carry out energy audits of any building for the purposes of identifying energy conservation issues and making recommendations for corrective measures. Through such audits, NEECA can not only play a facilitatory and educational role as regards to adoption of energy efficient and green building standards and practices but can also develop a formal legal mechanism for ongoing monitoring of certain larger scale projects to ensure compliance on an ongoing basis. Such a mechanism, for instance, could involve an initial inspection / audit at the pre-approval stage based on the submitted plans and drawings and then follow-up audits and inspections as construction proceeds.
83. If NEECA and through it, the provincial designated agencies such as PEECA, seek to improve enforcement on matters related to energy efficient, they must undertake serious efforts and make available adequate financial resources to build out its inspection and audit capacities. This is only possible if there is a collective appreciation on Federal and provincial government levels of the dire need for the adoption of energy efficient and green building provisions in Pakistan and a willingness to direct significant financial resources towards this issue. Such resources could be granted to NEECA, for instance, through the Energy Conversation Fund, a Fund which is envisioned under the Act, to be established by the Federal Government for the purposes of promoting efficient use of energy and for meeting out the expenses incurred in the implementation of the law.
84. The MoCC also has an important role to play *vis a vis*, devising, streamlining and coordinating implementation plans. As the Federal Government's primary ministry that deals with issues of climate change and environmental coordination, the MoCC can play a beneficial faciliatory role in the development and adoption of green building standards for Pakistan. Where support of the Federal Government is provided, both financial and political, the MoCC is well placed to gather all stakeholders, both at the provincial and federal levels, at one forum in order to devise national mechanisms for the adoption and enforcement of green standards as well as to resolve any ongoing concerns that arise as regards to the jurisdiction of a particular agency, authority, ministry or government to act in a particular area. The currently active coordination mechanism instigated by MoCC for NDC

implementation, monitoring and reporting is a testament to how such an engagement is possible between the provincial and federal entities. Being the focal and decision-making entity on decarbonizing the economy and environmental sustainability, a green building certification system administered by MoCC and supported by NEECA is suggested. At federal level, the enforcement of the certification system can be handled by PEC. This certification system can be implemented by both public and private entities possessing research capacities and testing labs. Academic institutions can play a pivotal role in conducting green building materials testing.

85. On a provincial level, the focal agencies that must pay their role are the provincial designated agencies. As discussed previously, the majority of local building development authorities have not yet adopted even the 2011 Energy Provisions, let alone any of the energy efficient codes or guidelines. The Provincial Designated Agencies must, therefore, as an initial and first step, undertake efforts to ensure that standards as regards efficiency efficient are formally adopted as part of the respective building regulations / standards in force in their provinces so that these may be formally enforced.
86. Notwithstanding, it should be remembered that the capacity, competency and commitment of local development authorities, such as the LDA, itself is under question and in such circumstances, it is unlikely that such bodies will consider the enforcement of energy efficient and green building provisions as a priority. In this respect, delegating this responsibility further, to the private housing schemes, which have demonstrated a greater capacity and willingness to enforce building code provisions and punish violations may be a solution worth exploring. Where such schemes do not exist, greater private participation in matters related to enforcement of energy efficient and green building standards could provide a solution. Such participation could be in a number of forms, such as through a direct outsourcing of the enforcement of energy efficient and green building standards or through more tailored measures such as increasing the involvement and responsibility of architects working on a particular project, through amendments in bylaws providing for the professional ethics and standards of licensed architects and town-planners which add specific obligations upon architects and town planners to ensure that any building they design and construct conforms with the relevant energy efficiency and green building requirements applicable. While currently, there is only an obligation to "*advise on the efficient use of energy in new and existing buildings*.", this could be expanded to include more specific obligations regarding design, choice of material etc.
87. As this report has attempted to make clear, given the nature of Pakistan's governance structure without provincial and federal coordination, serious progress in the area of development and enforcement of energy efficient and green building standards will likely remain lacking.
88. A consultative inter-agency committee on building codes could potentially solve this problem – it could be a consultative caucus for provincial, federal and local

stakeholders to interact and coordinate their respective efforts with regards to impletion of a uniform building code, based on green building principles, which contains the appropriate enforcement mechanisms as regards energy efficiency. The committee could have representation from NEECA, each provincial designated agency, all the building control authorities discussed earlier (LDA, CDA, the Cantonment Boards, the Naya Pakistan Housing Development Authority) and from the local government. Such a platform could be beneficial not only for purpose of coordination of efforts of the individual stakeholders but for the resolution of any issues as regards jurisdiction in a more streamed and timely fashion.

Regular Updates of the Relevant Building Codes

89. In addition to developing a stringent enforcement mechanism as regards energy efficient and green building standards, at international best practices inform us, it is equally important to regularly, at defined intervals, update the building standards and codes to account for changes in technology, building practices, availability of materials etc. While the Energy Conservation and Building Code, 2023 states that *"The code would be revised every 3 years, with the possibility of earlier updates if necessary to ensure its continued relevance and effectiveness"*, in the past, it has been seen that regular revisions in the codes rarely occurs according to this timeline.
90. For instance, while both the Building Energy Code for Pakistan, 1990 and the Punjab Energy Conversation Building Code 2017 both provided for defined periods after which the codes would be reviewed and updated as required, neither code has seen any substantial amendment following its initial publication. Given the rapid pace of technological change, it is therefore imperative that the obligations as regards to regularly reviewing the building codes and updating them as required is adhered to and the relevant stakeholders chalk out an implementation mechanisms through which such reviews and updates may be made, in accordance with the provided timelines and best practices.

Material and Energy Efficiency Standards & Certifications

91. For green buildings to be viable, the material that is used to construct them must be convenient to identify and source. There is already a wide enabling framework available for the government to implement material standards certifications.
92. While the NEECB has the power to establish organizations for the purposes of carrying out its functions under the NEECA Act, given its already pre-existing expertise in the area, the PSQCA is probably best placed to take on the mantle of establishing quality control and certification standards for equipment and materials, with participation from the private sector in carrying on inspections through a fee based model in order to bring energy efficiency and green building certifications to market.
93. The NEECA Act also provides for a potential end-user certification system that potentially looks to create secondary market for energy conservation certificates that can be used to offset a consumer's non-energy-efficient practices (much like the carbon credit system sought to be implemented by the Kyoto Protocol). While this provision is promising, it must be borne in mind that, looking across the field to Pakistan's small, shallow and weak secondary markets for securities (the PSX and the PMEX), the possibility of a robust secondary market in energy efficiency credits and tradable energy certificates is best left as a second step once there is more widespread understanding and acceptance of green buildings and energy efficient buildings, a well-established enforcement mechanism, and a larger market for green building related products.

Fiscal and Tax Incentives.

94. Fiscal incentives can also have a substantial impact on the implementation and realization of an effective green building regime, combining benefits stemming from both the Federal and provincial tax regimes to create a cascade of benefits for all the stakeholders involved in the building process.
95. Financing plays a crucial role in promoting green buildings by incentivizing sustainable practices, encouraging energy efficiency, and addressing environmental concerns. Green building financing can come from various sources, including government initiatives, private investors, and financial institutions. Countries like
96. In some African countries, microfinance institutions provide loans to small-scale developers and homeowners to implement green building techniques. These loans can be specifically targeted at improving energy efficiency and using sustainable materials. Brazil has implemented public-private partnerships to fund sustainable urban development projects, including green buildings. The collaboration between government entities and private investors helps mobilize resources and expertise.
97. Private companies or municipalities can enter into energy performance contracts where the financing is tied to achieving specific energy efficiency goals. The savings generated from improved energy performance can be used to repay the financing.
98. There are numerous other opportunities for the State Bank of Pakistan to intervene to assist in promoting green building financing. It can, for instance, work with financial institutions to enable them to offer financial products that reward green building practices. Lower interest rates or special coverage for green features can incentivize developers to invest in sustainable construction.
99. Green financing has also made significant headway in the past decade internationally. Sweden have issued green bonds to finance environmentally friendly projects, including green buildings. Investors purchase these bonds, and the funds are allocated to sustainable development projects.
100. The SECP has also just recently introduced guidelines for the issuance of green bonds/sukuks by public and private, which expressly recognizes green buildings as a legitimate subject of the use of proceeds from raising green bonds. These guidelines create the opportunity for businesses looking to improve their ESG metrics to use green building standards as a means to show their commitment to environmental sustainability, and to raise financing more easily specifically for this purpose. The Federal Government, the State Bank and the SECP can implement a range of further policy measures to promote the utilization of this mode of financing to encourage companies to implement green buildings, such as encouraging mutual funds and public funds to invest in these funds more actively.
101. As discussed earlier, the operationalization of Energy Efficiency certificates under the NEECA regime, which closely emulate Emissions Reduction Certificates (ERCs), is also a potentially useful tool in improving the demand for green buildings. ERCs have emerged as a powerful instrument in the realm of sustainable development, offering a tangible way to incentivize and promote green building practices. One of the key advantages of ERCs is their tradability. Building owners or developers can monetize the certificates by selling them in emissions trading markets. Buyers, often

companies seeking to offset their own emissions or comply with environmental regulations, purchase these certificates as a way to invest in sustainability while meeting their carbon reduction goals.

102. The existence of a market for ERCs creates a financial incentive for housing society developers, investors and building owners to prioritize sustainable building practices. By attaching a tangible value to emissions reduction, ERCs encourage the adoption of energy-efficient technologies, renewable energy sources, and other green building strategies. This, in turn, fosters a shift towards more sustainable and environmentally friendly construction practices.

103. Tax benefits also serve as potent tools for molding market behavior, and the Federal and provincial governments could offer several different kinds of tax concessions to incentivize building developers and owners to opt for green building frameworks.

104. The Federal Government, which has legislative and administrative authority over federal taxes (income, excise, customs and sales tax on goods), could consider amending the Income Tax Ordinance 2001 to introduce a tax credit, or other concessions or benefits, to persons deriving income from property if they possess a recognized green building certification or an energy efficiency certification. Similarly, builders, constructors, engineers, and architects can be given concessionary rates applicable to their income from business if they're able to show that a certain percentage of their projects in a given tax year are certified green or energy efficient.

105. At the end of material sourcing, the Sales Tax Act 1990 and the Customs Act 1969 could be amended to provide concessionary sales tax and customs duty rates for building materials and appliances that are duly certified by the PSQCA and NEECA as "green" or "energy efficient".

106. At the provincial level, the provincial tax on immoveable property acts could be amended to provide concessionary rates or tax holidays to properties that are able to obtain a LEED or SEED certification. The sales tax on services acts could make reduced tax rates to applicable to the services of architects, builders and engineers who achieve a minimum number of LEED, SEED or other building certification standards as a percentage of their total projects in a given tax year.

107. In addition to incentives provided through the taxation regime, private lending institutions could be brought on board by the respective governments in an effort to make financing available for the retrofitting of old buildings with new, energy efficient and green standard materials and technology. The markup rates for finance availed under such schemes could be subsided by the governments directly or the governments could agree to act the surety for the loans granted under such schemes, in return for the financial institution charging a lower or sustained rate of interest.

108. Both models have been used in the past by both the provincial and Federal governments to increase access to finance for targeted segments of society. Such schemes would be helpful in not only providing property developers and builders with the needed additional capital to undertake energy efficient measures at their buildings but will also open up an avenue where through retrofitting, the long-term costs associated with operating an older building are reduced, providing a direct

financial incentive to the building owner who has undertaken the changes. The adoption of solar technology in Pakistan is a testament to the success of such a model where once the long-term financial value for the consumer becomes apparent, the adoption rates see a significant uptick as a *snowball effect* begins to occur.

Table I

Name	**Governing Legislation**	**Power to administer & legislate**	**Notable Rules, Regulation, Bylaws or Codes Administered**
Building Control			
CDA	The Capital Development Authority Ordinance, 1960	Federal	Islamabad Residential Sectors Zoning (Building Control) Regulations, 2020
LDA	The Lahore Development Authority Act, 1975	Provincial (Punjab)	Lahore Development Authority Building and Zoning Regulations 2019 (amended up till 2020)
Cantonment Board Clifton, Karachi	The Cantonments Act, 1924	Federal	The Cantonment Board Clifton Building By-Laws, 2007
SBCA	Sindh Building Control Ordinance, 1979	Provincial (Sindh)	The Karachi Building & Town Planning Regulations, 2002
DHA Islamabad / Rawalpindi	Defence Housing Authority Rawalpindi Act, 2013	Federal	DHA Islamabad/ Rawalpindi By Laws and Regulations Revised 2022
DHA Lahore	Defence Housing Authority Lahore Order, 2002	Federal	DHA Construction & Development Regulations 2014
Naya Pakistan Housing and Development Authority	Naya Pakistan Housing and Development Authority, 2020	Federal	Standardization of Building Codes Standards and Specifications for Low-Cost (Affordable) Units - 2021
Building Codes and Energy Efficiency Codes			
PEC	Pakistan Engineering Council Act 1976	Federal	• Building Code of Pakistan, 2021 • PEC (Conduct & Consulting) By-Laws 1986 • Building Code of Pakistan – Energy Provisions 2011
NEECA / NEECB		Federal	• National Energy Efficiency Authority (Pakistan Energy Labels) Regulations, 2022 • National Energy Efficiency and Conversation Policy, 2023

	National Energy Efficiency and Conservation Act 2016		- Energy Conservation Building Code 2023
Sindh Energy Efficiency and Conservation Agency		Sindh	N/A
Pakhtunkhwa Energy Development Organization		KPK	N/A
Punjab Energy Efficiency and Conservation Agency		Punjab	- Draft Punjab Energy Efficiency Code 2023
Baluchistan Energy Department		Balochistan	N/A
National Certification Regime			
Pakistan Standards and Quality Control Authority	Pakistan Standards and Quality Control Authority Act 1996	Federal	- Various Pakistan Standards, including but not limited to Pakistan Standard for Comfort Fans and Regulators for Household and Similar Purposes – Methods for Measuring Performance
Taxation			
Federal Board of Revenue	- Federal Board of Revenue Act, 2007 - Income Tax Ordinance 2001 - Sales Tax Act, 1990 - Federal Excise Act, 2006 - Customs Act, 1962	Federal	
Punjab Revenue Authority	- Punjab Revenue Authority Act 2012 - Punjab Sales Tax on Services Act 2012	Punjab	
Sindh Revenue Board	- Sindh Revenue Board Act, 2010 - Sindh Sales Tax on Services Act, 2011	Sindh	
KPK Revenue Authority	- KPK Revenue Authority Act, 2022	KPK	

	• KPK Sales Tax on Services Act, 2022		
Balochistan Revenue Authority	• Balochistan Revenue Authority Act, 2015 • Balochistan Sales Tax on Services Act 2015	Balochistan	
Finance			
State Bank of Pakistan	• State Bank of Pakistan Act, 1956	Federal	• Green Banking Guidelines
Securities and Exchange Commission of Pakistan	• Securities and Exchange Commission of Pakistan Act, 1997 • Companies Act, 2017	Federal	• Guidelines on Green Bonds

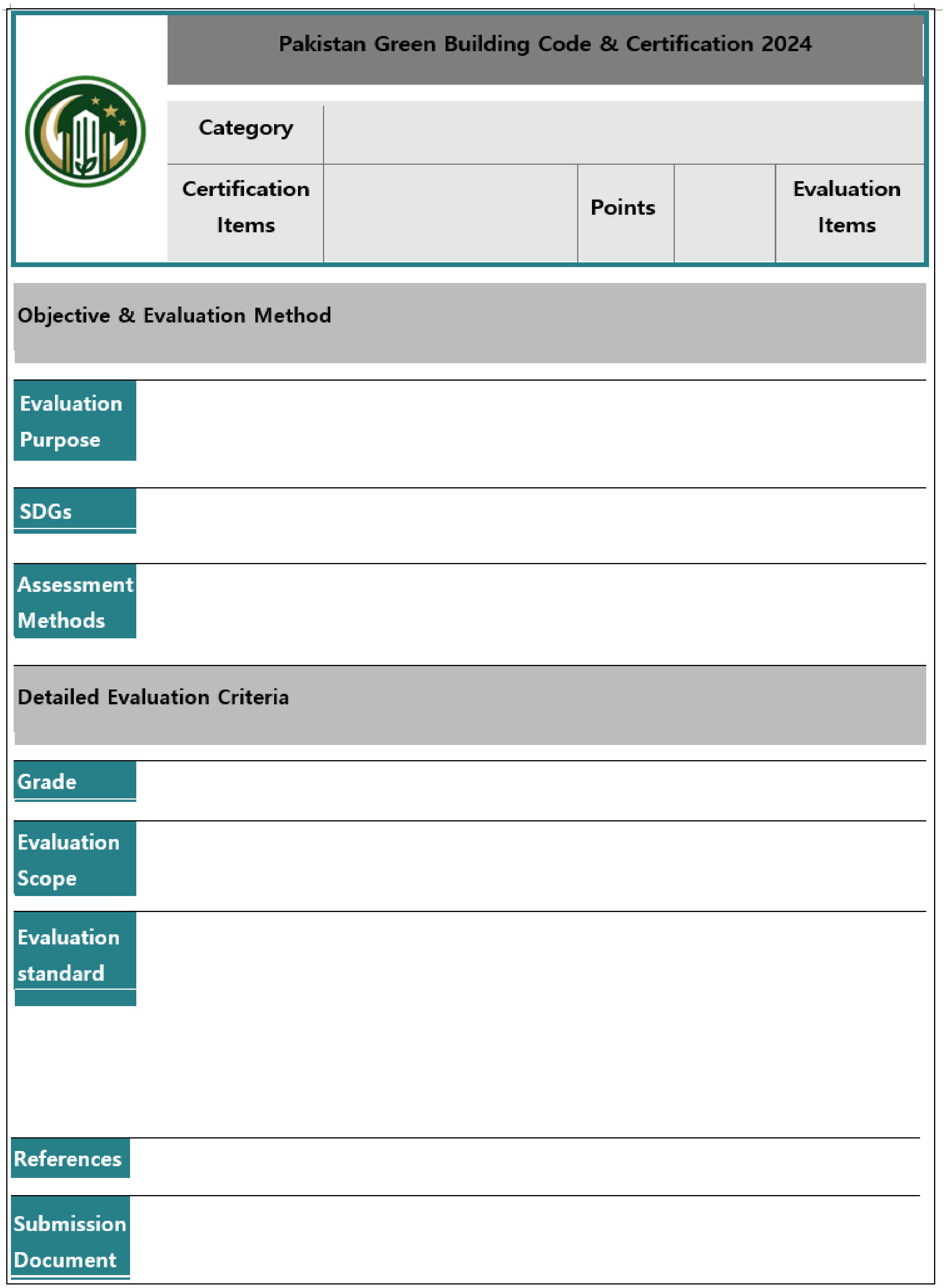
① **Header Section and Classification:** Indicates the title of the rating system with the Pakistan Green Building Certification logo; specifies the applicable area of the Pakistani standards and detailed assessment item, as well as the score and area-specific mandatory requirements/evaluation/additional points applied. Given that the green building infrastructure still remains in infancy in Pakistan, mandatory and additional points elements have been excluded from the assessment structure presented in this study.

② **Objective & Evaluation Method**: Describes the purpose of the criteria and ways to meet them; contains iconized illustration of their relevance to the UN SDGs.

③ **Detailed Evaluation Criteria:** Provides a set of qualitative and quantitative metrics and sub-metrics for evaluation; assigns scores and weight based on the type and grade; determines a rating by adding up and/or multiplying numbers and scores.

④ **References, Submission Documents:** Lists documents that have been referenced for the metrics and sub-metrics. These documents primarily consist of regulations, laws, policies, strategies, standards, and other materials provided by governments and international organizations. The literature referenced in this study is for illustrative purposes and consists of sources from Korea and other countries. It should be updated with equivalent or similar Pakistani sources.

These components are intended organize the structure and content of the green building certification process to ensure well-structured evaluations.



Pakistan Green Building Code & Certification 2024				
Category				
Certification Items		Points		Evaluation Items

Objective & Evaluation Method

Evaluation Purpose

SDGs

Assessment Methods

Detailed Evaluation Criteria

Grade

Evaluation Scope

Evaluation standard

References

Submission Document

Figure 25. Sample of the PGBC standard format

VII. Development of Education Materials and Recommendation

1. Education Material

In addition to the G-SEED and element technology list that we would like to suggest to Pakistan, we developed education materials for green building capacity enhancement educational programs that Pakistan's experts and locals can use for their own education as the third achievement of this project

The education materials for educational programs that will be provided as the final outcome of this Pakistan project can help Pakistani locals and experts strengthen their green building capabilities by summarizing theories and case studies on green building elements.

This project found out that Pakistan has a rather low public awareness of green buildings. Therefore, this educational program was created for experts in the Pakistan green building sector as well as the general public who are pursuing development in the field.

The table below shows the table of contents for the educational program for strengthening human capacity for green buildings in Pakistan. Starting with a theoretical approach to the overview of green buildings, it contains theoretical content on cases of green building design and various element technologies (passive, active, renewable energy, and green remodeling technology).

Specifically, rather than covering all element technologies for construction of green buildings, the content focuses on element technologies deemed to be highly applicable to the country based on the characteristics of the region identified through a fact-finding survey of Pakistan. For example, among renewable energy sources, the content focuses on PV and solar thermal technologies that are deemed to be appropriate for application to Pakistan, as well as theory and case analysis, and the content on other renewable energy technologies focusing on basic theoretical content.

Finally, the education materials for this educational program will be written in English versions, and the English version will be provided to relevant organizations and locals we met in Pakistan

[Table] Educational program for Capacity building on green buildings sector

Classification	Education name	Type	Main content
Overview and System of Green Buildings	Overview of Green Buildings	Theory	- Concept and necessity of green buildings
	Green Building Certification System	Theory	G-SEED & LEED certification overview and certification method
	Suggestion standards for Pakistan Green Building Certification(PGBC)	Theory/ Evaluation	PGBC field composition and certification evaluation
Design and Cases of Green Buildings	Green Building Integrated Design	Theory	- Integrated design concept and theory of green buildings
	Detailed Design for Green Buildings	Case	- Passive detailed design cases including insulation details
	Cases of Zero Energy Buildings in Korea	Case	- Cases of Korean ZEB certification and ZEB buildings
Building Energy Savings	Building Insulation Technology	Theory/ Technology	- Importance of insulation, insulation/heat bridge theory, insulation technology
	Passive Building Technology	Technology	- Window area ratio, doors and windows, ventilation tech
	Active Building Technology	Technology	- High-efficiency equipment, heating and cooling technology, lighting

Renewable Energy Technology	Solar Thermal Technology and Cases	Theory/ Technology	- Technology and cases using solar heat
	PV Technology and Cases	Theory/ Technology	- PV, BIPV tech and cases
	Other Renewable Energy Technologies	Theory	- Geothermal heat, wind, fuel cell technology
Water circulation management	Water Saving Facilities in Buildings	Theory/ Technology	- Water-saving facility technology in buildings
	Heavy water facility technology and cases	Case	Heavy water facility principles and installation cases
	Rainwater Management Technology	Theory	Water circulation and groundwater utilization, rainwater management technology
Eco-friendly Materials	Eco-friendly construction materials	Technology	- Korea's eco-friendly construction materials
	Certification of eco-friendly construction materials	Evaluation	- Environmental Product Declaration (EPD) and evaluation
Ecological Environment and Maintenance	Building Greening & Ecological Technology	Theory/ Technology	Rooftop greening, wall greening, green space creation technology
	Building TAB & Commissioning	Theory	- TAB and commissioning overview and method

	BEMS Technology	Theory	Overview and content of building energy management systems

2. Recommendations: Institutional Foundations and Directions for a Successful Green Building Policy

The evaluation items and item-specific criteria are intended as draft materials that will need to be updated through the input from the local task force team, planning commission, and other experts in Pakistan. Below are additional measures to be taken, along with the proposed evaluation criteria, to ensure the successful implementation of green building in Pakistan.

- **Lay the foundation for industrialization by strengthening legal and policy grounds**: Efforts be made to reinforce the legal framework for green building certification and update relevant laws and regulations. This should include legislation to regulate and support the design, construction, operation, and maintenance of green buildings. Designating a government agency responsible for green building management, establishing a governance structure, and developing legal foundations will enable Pakistan to pursue the gradual industrialization of green building. In addition, building a sustainable green building ecosystem requires that the organization responsible for green building manage the rating system and work with stakeholders to ascertain that the system works in the best interest of the nation's green building mission and vision.

- **Designate an organization responsible for green building:** It is recommended that the Pakistani government designate an organization responsible for green building. This organization should form a technical working group for green building, which will perform tasks including policy review, feedback, demonstration of the certification system, and decision-making. This organization will also serve as the basic platform for communication between the government and stakeholders. It will contribute to the implementation of the Pakistan Green Building Code, the certification system, awareness-building, and training modules and programs.

  Designating a specialist authority will enable Pakistan to improve the quality and efficiency of green buildings, ensure the flexibility of policies in response to changes in market conditions, and minimize the environmental impact of buildings throughout their lifecycle. The designated authority should provide training and workshops to help the building industry keep pace with the latest green building techniques and technologies. It is also important for the government to continue gauging and adjusting their progress towards the SDGs and developing and implementing policies that aim to gradually increase the number of buildings that meet international environmental standards through public-private partnerships. Furthermore, a regular review process should be in place to ensure that the national green building vision and mission are being achieved.

- **Organize public awareness campaigns**: Public relations activities and campaigns should be implemented to build public awareness of the importance and need for green building. The emphasis should be on promoting the advantages and benefits of green building.
- **Develop economic incentives in connection with international cooperation/support**: To ease the burden of upfront investment in green building, the government and international organizations should provide financial support to facilitate the adoption of green building certification systems. In addition, economic support programs and incentives can be used to promote voluntary acceptance (e.g. tax benefits, financial support, low-interest loans, etc.).

Develop local materials and technologies: Green building materials and technologies that are suitable for Pakistan's climate and environment should be developed and made available to the local market. This could include modernizing vernacular building methods.

Develop a monitoring system and collect and analyze data: A monitoring and verification system should be developed to measure and improve the performance of green building. This should include a system to evaluate the energy efficiency of buildings and resource use, among others. Efforts should also be made to systematically collect and analyze green building performance data to inform policy decisions.

These measures will play an important role in Pakistan's successful implementation of green building rating criteria and achievement of sustainable development.

VIII. Activity and Discussion in Pakistan

1. Inception meeting (8th Aug. 2023)

■ Introduction

- Pakistan's building sector offers great potential for transitioning to an energy efficient sector however, compliance with the Green Building codes has remained a challenge in Pakistan. Due to a lack of adoption of green building standards and regulations, the rapid urbanization across Pakistan has seen an infrastructural development that is not environmentally sustainable and responsible. In the support of spearheading the green buildings infrastructure implementation and conversion to net zero buildings, it is important to note that the major impediments for the country primarily include the lack of clear and mandatory guidelines, inadequate financial and institutional resources, lack of awareness, as well as lack of knowledge and availability of technology options.

- A major initiative is required to be taken towards implementing green building standards with a clear methodology, monitoring verification, and enhancement (MV&E), and financing. In this regard, the technical assistance (TA) from **CTCN** aims at introducing green building standards in Pakistan. This includes a baseline assessment of current infrastructure (including commercial, office, and residential buildings), as well as the development of standards for new green building infrastructure and the conversion of existing infrastructure to net zero buildings. The suggested measures will help in devising policies and economic measures to promote the construction of green and environment-friendly buildings. At length, green building standards will lead to a drastic reduction in demand for energy and considerable monetary savings, including for the common people.

- To meet the objectives of the TA, the establishment of a technical working group TWG with relevant stakeholders has been formulated to provide a technical overview and high-level guidance at every stage of the technical assistance. The inception meeting of the TWG was organized on September 14th, 2023 in Islamabad, Pakistan.

■ Meeting Agenda

- The overall agenda of the meeting was designed in a way to ensure proper communication between the technical working group and the green building team to get their feedback and suggestions on this project. The meeting agenda is as follows:

(Pakistan Standard Time)	
14:30 – 14:40	Opening and Welcome
14:40 – 15:05	Scene-setting presentation on project workplan
15:05 – 15:30	Q&A on project
15:30 – 15:45	Presentation on the role of Working group and regular working group meetings
15:45 – 16:20	Feedback round to establish a consensus on the regular working group meetings
16:20 – 16:30	Summary and wrap-up

■ Participants/Stakeholders

- A diverse group of stakeholders had been carefully selected to formulate the TWG and participate in the meeting, each serving a specific purpose. Governmental institutions at the national and sub-national levels were chosen to provide regulatory insights and policy support for green building standards. Representatives from the building and construction industry were selected to bring practical knowledge and on-the-ground experience in construction practices. The energy efficiency and renewable energy sector contributed expertise in energy-saving technologies and renewable energy integration. Private sector participants offered their financial resources and market perspectives to drive green building adoption. Development sector and Civil society representatives ensure community engagement and advocacy for sustainable building practices. Academic institutions provide research capabilities and expertise in sustainable construction methodologies, and beneficiaries ensure the project aligns with the needs and aspirations of those who will ultimately benefit from green building initiatives. This diverse group will collectively contribute to the success of the project.
- The list of the participants/stakeholders is attached

No	Names	Gender	Designation/Department
Public Sector			
1	Dr. Ambreen Nadeem Khan	Female	Deputy Director General, Ministry of National Health Services Regulation & Coordination
2	Dr. Nadia Waqas	Female	Consultant HPSIV, Ministry of National Health Services Regulation & Coordination
3	Attiq-ur-Rehman	Male	Deputy Director General, Pakistan Bureau of Statistics
4	Dr. Khalid Farooq	Male	Chief Statistical Officer, Pakistan Bureau of Statistics

5	Hafsa Anwar	Female	Statistical Officer, Pakistan Bureau of Statistics
6	Engr. Asif	Male	Senior Engineer, Pakistan Agricultural Research Council
7	Dr. Arshad Ashraf	Male	Principal Scientist, Pakistan Agricultural Research Centre
8	Shahzad Hussain Dahri	Male	Scientific Officer, National Agriculture Research Centre
9	Amar Najeeb	Male	Assistant Director, National Disaster Management Authority
10	Akhlaque Ahmed Qureshi	Male	Director General (CC&CD) & NDC Focal Person (Sindh), Directorate of Climate Change & Sindh Coastal Development Authority
11	Azmat Naz	Female	Deputy Director (TT) Environmental Protection Agency Punjab
12	Mariam Tariq	Female	NDC Focal Person Punjab, Planning and Development Department, Government of Punjab
13	Dr. Sardar Muhammad Rafique	Male	Deputy Director (Climate Change), Environmental Protection Agency AJK
14	Mirza Karim	Male	Deputy Director (Climate Climate), Environmental Protection Agency AJK
15	M Irshad	Male	Chief Analyst, Environmental Protection Agency Khyber Pakhtunkhwa
16	Uzair Naqvi	Male	Environmental Geologist, AJK Power Development Organization
17	M Adil Khan	Male	Planning Officer, Khyber Pakhtunkhwa Economic Zones Development and Management Company
18	Abdul Wali	Male	Deputy Director, EPA Balochistan
19	Dr. Abdul Haq	Male	Local Government Balochistan

- ■ Main discussion

- Sungmo Seo, team lead and energy efficiency and technology expert from KICT, introduced the project of the establishment of a green building certification system and workplan for the project. The technical working group was selected to guide them about the project and get their endorsement with valuable feedback. The technical working group in the Q&A raised several concerns and gave valuable suggestions and the response from Dr. Irfan, leader from GGC, was as follows:

- A representative from EPA KPK inquired if a building becomes green only with the inclusion of solar panels or planting some trees. Dr. Yousaf explained that it is just a component of green building. He also explained all other important factors such as structure, architecture, layout, and energy efficiency which make a building green. Further, the different certification systems such as BREAMS, LEED, and Green Star were explained including their criteria for identifying if a building is green or not.

- A representative from Cherat Cement asked about the sustainable construction materials that will be used, to which Dr. Yousaf explained the concept of green cement, which has reduced CO_2 Emissions, and mentioned the chemical processes' reduction in its production.

- A representative from Fauji Cement suggested that Magnesium carbonate should be used instead of calcium carbon aggregates as it absorbs CO_2 from the environment. He also suggested that Pakistan should move towards low-grade cement, which will be very beneficial in this regard. Dr. Yousaf endorsed the suggestion and mentioned that this suggestion will also be discussed further in the analysis and upcoming meetings with the technical working group.
- A representative from AJK Climate Change Department inquired about the inclusion of green building bylaws in Pakistan and asked about the availability of information and international examples of green buildings. Dr. Irfan Yousaf mentioned that the Pakistan Engineering Council has already made the green building code, and the National Energy Efficiency and Conservation Authority has also developed an energy efficiency code. Taking the lead from that, we are working on the establishment of a certification system. He added that there is research going on and international best practices are also part of that research.

- A representative from EPA Punjab suggested that the certification system should be kept as simple as possible while keeping in mind the awareness among the people in Pakistan about this concept. Dr. Irfan Yousaf mentioned that his suggestion was very important and the certification system will be kept as adaptable and simple as possible to facilitate the Community. In addition, another representative from the Planning Department of the Government of Punjab suggested that as most of the population of Pakistan lives in rural areas but these initiatives are mostly supported and accepted by the urban pollution, more actions should be taken to incentivize the people to make their buildings green not only in terms of money only but in terms of support maybe to their children's education and other ways which can be discussed further. He also used the example of Melbourne, Australia which pays half the money for the installation of grey water tanks as it contributes to reduced urban flooding. Dr. Irfan Yousaf endorsed the suggestion.

- A representative from Maple Leaf suggested that a system for certifying already built infrastructure should also be looked upon because large urban buildings are the major cause of Urban heating. Dr. Yousaf responded that there is a mechanism of retrofitting for the already-built infrastructure. Large urban buildings can be retrofitted and fall under the category of green buildings and attain their certificate as well.

- A representative from the Pakistan Bureau of Statistics suggested that the building process starts with the layout/map approval, some measures should be taken to make terms and conditions for the layout approval which will lead to a green building. Dr. Irfan mentioned that the team has met with all the relevant authorities for the inclusion of green building and energy codes to be included in the bylaws but these things take time. The meetings with authorities will ensure that major construction in the future is green buildings.

- A representative from the National Disaster Management Authority inquired about the cost of green buildings if it is higher or lower than conventional buildings and if it is higher, how will the people of Pakistan, who already are suffering from poverty handle this? Dr. Yousaf replied that the cost of a green building is higher than a conventional building but the extra cost is paid back in 3-4 years and long- term socio-economic benefits can be leveraged by the overall energy savings, health benefits, and water conservation of the individuals residing within those buildings.

- A representative from UNDP asked about the technologies that will be used in a green building. He suggested that the houses in Pakistan in the 1950s were made of mud and were very energy efficient and we should use their concept in a modern way for construction these days. Dr. Yousaf said that all the materials and technologies have been mentioned in the green building code by the Pakistan Engineering Council and the suggestion is very important and will be included in the research.
- A representative from Khyber Pakhtunkhwa Economic Zones Development and Management Company asked how will EIA be incorporated in the construction phase of green buildings. Dr. Irfan Yousaf answered that this will be discussed with the relevant organizations such as EPA to develop consensus on its incorporation against the suggestion made by the technical team once the standards are designed.

- A representative from Pakistan Agriculture Research Center asked if the green buildings will be allowed for construction on agricultural lands, are there any bylaws for that? Dr. Irfan Yousaf mentioned that it is not part of the bylaws yet but it can be part of the land utilization policy on a provincial level.

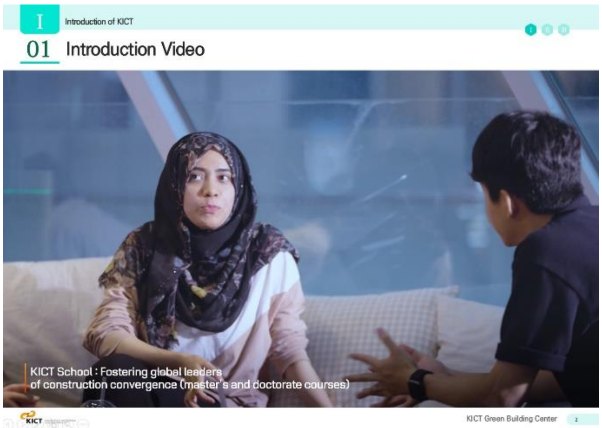
KICT

Adoption of Green Buildings in Pakistan
to achieve Pakistan's Nationally Determined Contribution

Introduction of Pakistan Project

8th. Aug. 2023

KICT
Sungmo Seo

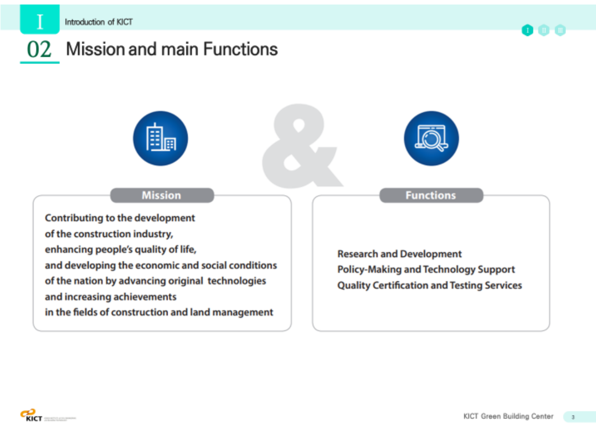


I Introduction of KICT

01 Introduction Video

KICT School : Fostering global leaders
of construction convergence (master's and doctorate courses)

KICT Green Building Center 2



I Introduction of KICT

02 Mission and main Functions

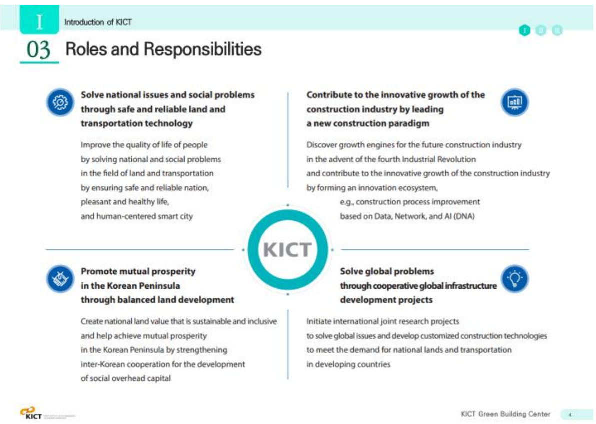
Mission

Contributing to the development
of the construction industry,
enhancing people's quality of life,
and developing the economic and social conditions
of the nation by advancing original technologies
and increasing achievements
in the fields of construction and land management

Functions

Research and Development
Policy-Making and Technology Support
Quality Certification and Testing Services

KICT Green Building Center 3



I Introduction of KICT

03 Roles and Responsibilities

Solve national issues and social problems through safe and reliable land and transportation technology

Improve the quality of life of people by solving national and social problems in the field of land and transportation by ensuring safe and reliable nation, pleasant and healthy life, and human-centered smart city

Contribute to the innovative growth of the construction industry by leading a new construction paradigm

Discover growth engines for the future construction industry in the advent of the fourth Industrial Revolution and contribute to the innovative growth of the construction industry by forming an innovation ecosystem,
e.g., construction process improvement based on Data, Network, and AI (DNA)

KICT

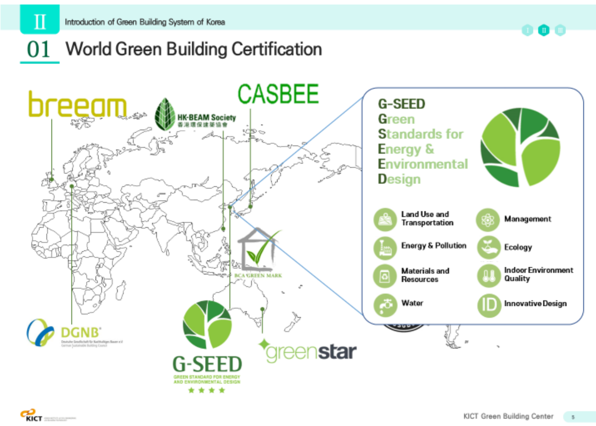
Promote mutual prosperity in the Korean Peninsula through balanced land development

Create national land value that is sustainable and inclusive and help achieve mutual prosperity in the Korean Peninsula by strengthening inter-Korean cooperation for the development of social overhead capital

Solve global problems through cooperative global infrastructure development projects

Initiate international joint research projects to solve global issues and develop customized construction technologies to meet the demand for national lands and transportation in developing countries

KICT Green Building Center 4



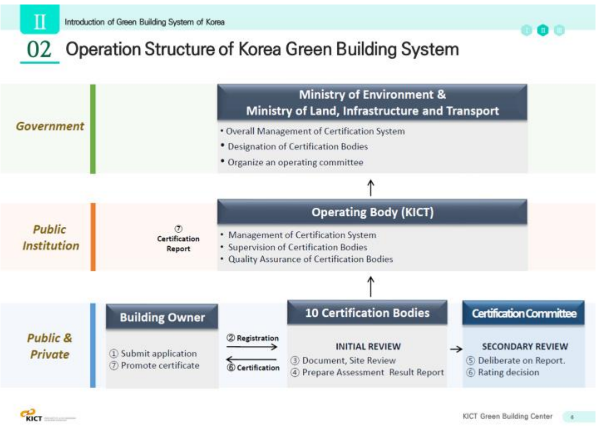
II Introduction of Green Building System of Korea

01 World Green Building Certification

G-SEED
Green
Standards for
Energy &
Environmental
Design

- Land Use and Transportation
- Management
- Energy & Pollution
- Ecology
- Materials and Resources
- Indoor Environment Quality
- Water
- Innovative Design

KICT Green Building Center 5



II Introduction of Green Building System of Korea

02 Operation Structure of Korea Green Building System

Government

Ministry of Environment & Ministry of Land, Infrastructure and Transport
- Overall Management of Certification System
- Designation of Certification Bodies
- Organize an operating committee

Public Institution

⑦ Certification Report

Operating Body (KICT)
- Management of Certification System
- Supervision of Certification Bodies
- Quality Assurance of Certification Bodies

Public & Private

Building Owner
① Submit application
⑦ Promote certificate

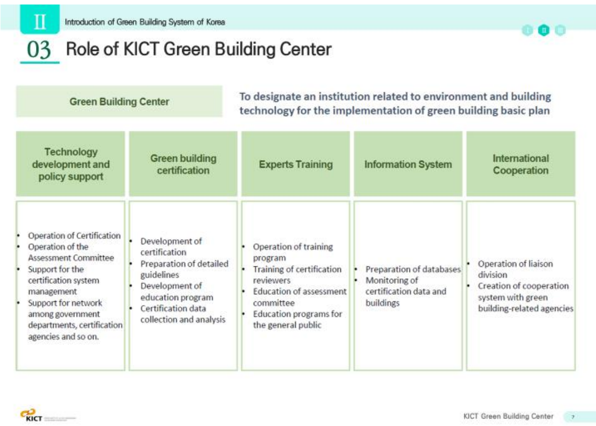
② Registration →
← ⑥ Certification

10 Certification Bodies
INITIAL REVIEW
③ Document, Site Review
④ Prepare Assessment Result Report

→

Certification Committee
SECONDARY REVIEW
⑤ Deliberate on Report.
⑥ Rating decision

KICT Green Building Center 6



II Introduction of Green Building System of Korea

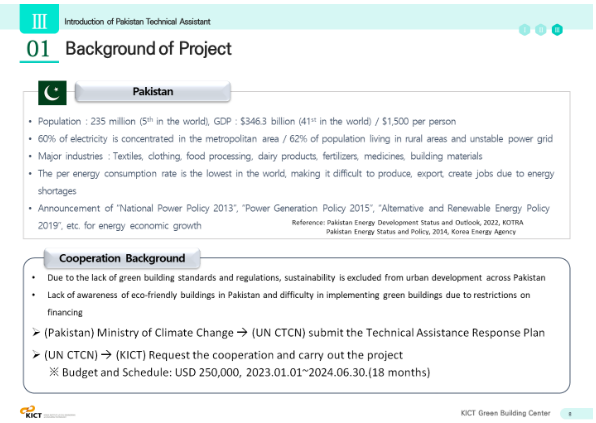
03 Role of KICT Green Building Center

Green Building Center

To designate an institution related to environment and building technology for the implementation of green building basic plan

Technology development and policy support	Green building certification	Experts Training	Information System	International Cooperation
• Operation of Certification • Operation of the Assessment Committee • Support for the certification system management • Support for network among government departments, certification agencies and so on.	• Development of certification • Preparation of detailed guidelines • Development of education program • Certification data collection and analysis	• Operation of training program • Training of certification reviewers • Education of assessment committee • Education programs for the general public	• Preparation of databases • Monitoring of certification data and buildings	• Operation of liaison division • Creation of cooperation system with green building-related agencies

KICT Green Building Center 7



III Introduction of Pakistan Technical Assistant

01 Background of Project

Pakistan

- Population : 235 million (5th in the world), GDP : $346.3 billion (41st in the world) / $1,500 per person
- 60% of electricity is concentrated in the metropolitan area / 62% of population living in rural areas and unstable power grid
- Major industries : Textiles, clothing, food processing, dairy products, fertilizers, medicines, building materials
- The per energy consumption rate is the lowest in the world, making it difficult to produce, export, create jobs due to energy shortages
- Announcement of "National Power Policy 2013", "Power Generation Policy 2015", "Alternative and Renewable Energy Policy 2019", etc. for energy economic growth

Reference: Pakistan Energy Development Status and Outlook, 2022, KOTRA
Pakistan Energy Status and Policy, 2014, Korea Energy Agency

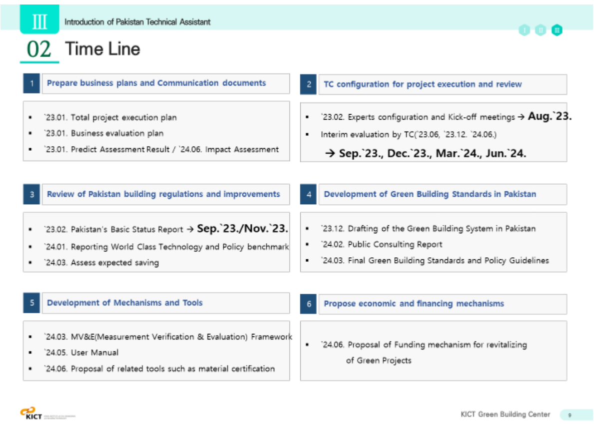
Cooperation Background

- Due to the lack of green building standards and regulations, sustainability is excluded from urban development across Pakistan
- Lack of awareness of eco-friendly buildings in Pakistan and difficulty in implementing green buildings due to restrictions on financing

➢ (Pakistan) Ministry of Climate Change → (UN CTCN) submit the Technical Assistance Response Plan

➢ (UN CTCN) → (KICT) Request the cooperation and carry out the project
※ Budget and Schedule: USD 250,000, 2023.01.01~2024.06.30.(18 months)

KICT Green Building Center 8



Ⅲ Introduction of Pakistan Technical Assistant

02 Time Line

1 Prepare business plans and Communication documents

- `23.01. Total project execution plan
- `23.01. Business evaluation plan
- `23.01. Predict Assessment Result / `24.06. Impact Assessment

2 TC configuration for project execution and review

- `23.02. Experts configuration and Kick-off meetings → **Aug.`23.**
- Interim evaluation by TC(`23.06, `23.12. `24.06.)

  → **Sep.`23., Dec.`23., Mar.`24., Jun.`24.**

3 Review of Pakistan building regulations and improvements

- `23.02. Pakistan's Basic Status Report → **Sep.`23./Nov.`23.**
- `24.01. Reporting World Class Technology and Policy benchmark
- `24.03. Assess expected saving

4 Development of Green Building Standards in Pakistan

- `23.12. Drafting of the Green Building System in Pakistan
- `24.02. Public Consulting Report
- `24.03. Final Green Building Standards and Policy Guidelines

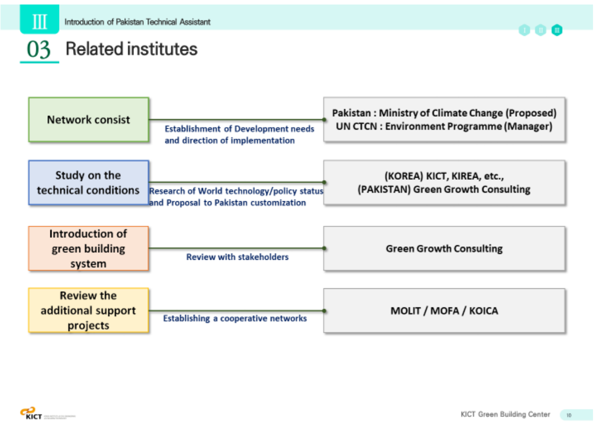
5 Development of Mechanisms and Tools

- `24.03. MV&E(Measurement Verification & Evaluation) Framework
- `24.05. User Manual
- `24.06. Proposal of related tools such as material certification

6 Propose economic and financing mechanisms

- `24.06. Proposal of Funding mechanism for revitalizing of Green Projects

KICT Green Building Center 9



Ⅲ Introduction of Pakistan Technical Assistant

03 Related institutes

Network consist	Establishment of Development needs and direction of implementation	Pakistan : Ministry of Climate Change (Proposed) UN CTCN : Environment Programme (Manager)
Study on the technical conditions	Research of World technology/policy status and Proposal to Pakistan customization	(KOREA) KICT, KIREA, etc., (PAKISTAN) Green Growth Consulting
Introduction of green building system	Review with stakeholders	Green Growth Consulting
Review the additional support projects	Establishing a cooperative networks	MOLIT / MOFA / KOICA

KICT Green Building Center 10

Q&A

■ Conclusion

- The meeting was very productive where stakeholders had very good suggestions that should be considered. The team was also able to gauge the positive interest of all stakeholders in the certification system and all the participants agreed with the idea and showed their commitment to work as a member of the technical working group for the delivery of project objectives.

2. Second Technical Group Meeting (22nd Feb. 2024)

■ Introduction

- The project seeks to utilize the energy efficiency potential in Pakistan's building sector by addressing challenges in Green Building code compliance, including unclear guidelines, financial constraints, limited awareness, and scarce sustainable resources. Government intervention is crucial to establish standards, promote innovation, and raise awareness. The project includes a Green Building Certification System and materials database. Technical aspects involve methodology, monitoring, verification, and financing, supported by CTCN. The goal is to enforce green building standards, conduct assessments, and develop new standards, resulting in energy savings and cost reductions, aligning with Pakistan's sustainability goals.
- The "Second Technical Working Group Meeting on the Establishment of a Green Building Certification System in Pakistan" was organized by GGC on 22nd February 2024 at the Ramada Hotel, Islamabad. Experts from provincial and federal departments were present in the meeting, alongside private organizations' representatives as well.

■ Meeting Agenda

- The overall agenda of the meeting was designed in a way to ensure proper communication between the technical working group and the green building team to get their feedback and suggestions.

(Pakistan Standard Time)		**(TBC)**
10:00 – 10:10	Opening and Welcome	MoCC&EC KICT/GGC
10:10 – 10:30	Presentation on Project Progress and review reports on energy, structure, and architecture, analysis	GGC
10:30 – 11:00	Feedback round with Group	GGC
11:00 – 11:15	Presentation on Green Building Certification System in Pakistan	KICT
11:15 – 11:45	Feedback round with Group	GGC
11:45 – 12:00	Presentations on enablers (regulatory analysis, economic revitalization, and capacity building)	GGC
12:15 – 12:50	Feedback round with Group	GGC
12:50 – 13:00	Summary and wrap-up	

- Participants/Stakeholders

- A diverse group of stakeholders had been carefully selected to participate in the meeting, each serving a specific purpose. Governmental institutions at the national and sub-national levels were chosen to provide regulatory insights and policy support for green building standards. Representatives from the building and construction industry were selected to bring practical knowledge and on-the-ground experience in construction practices. The energy efficiency and renewable energy sector contributed expertise in energy-saving technologies and renewable energy integration. Private sector participants offered their financial resources and market perspectives to drive green building adoption. Civil society representatives ensure community engagement and advocacy for sustainable building practices. Academic institutions provide research capabilities and expertise in sustainable construction methodologies, and beneficiaries ensure the project aligns with the needs and aspirations of those who will ultimately benefit from green building initiatives. This diverse group will collectively contribute to the success of the project.

No	Name	Gender	Designation & Department
1.	Tanzeela Saleem	Female	Bestway Cement SAM (Procurement)
2.	Hina Sarwar	Female	Bestway Cement AM (Procurement)
3.	M. Afzal	Male	Manager (Operation) Gharibwal Cement ltd.
4.	Engr. Sherin Khan	Female	XEN/ irrigation, KPK
5.	Irfan Parvez	Male	D.D Environment (PPIB)
6.	Mumtaz Ali	Male	EPA - KPK
7.	M. Amin Liaqat	Male	Head of Civil Dept. DG Khan Cement
8.	Arif Mohi-ud-din	Male	Head of Production. DG Khan Cement.
9.	Rizwan Ali	Male	Assistant Chief (Env. & CC)/P&D Board Punjab
10.	Mirza Karim	Male	Deputy Director (LG & RD) Gilgit-Baltistan
11.	Dr. Sardar Rafique Khan	Male	Deputy Director (CC) AJK-EPA
12.	Uzair Naqvi	Male	Environmental Geologist AJK-PDO
13.	Muhammad Amjad	Male	Senior Scientific Officer

14.	Muhammad Irfan Taher	Male	DGM. Maple Leaf Cement
15.	Mumtaz Hussain	Male	DGM. Maple Leaf Cement
16.	Fayyaz Salih Hussain	Male	Assistant Director SEDA
17.	Dr. Khalid Farooq	Male	CSO Pak. Bureau of Statistics
18.	Naveed Ashraf Chema	Male	Head HSE Fauji Cement
19.	Zaryab Babar	Male	
20.	Hasaan Babar	Male	
21.	Sanam Zafar	Female	Planning & Development Deptt. Gilgit-Baltistan (GB)
22.	Tanveer Rahim	Male	DS (Dev), PHED Balochistan
23.	Wasi Haider	Male	Research Analyst
24.	Ijlal Hussain	Male	LG&RD, Gilgit-Baltistan
25.	Afnan Yasar	Male	Assistant Manager Bestway
26.	Faheem Ashraf	Male	CEO (ZEUS Energy)
27.	Hasnain Kazami	Male	Advocate, Member Board of Investment
28.	Syed Arshad Hussain Shah	Male	DG (J) Irrigation Deptt. Govt. of Balochistan
29.	Azam Ali	Male	SQA. LAW
30.	Sikandar Ali Shito	Male	Chief Engineer (OEM/PHED)
31.	Samreen Liaqat	Female	Scientific Officer, GB-EPA
32.	Omer Khatab	Male	Group GM Chakar & Environment
33.	Engr. Faisal Javaid	Male	LUMS Energy Institute LEI.
34.	Syed Shahneel	Male	GGC
35.	M Asad	Male	MoCC

36.	Obaid ur Rehman	Male	MoCC
37.	Rizwan Zafar	Male	MoCC
38.	Madiha Naz	Female	Assistant Director, MoCC
39.	Syed Kumail	Male	Researcher, GGC
40.	Hamza Arshad	Male	Researcher, GGC

■ Main discussion

- The meeting was focused on sharing the initial design of the green buildings certification system and gathering feedback for improvement. The following questions were asked along with their responses:

  1) Foundations of Green Building Practices and Evaluation

  - An inquiry sought basic information on green buildings and the differences from traditional buildings. The response provided an overview, explaining that green buildings focus on various aspects, including material selection, building design, structure, energy efficiency, air quality, water conservation, and waste management. This was contrasted with traditional buildings in Pakistan, which do not emphasize these aspects.
  - Another individual sought clarification on the distinctions between normal building codes and green building codes. The response elaborated that the Green Building Code incorporates additional concepts, including water conservation, building orientation, rainwater harvesting, window-to-wall ratio, waste management, and air quality, making it significantly different from normal building codes.
  - Additionally, the basis of the scoring criteria and the grading system was questioned. The response explained that the grading criteria are developed based on international standards like LEED, with considerations for the local context

  2) Financial Landscape for Green Building Initiatives

  - One question centered around climate financing options. The comprehensive response listed several options such as GCF, GEF, IKI, and World Bank. It highlighted that funds flow through accredited development organizations like UNDP, UNEP, UNICEF, ADB, USAID, and UKAID. Practical advice included developing a concept note and project proposal for financial assistance.
  - Another inquiry delved into the available funding sources for green building initiatives and the recommended approach to accessing them. The response highlighted the Green Climate Fund (GCF) as a primary source and provided an illustrative example of JS Bank in Pakistan securing USD 10 million for green initiatives. Additionally, advice was given

to approach development banks such as UNDP, World Bank, and ADB for direct climate finance.

- Questions were raised about proposed incentives for green buildings. The comprehensive answer outlined three proposed incentives: low-interest rate loans, tax reduction until local material supply is functional, and awareness campaigns to encourage the adoption of green building practices

3) Feasibility and Material Supply Chain in Green Building

- The feasibility of using fly ash bricks in green buildings was questioned, with concerns about their lifespan, strength, and durability. The response addressed these concerns by citing results from studies indicating comparable strength and durability with mud bricks. Additionally, emphasis was placed on the cost-effectiveness of fly ash bricks.
- Inquiries were made about insulation materials available in the market, including the feasibility of using hollow bricks for insulation. The response listed several materials like Fly Ash Bricks, Bamboo, Wood, Gypsum Boards, Sawdust, and straw bales, with a preference for local availability. While hollow clay bricks can be used, other materials were noted to offer better insulation.
- A representative highlighted the energy-efficient nature of heat pumps and suggested their use in Pakistan for cooling purposes. The response expressed appreciation for the suggestion and indicated that it would be taken into consideration for further exploration.
- A representative suggested considering gypsum boards for green buildings to enhance local production in Pakistan. The response acknowledged the suggestion and conveyed that gypsum boards are part of the review process. Further exploration of their viability was mentioned, based on the recommendation.
- A question was raised about potential challenges in Pakistan for shifting towards green buildings. The response acknowledged challenges, including the need for local material supply and the absence of a robust supply chain for green materials. The suggestion was made to provide incentives for green materials to address these challenges

4) Navigating Challenges in Green Building Certification

- The question was raised regarding how to overcome issues faced by public bodies in the context of green building certification. In response, it was explained that resolving these issues entirely is not necessary for green building certification. The suggested approach involved providing training to individuals, enabling them to become LEED or BREAM auditors. This allows private entities to assume the certification role, subsequently reducing regulatory obstacles.
- Questions were asked about who will certify buildings when the certification system is established. The answer clarified that any individual, firm, or organization receiving training from international certification bodies such as LEED, BREAM, and Green Star can certify green buildings

5) Role of Institutions in Green Building Development

- Concerns were raised about the current wastewater management and its impact on agriculture. In response, it was acknowledged that green buildings could offer an alternative for wastewater treatment, potentially benefiting agricultural practices.
- The role of the cement industry in the transition to green buildings was questioned. The response underscored the vital role of the cement industry in producing low-grade cement. It emphasized the industry's potential to contribute significantly to reducing emissions in the industrial sector.
- The role of Research and Academia was inquired about. The response emphasized their crucial role in promoting the benefits of green buildings, contributing to policy-making, and conducting research on new materials to advance sustainability.
- Queries were raised regarding material testing institutions and the availability of testing facilities. The response highlighted the crucial role of research facilities in assessing the durability and sustainability of new materials and determining their viability in the context of green buildings

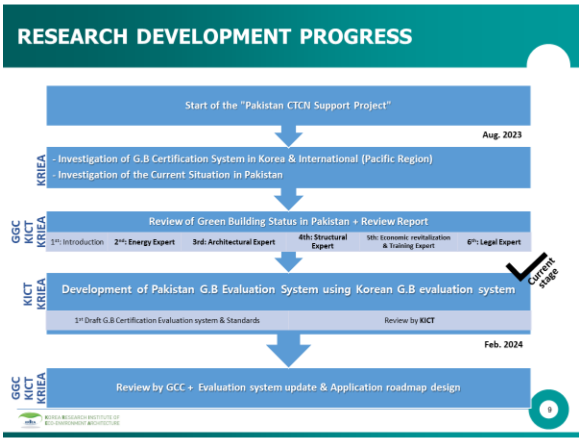
6) Others

- Concerns were raised about the current wastewater management and its impact on agriculture. In response, it was acknowledged that green buildings could offer an alternative for wastewater treatment, potentially benefiting agricultural practices.

GREEN BUILDING CERTIFICATION EVALUATION SYSTEM & STANDARDS FOR PAKISTAN

ADOPTION OF GREEN BUILDINGS IN PAKISTAN TO ACHIEVE PAKISTAN'S NATIONALLY DETERMINED CONTRIBUTION

2024.02.22



RESEARCH DEVELOPMENT PROGRESS

Start of the "Pakistan CTCN Support Project"

Aug. 2023

KRIEA
- Investigation of G.B Certification System in Korea & International (Pacific Region)
- Investigation of the Current Situation in Pakistan

GGC KICT KRIEA
Review of Green Building Status in Pakistan + Review Report
1st: Introduction | 2nd: Energy Expert | 3rd: Architectural Expert | 4th: Structural Expert | 5th: Economic revitalization & Training Expert | 6th: Legal Expert

KICT KRIEA
Development of Pakistan G.B Evaluation System using Korean G.B evaluation system
1st Draft G.B Certification Evaluation system & Standards | Review by KICT

Current stage

Feb. 2024

GGC KICT KRIEA
Review by GCC + Evaluation system update & Application roadmap design

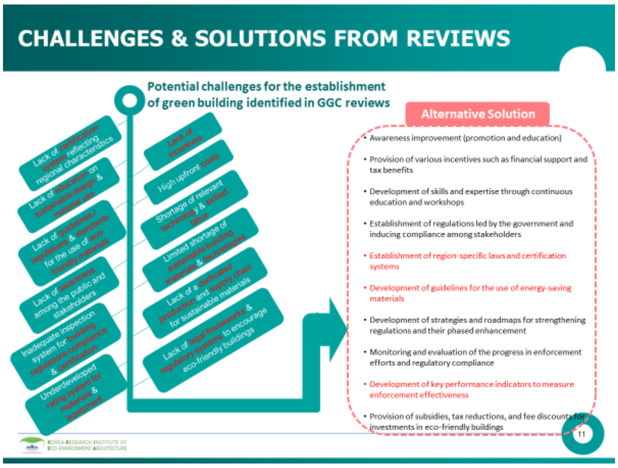
GGC EXPERTS' REVIEWS & REVIEW REPORTS

1 Inception Meeting Report + 5 Expert Report

Sept. 2023 | Oct. 2023 | Oct. 2023 | Dec. 2023

6 Review Report +Draft green building evaluation system and standards

Oct. 2023 | Oct. 2023 | Nov. 2023 | Dec. 2023 | Jan. 2024



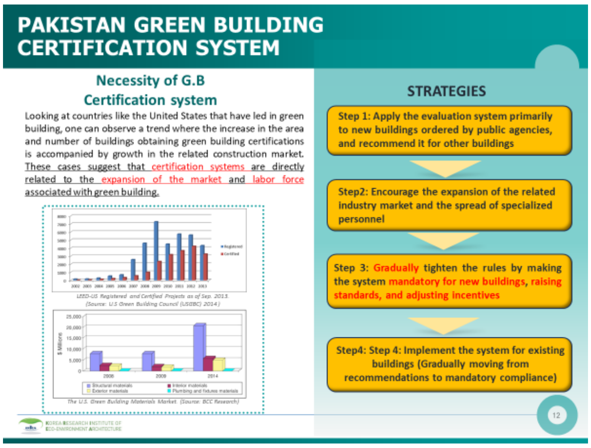
CHALLENGES & SOLUTIONS FROM REVIEWS

Potential challenges for the establishment of green building identified in GGC reviews

- Lack of certification system reflecting regional characteristics
- Lack of education on sustainable design & material use
- Lack of guidelines / regulations & standards for the use of eco-friendly materials
- Lack of awareness among the public and stakeholders
- Inadequate inspection system for building regulations compliance & certification
- Underdeveloped rating system for materials & equipment
- Lack of incentives
- High upfront costs
- Shortage of relevant technology & skilled labor
- Limited shortage of sustainable building materials & technologies
- Lack of a dedicated production and supply chain for sustainable materials
- Lack of legal frameworks & regulatory systems to encourage eco-friendly buildings

Alternative Solution

- Awareness improvement (promotion and education)
- Provision of various incentives such as financial support and tax benefits
- Development of skills and expertise through continuous education and workshops
- Establishment of regulations led by the government and inducing compliance among stakeholders
- Establishment of region-specific laws and certification systems
- Development of guidelines for the use of energy-saving materials
- Development of strategies and roadmaps for strengthening regulations and their phased enhancement
- Monitoring and evaluation of the progress in enforcement efforts and regulatory compliance
- Development of key performance indicators to measure enforcement effectiveness
- Provision of subsidies, tax reductions, and fee discounts for investments in eco-friendly buildings



PAKISTAN GREEN BUILDING CERTIFICATION SYSTEM

Necessity of G.B Certification system

Looking at countries like the United States that have led in green building, one can observe a trend where the increase in the area and number of buildings obtaining green building certifications is accompanied by growth in the related construction market. These cases suggest that certification systems are directly related to the expansion of the market and labor force associated with green building.

LEED-US Registered and Certified Projects as of Sep. 2013.
(Source: U.S Green Building Council (USGBC) 2014)

The U.S. Green Building Materials Market. (Source: BCC Research)

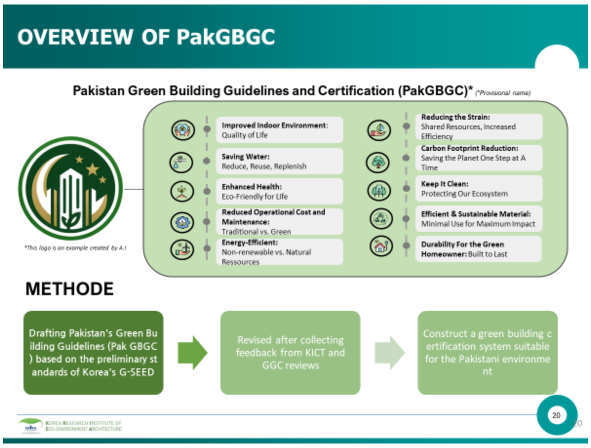
STRATEGIES

Step 1: Apply the evaluation system primarily to new buildings ordered by public agencies, and recommend it for other buildings

Step2: Encourage the expansion of the related industry market and the spread of specialized personnel

Step 3: Gradually tighten the rules by making the system mandatory for new buildings, raising standards, and adjusting incentives

Step4: Step 4: Implement the system for existing buildings (Gradually moving from recommendations to mandatory compliance)



OVERVIEW OF PakGBGC

Pakistan Green Building Guidelines and Certification (PakGBGC)* (*Provisional name)

*This logo is an example created by A.I

Improved Indoor Environment: Quality of Life

Saving Water: Reduce, Reuse, Replenish

Enhanced Health: Eco-Friendly for Life

Reduced Operational Cost and Maintenance: Traditional vs. Green

Energy-Efficient: Non-renewable vs. Natural Ressources

Reducing the Strain: Shared Resources, Increased Efficiency

Carbon Footprint Reduction: Saving the Planet One Step at A Time

Keep It Clean: Protecting Our Ecosystem

Efficient & Sustainable Material: Minimal Use for Maximum Impact

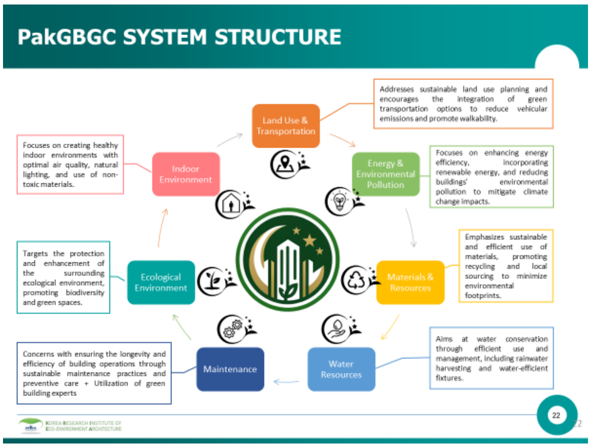
Durability For the Green Homeowner: Built to Last

METHODE

Drafting Pakistan's Green Building Guidelines (Pak GBGC) based on the preliminary standards of Korea's G-SEED

Revised after collecting feedback from KICT and GGC reviews

Construct a green building certification system suitable for the Pakistani environment



PakGBGC SYSTEM STRUCTURE

Land Use & Transportation: Addresses sustainable land use planning and encourages the integration of green transportation options to reduce vehicular emissions and promote walkability.

Energy & Environmental Pollution: Focuses on enhancing energy efficiency, incorporating renewable energy, and reducing buildings' environmental pollution to mitigate climate change impacts.

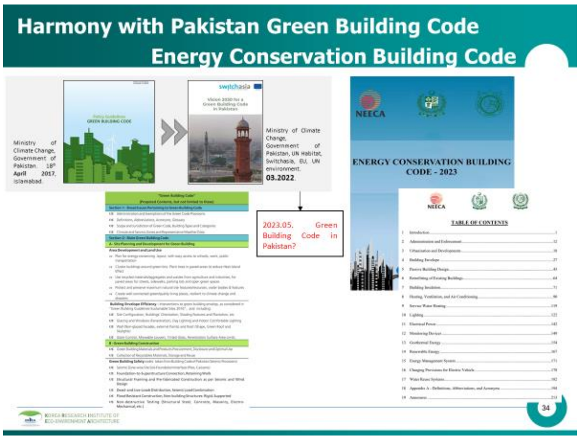
Materials & Resources: Emphasizes sustainable and efficient use of materials, promoting recycling and local sourcing to minimize environmental footprints.

Water Resources: Aims at water conservation through efficient use and management, including rainwater harvesting and water-efficient fixtures.

Maintenance: Concerns with ensuring the longevity and efficiency of building operations through sustainable maintenance practices and preventive care + Utilization of green building experts

Ecological Environment: Targets the protection and enhancement of the surrounding ecological environment, promoting biodiversity and green spaces.

Indoor Environment: Focuses on creating healthy indoor environments with optimal air quality, natural lighting, and use of non-toxic materials.

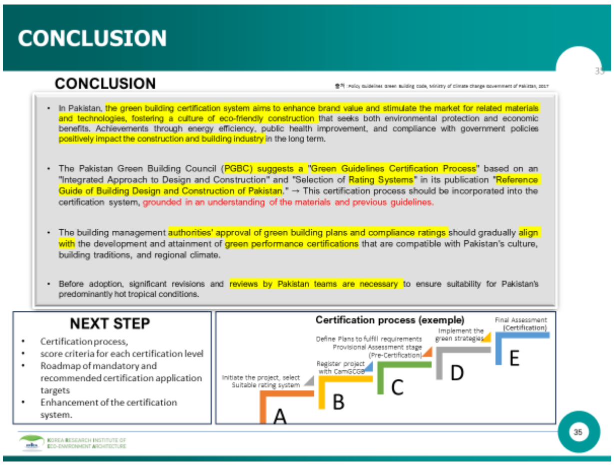


Harmony with Pakistan Green Building Code
Energy Conservation Building Code

Ministry of Climate Change, Government of Pakistan. 18th April 2017, Islamabad.

Ministry of Climate Change, Government of Pakistan, UN Habitat, Switchasia, EU, UN environment. **03.2022**.

2023.05. Green Building Code in Pakistan?



CONCLUSION

CONCLUSION

출처 : Policy Guidelines Green Building Code, Ministry of Climate Change Government of Pakistan, 2017

- In Pakistan, the green building certification system aims to enhance brand value and stimulate the market for related materials and technologies, fostering a culture of eco-friendly construction that seeks both environmental protection and economic benefits. Achievements through energy efficiency, public health improvement, and compliance with government policies positively impact the construction and building industry in the long term.
- The Pakistan Green Building Council (PGBC) suggests a "Green Guidelines Certification Process" based on an "Integrated Approach to Design and Construction" and "Selection of Rating Systems" in its publication "Reference Guide of Building Design and Construction of Pakistan." → This certification process should be incorporated into the certification system, grounded in an understanding of the materials and previous guidelines.
- The building management authorities' approval of green building plans and compliance ratings should gradually align with the development and attainment of green performance certifications that are compatible with Pakistan's culture, building traditions, and regional climate.
- Before adoption, significant revisions and reviews by Pakistan teams are necessary to ensure suitability for Pakistan's predominantly hot tropical conditions.

NEXT STEP

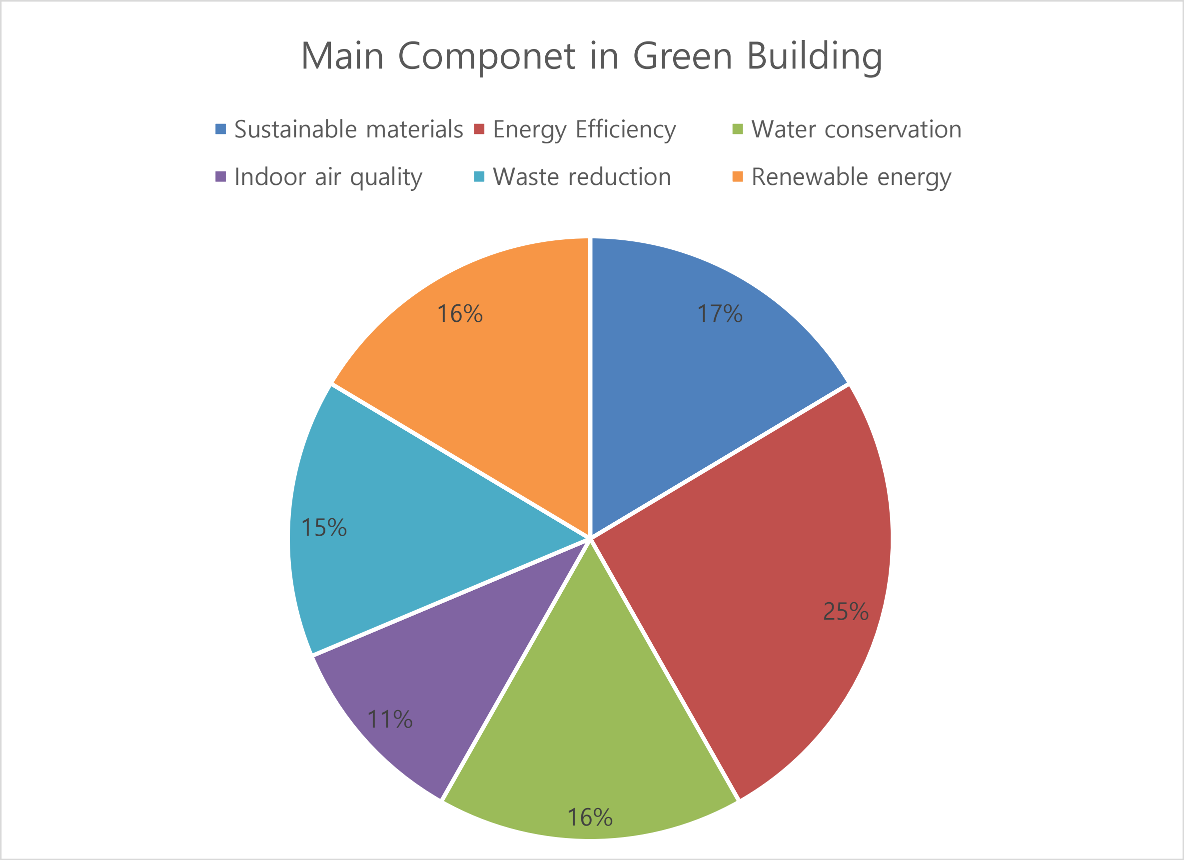
- Certification process,
- score criteria for each certification level
- Roadmap of mandatory and recommended certification application targets
- Enhancement of the certification system.

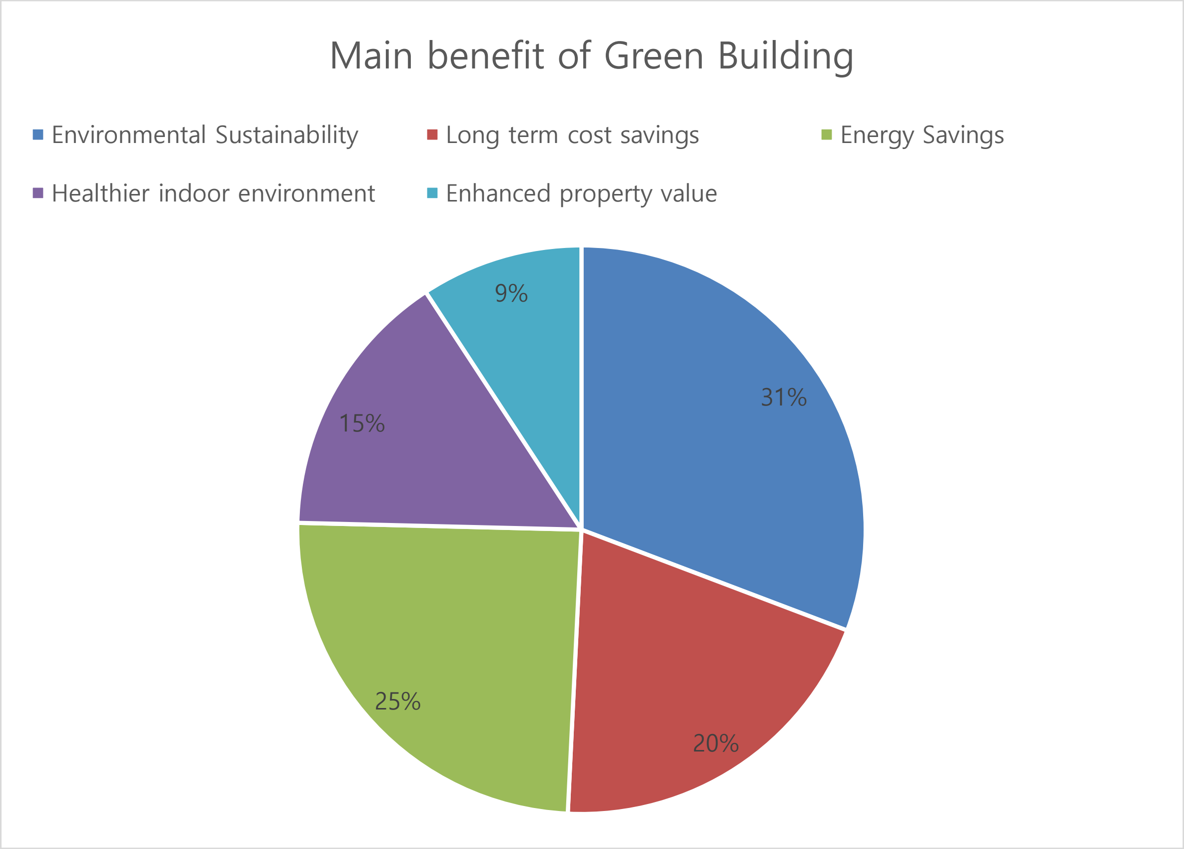
Certification process (exemple)


PakGBGC SYSTEM STRUCTURE
PakGBGC SYSTEM STRUCTURE

3. Expert Questionnaire (Jun. 2024)

- A survey on certification in Pakistan was conducted among the experts who attended the first and second rounds of the event to help guide the direction of certification in Pakistan, and 21 experts responded to the survey.
- The questionnaire asked for general understanding of green building, understanding of Pakistan's NDC, participation in and understanding of Pakistan's green building standards, and opinions on the proposed green building certification standards.
- The surveyed professionals included 10 civil servants, 8 engineers, 1 lawyer, 1 architect, and 1 urban planner, 15 of whom had more than 10 years of experience, and 16 of whom were fairly familiar with the concept of green building certification. However, only four of the participants had been involved in actual green building projects and 17 were only theoretically familiar with the concept.
- Regarding the NDC in Pakistan, 14 respondents said they had a good understanding of the NDC criteria, 5 respondents said they were not familiar with it, and all 21 respondents said that green building certification standards would play a very important role in the NDC.
- Regarding the Pakistan Green Building Certification currently being developed locally in Pakistan or proposed by KICT, 14 respondents said it was the right direction, while 7 respondents were unsure or neutral.
- When asked to comment on the most important areas and directions for the finalized certification standards in Pakistan, the respondents said that 1. Sustainability, 2. Energy Savings, and 3. Long term cost savings are the main goals that green building should achieve, and 1. Energy Efficiency, 2. Sustainable Materials, and 3. Water conservation / Renewable Energy are the most important factors.
- In terms of the development and application of the certification standards, the most common request was for the involvement of experts from different sectors and regions, and the need for a phased application to respond to the local construction conditions and market in Pakistan.
- In addition, there were opinions that the proposed certification standards have some technical and product standards that are difficult to apply in Pakistan, so it is necessary to review the contents with local experts, and that a number of capacity-building trainings are needed in various fields to train relevant experts.
- However, the current standards are influenced by Korean, so it is not appropriate to provide education on this content at now, and it is necessary to support education after the relevant government departments and organizations in Pakistan are organized.


Main Componet in Green Building
Sustainable materials
Energy Efficiency
Water conservation
Indoor air quality
Waste reduction
Renewable energy
17%
25%
16%
11%
15%
16%


Main benefit of Green Building
Environmental Sustainability
Long term cost savings
Energy Savings
Healthier indoor environment
Enhanced property value
31%
20%
25%
15%
9%

4. Third Technical Working Group Meeting (11th Sep. 2024.)

■ Introduction

- The "Third Technical Working Group (TWG) Meeting on the Establishment of a Green Building Certification System in Pakistan" was convened on 11th September 2024 at the Mariott Hotel, Islamabad. This meeting followed up on the progress made in previous discussions and aimed to build upon the foundational work laid in prior sessions, particularly focusing on the advancement and refinement of the Green Building Certification mechanism in local context. The meeting was facilitated by experts from provincial and federal departments alongside representation from private sector and academia as well.
- The session sought to gather and integrate feedback from various stakeholders on the results of analyses conducted, revisions made, and the overall design of the Green Building Certification System. Additionally, the meeting aimed to solidify consensus among participants, fostering the momentum needed for the system's consideration and potential adoption by the Government of Pakistan.

■ Meeting Agenda

- The overall agenda of the meeting was designed in a way to ensure proper communication between the technical working group and the green building team to get their feedback and suggestions.

(Pakistan Standard Time)		
10:00 – 10:10	Opening and Welcome	MoCC&EC KICT/GGC
10:10 - 10:30	Presentation on reports on energy, structure, and architecture analysis, and enablers	GGC
10:30 - 11:00	Feedback round with group	GGC+KICT
11:00– 11:15	Presentation on G-SEED green buildings certification system	KICT
11:15 – 11:45	Feedback round with group	GGC+KICT
11:45 – 12:00	Presentation Results and Suggested green buildings certification system for Pakistan	KICT
12:15 – 12:50	Feedback round with group	GGC+KICT
12:50 – 13:00	Summary and wrap up	KICT

- Participants/Stakeholders

- A diverse group of stakeholders had been carefully selected to participate in the meeting, each serving a specific purpose. Governmental institutions at the national and sub-national levels were chosen to provide regulatory insights and policy support for green building standards. Representatives from the building and construction industry were selected to bring practical knowledge and on-the-ground experience in construction practices. The energy efficiency and renewable energy sector contributed expertise in energy-saving technologies and renewable energy integration. Private sector participants offered their financial resources and market perspectives to drive green building adoption. Civil society representatives ensure community engagement and advocacy for sustainable building practices. Academic institutions provide research capabilities and expertise in sustainable construction methodologies, and beneficiaries ensure the project aligns with the needs and aspirations of those who will ultimately benefit from green building initiatives. This diverse group will collectively contribute to the success of the project.

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No	Name	Designation & Department	Contact & Email	Gender
1	Sungmo Seo	KICT	ssm1216@ktctse.kr	Male
2	Rizwan Ali	Assistant Chief (Env & CC) P&D Board	rizwan.hassan251@gmail.com	Male
3	Dr. Irfan Yousaf	GGC	0300-5220722 / irfan.yousaf@yahoo.com	Male
4	Shahnawaz Farhan	Deputy Director (AE) Energy Department, GoS	shahnawazfarhan@gmail.com	Male
5	Leena Aftab	GGC		Female
6	Uzair Naqvi	AJK PDO	naqvi.uzair@gmail.com	Male
7	Dr. Liaqat Ali	Chief Statistic Officer – PBS	bbsra.ns@gmail.com	Male
8	Hafsa Anwar	Statistic Officer	hafsakhan_93@hotmail.com	Female
9	Shahbaz Faheem	JS Petrole		M
10	M. Amjad	SSO / GCISC	0321-5309339 / callamjad@gmail.com	Male
11	Asad Yousaf	DO Intra RVDA	0306-8876310	Male
12	Engr. Ubaidullah	Research Officer (PHED) KPK	0346-9100149 / engrubaidphe2015@gmail.com	Male
13	Asif Iqbal	Production (SDM)	0333-6219092 / rana.asif@dgcement.com	Male
14	Zaryab Babar	Material Melter’s	0322-5060008	Male
15	M. Abdullah	//	0332-5027353	Male
16	Yasir Bashir	Director (Project) NZ	0334-6858102	Male

17	Noman Irshad	Assistant Manager	0322-3811079	Male
18	Saif		0322-4283207	Male
19	Irfan Walli	Power Developmet	0312-9523012	Male
20	Sardar M. Raffique	EPA. AJK	0346-5415507	Male
21	Iqbal Srpara	Industrial Department	0300-9521668	Male
22	Dr. Safqat	Livestock & Dairy Development	0334-1900711	Male
23	Allah Warayo Rindh	Agri. Dept.	0302-9520005	Male
24	Afsar Khan	EPD, KPK	0302-2591001	Male
25	Abdul Qadeer Kakar	PHED, Balochistan	0303-9241005	Male
26	Ayesha	Gender Department	0300-5511002	Female
27	Dr. Saira Ramzan	EPA Deptt.	0341-2150738	Female
28	Peer Zubair	Transport Dept.	0311-1359002	Male
29	Waris Gabool	Sindh Environmental Protection Agency	0300-9150431	Male
30	Babar Minhas	Local Govt. & Rural Development	0305-6780113	Male
31	Rizwan Ali	Planning & Development	0300-7200490	Male
32	Ayan M. Bhutto	DG Climate Change / Sp. Sec ECC & CD	0300-9297706 / ayhanbhutto123@gmail.com	Male
33	Saqib Nawaz	A. General Manager QC Cherat Cement	0314-5403579 / saqib.nawaz@gfg.com.pk	Male
34	Abdul Rehman	DGM Prd. Cherat Cement	0333-9995661 / abdul.rehmen@gfg.com.pk	Male
35	Azhar Bin Shams	Sn. Magr. Prod. Cherat Cement	0313-9282999 / azharbin. sharms@gfg.com.pk	Male
36	Misbah Younis	Phd Student Quid e Azam University	0311-2502212	Male
37	Syed Shahneel	GGC	0335-5666179	Male
38	Nadia Tahir	Director Env. RVDA	0333-4598323	Female
39	M Asad Ikram	Principal Advisor national incubation Center for space Technologies	0322-8594039 / asadikram@ieee.org	Male
40	Attiq ur Rehman	DDG, PBS	0346-9579700 / attiq.jadoon@gmail.com	Male

41	Dr. Khalid Farooq	CSO PBS	0331-6813939 / kfarooq1966@gmail.com	Male
42	Abdul Wali	Dy. Director	0312-890046 / wali.environ@gmail.com	Male
43	Imran Saeed	D. Director	0300-9388074 / saeed_imran1580@gmail.com	Male
44	Asad Mehmood	Sustainability Lead	0333-5501805	Male
45	Muddasar Zeb Khan	Manager Project Planning/ KPEZDMC KPK	0335-0099214	Male
46	Syeda Hadika Jamshed	GGC		Female
47	Dr. Asif	Sr. Assistant Prof.	0333-5062868	Male
48	Ammara Naqvi	Manager / SGS	0321-5591220	Female
49	Ramshah Kulsoom	Sr. Engineer / SGS	0301-1192326	Female
50	Kashan Babar	Material Melter’s	0340-3529845	Male
51	Babar Siddique	//	0334-5141212	Male
52	Arshad Ashraf	Principal Scientist – NARC	0323-5017456 / rnashr22@yahoo.com	Male
53	Mishal Zahra	Scientific Officer GB-EPA	mishalzahraepa@gmail.com / 0311-9791994	Female
54	Uroosa Anwar	Climate Change	uroosaanwar66@gmail.com / 0313-1112008	Female
55	Jehanzeb Amin	Partner. SQA PWC	jehanzeb.amin@pwc.com / 0300-5002510	Male
56	Dr. Bashir Ahmed	Director	dr.bashir70@gmail.com / 0333-5487506	Male
57	Azam Ali	Partner SQA	0333-5089988	Male
58	Nadeem Shauqat	CFS ADB		Male
59	Dr. Riaz Ali	Agriculture livestock & Fisheries Dept.	0303-5009123	Male
60	Mirza Karim	Local Govt. & Rural Development	0311-2970005	Male
61	Bilal Ahmed	GGC	0300-2391005	Male
62	Amir Mehmood	Manager	0313-1215003	Male

■ Main discussion

- The meeting was focused on sharing the initial design of the green buildings certification system and gathering feedback for improvement. The following questions were asked along with their responses:

1) Reference Tools available

- Light was shed by a participant on availability of promising tools that address the high costs associated with certifications such as LEED. This particularly focused on the initiative by International Finance Corporation (IFC) in development of their tool "EDGE Buildings" for certifying buildings as green buildings. The tool was commented to build on local data sets and climatic conditions aiding utility in local contexts. Efforts were also highlighted by the IFC regarding the costing associated with transition to green buildings. These efforts were mentioned to be under progress to ensure compliance with local contexts in highlighting alignment with best practices extending to local costs, materials and available infrastructure.
- The initiative by IFC was applauded, but the pertinence of availability of an indigenous tool was highlighted in benefiting beyond only green buildings in terms of ownership, capacity building and sector level prioritization. The tool was seen as an excellent resource as a reference in development of a local tool

2) Mention of list of Materials

- Given construction of structures having variable dynamics in the North in contrast to South of Pakistan, question was raised regarding non-inclusion of green/insulation materials. The comment continued expanding on the materials in terms of their economics eyeing viability for commercialization.
- The response suggested that the analysis did not dive deep into the granularities. The reason suggested for this was that providing a selected list of materials narrows the focus on those particular materials only. It continued explaining that some materials are locally available, some materials need to be imported whereas, some materials need further research on viability. Therefore, through this analysis, the intention was not to confine the focus but to give room to further innovation given much room is still available for expansion. The response closed suggesting that once the market is deemed to be reaching appropriate maturity levels, then limiting the list of materials would seem to be a more sensible option.

3) Inventory of Codes Available and Green Building Considerations

- The participant suggested that there are several codes and policies already available including building codes, clean air policies, seismic provisions etc. Therefore, the question delved into the prioritization of these available materials in conjunction to the analysis. The question continued inquiring that are climatic resilience and Disaster Risk Reduction elements considered in these analyses.

- The response suggested that the intended purpose of this activity as per the scope of green buildings was to explore, and provide suggestions as per the climatic zones, on building envelopes, openings, conservation techniques and utility of natural resources in building design. The response continued to suggest that all other factors, for instance, the seismic provisions, climate resilience etc. are beyond the scope of green buildings, which focuses on environmental service, and require consulting other relevant codes for enhancing the building designs. It explained that it depends on the project developer what factors they want to include in their building designs for which they have to consult relevant resources for developing the building designs.

4) Development of Generic Systems

- Concerns were raised about having a generic system on green buildings applicable to all areas in Pakistan citing non-viability in terms of application in all areas with same considerations.
- The response suggested that energy efficiency element is divided by climatic zones whereas building orientation has been kept flexible. This activity is seen to be an initiator at a small level with room for expansion. As a test case, the pilot is targeted to be set up in Islamabad. The idea then foresees gradual expansion to the provincial capitals with the end goal of covering the whole country. The response suggested that gradual adoption and expansion reaps better results compared to country wide application from the start.

5) Fostering Industrial sector Attraction and Land Use

- A question was raised regarding how the industrial sector would be attracted for these good practices also ensuring efficient land utility through such certifications.
- The response suggested that having voluntary actions typically doesn’t reap much benefits. The recommendation suggested that interventions at the government level are necessary for mandatory actions for such endeavors. This complemented with suitable incentives in place to ease adoption and boosting motivation towards such practices are requisite to foster such attractions. The response continued by highlighting the development of Carbon Border Adjustment Mechanism (CBAM). It suggested that with such developments, it would be the need of the hour for the industrial sector to transition to such good practices to maintain competitiveness in the global markets

6) Clubbing Material and Water Efficiency

- A query was raised on the reason for clubbing material and water efficiency for elaboration.
- The response suggested that water conservation is achieved through utility of material or relevant technology making them related and interdependent concepts. All other distinct elements were clarified to be bifurcated as per their unique dynamics.

7) Catch for the Developers

- Discussion from the participants gave the context of an economic meltdown in the country and continued to inquire about a catch for a project developer to invest in such endeavors given the situation.
- The response suggested that a conducive environment for mainstreaming such activities is requisite at the country level as evident through examples of Korea and China where tax-rebates and other incentives are provided to ease adoption. Extending on the benefits associated, the response commented that besides long-term paybacks through such interventions, they can also generate certificates which are internationally tradable commodities. Monetizing the trade of such certificates is an added incentive that can attract the investors in such activities.

8) Academia Industry Nexus

- The discussions delved into the gaps between the industry and esteemed research institutions in Pakistan. It referenced many researches where academia is delving into suitable and sustainable solutions for the construction industry, for instance insulated concrete or sustainable cement. The dilemma of green requirements in the industry with the paper work on project requirements speaking otherwise expands on why innovation is not welcomed. The discussion focused on transitioning from traditional means, for instance ASTM standard cement, to innovative alternatives offered by research. Overhauling the construction documents was seen as the paramount step in welcoming innovation in the sector. Whereas, academia was seen as the driver of this innovation in providing sustainable and viable solutions for convincing adoption.

9) Retrofitting Model

- The participants inquired about existing buildings being retrofitted and development of pilot cases for retrofitting traditional buildings into green buildings.
- The response suggested that although retrofitting existing building is possible and has relevant certification for that but, it has many limitations off which expanded costs for retrofits is paramount. Therefore, the focus was highlighted on newer buildings having green building parameters in their design criteria as the priority action.

10) Scale Selection Criteria

- The participants inquired about the scale at which green building parameters are applicable.
- The response suggested that typically a cap is applied at 3000m2 for green buildings. However, for small scale, such as rural houses, campaigning is the way forward for adopting good practices.

11) Public consultant review

- The public consultant review has been discussed with GGC and MoCC. The status of green building in Pakistan and the certification standards developed through this project will be a great guideline for the establishment of a green building certification system in Pakistan, which had no basis. However, the public consultant review is a separate project and needs to be integrated with the ongoing project in Pakistan. The project is being conducted by the MoCC, and it seems appropriate to integrate the relevant contents after KICT submits its report and proceed with the final review report.

12) Capacity Building

- As discussed in the questionnaire survey, the Pakistan project conducted by KICT ultimately prepared certification standards for Pakistan, but it is based on the Korean certification system, and it is difficult to utilize it directly in the Pakistani system. Therefore, it is necessary to revisit the standards with a group of Pakistani experts and finally converge them with similar projects in Pakistan, as mentioned in the Public Review, and then re-establish a group of relevant experts to conduct training.

IX. Conclusions

The objective of this study was to develop an evaluation system and criteria for green buildings in Pakistan. To achieve the country's ambitious goal of reducing its carbon emissions by 50% by 2030, it is essential to implement a rating system that recognizes the importance of green building and is tailored to the local climate and building conditions. The key findings from this study are outlined below.

① **Analyze the current situation in Pakistan and identify challenges**: A literature review and field research were conducted to gain insight into the current status of green building in Pakistan. The findings revealed that the country is facing challenges related to a lack of expertise, technical limitations, and awareness about green building.

② **Identify overseas best practices, conduct a SWOT analysis, and develop strategies**: A comparative analysis of green building policies and certification systems in various countries in the Asia-Pacific region was conducted to identify best practices applicable to Pakistan's context. This provided the basis for developing a green building rating system for Pakistan.

③ **Develop the PGBC**: Subsequently, the foundation was laid for the Pakistan Green Building Code, along with the development of a rating model and certification system. Five assessment areas were identified: land use and transportation, energy and pollution, materials and support, indoor environment, and post-completion actions (maintenance). Detailed calculation criteria and indicators were developed for each of these areas. A team of local experts in Pakistan will further develop these criteria and indicators. In addition, clarifications were made for the certification process, level-specific scoring criteria, operations, and application.

④ **Recommend policy support measures**: It was recommended that the successful implementation of green building be ensured by establishing an institutional framework and policy support. This will serve as a policy driver to disseminate green building practices across Pakistan.

In conclusion, this study will contribute to the achievement of Pakistan's carbon reduction targets and the achievement of the SDGs. The introduction of the PGBC rating system and certification scheme will play an important role in improving the energy efficiency of buildings and easing the environmental burden by providing green building standards that take into account Pakistan's diverse climate conditions and built environment. Furthermore, they will serve as an essential element in strengthening the resilience and sustainability of Pakistan's construction industry, which will in turn play an important role in helping the country achieve global environmental goals.

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[41] Imran Rana, “Renewable energy: German firm to set up first solar panel plant in Pakistan,” *The Express Tribune*, Jan. 08, 2013. Accessed: Jun. 12, 2023. [Online]. Available: https://tribune.com.pk/story/491194/renewable-energy-german-firm-to-set-up-first-solar-panel-plant-in-pakistan

[42] Prof. Dr. Neelum Naz and Prof. Dr. Shabih-ul-Hassan Zaidi, “ Historical Perspective of Urban Development of Gujranwala”, Accessed: Jun. 12, 2023. [Online]. Available: https://www.academia.edu/9127199

[43] Subnational Doing Business, “Doing Business in Pakistan 2010 ,” The World Bank. Accessed: Jun. 12, 2023. [Online]. Available: https://subnational.doingbusiness.org/en/data/exploreeconomies/pakistan/sub/gujranwala

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X. Appendix

Appendix 1. Five most populated cities in Pakistan and their features for future green building master planning

No.	City	Population (2017) [33]	Features	Federal jurisdiction
1	Karachi	14,916,456	- The largest city in Pakistan and the capital of Sindh Province; the world's fourth most populated city; a port city. - A commercial and industrial city that is home to the stock exchange and banks[15]. - At least 50 150+ meter-tall buildings under construction in 2022; declining in urban livability rankings due to rapid urban growth, insufficient housing infrastructure, and poor urban planning and transportation policies[16].	Sindh Province
2	Lahore	11,126,285	- Pakistan's second largest city and the capital of Punjab Province in Pakistan's northeast; the nation's center of business, industry, and education[15]. - A city with a GDP similar to Karachi's in 2008[34] and an estimated share of 19% in Punjab Province's economy[35]. - Second largest financial hub; accounting for ~13% of the country's GDP[36].	Punjab Province
3	Faisalabad	3,204,726	- The richest city in Pakistan with the largest industrial hub; contributes 20+% of the country's GDP[36]. - Industries: agriculture, engineering, textile, food processing, grain milling, chemical, etc.[37]. - Significant funding from local governments to improve infrastructure, etc.[38]. - The Faisalabad Chamber of Commerce and Industry (FCCI) recognizes the importance of the development of renewable energy resources and infrastructure and is working to attract foreign investment[39], [40], [39]. - In 2023, German renewable energy company CAE announced a plan to construct a solar panel plant in Faisalabad[41].	Punjab Province
4	Rawalpindi	2,098,231	- A large city in the outskirt of Islamabad; social and economic connections to Islamabad. - Industries: refineries, gas processing, steel, mills, textiles[36].	Punjab Province
5	Gujranwala	2,027,001	- Pakistan's third largest industrial hub after Karachi and Faisalabad[42], accounting for 5% of the country's GDP[36]. - Industries: textile and other equipment, parts manufacturing[36], agriculture. - Ranked 6th among the top 13 cities in Pakistan in the World Bank's Ease of Doing Business index; 2nd for building permit processing[43].	Punjab Province

Appendix 2. Architectural forms and passive design elements of vernacular houses in

Principal Cities	Climate	(Regionally available construction) Materials	Passive Design
Giltgit, Chitral, Sakardu, Swat, Peshawar, Kohat, Waziristan, Quetta, Sibi and Kalat etc.	Highland	Timber, stone, mud bricks, clay and soil mortar	Skylight, stair hall, light ways, terraces, extended shades, Shaded Verandas, Potholes, Courtyard
Islamabad, Lahore, Faisalabad, Multan, Jacobabad, Shikapur, etc.	Lowland	Earthen materials like moulded mud or clay blocks, pise, sun dried and burnt bricks, kankar, white lime mortar and plaster, terracotta tiles, sheesham and neem wood, Wooden windows with iron bars in checker form(Punjabi houses), -Floor made of composite material using earth mixed with water and straw or dung(Increasing thermal conductivity), 6-9 inch thick y	-Wooden openings and thick mud plastered walls(increase the time lag of walls to the inside), -Reinforced concreted thick walls in some houses, elongated ventilators, screen geometric pattern, extended porches, roof shading, Column beam structure ("Pakka houses")
Indus delta, Karachi, and Makran coast.	Coastal (High humidity conditions))	Mud and cement sand block, Acacia and Sheesham timber frames, straw and earth plaster	High ceiling, central ridge, and double slope roof, cross ventilation, projected balconies, screens, lattices, wind catchers
Tharparkar (South-eastern provision of Sindh)	Arid	Granite rocks and crystalline rocks, straw, stone and timber ("Pucca house")	Ventilators, hut style room with thatched roofs of thick straw or reed supported by beams, traditional ponds and wells, Sundried bricks and plastered with mud finish for walls, wooden frame windows and doors

Pakistan (adapted from [23])

Appendix 3. Comparison table of EP-2011 and ECBC2023

Aspect	Building code of Pakistan (Energy Provision-2011)[25]	Energy Conservation Building Code (ECBC) 2023[29]
Target	• New commercial building and their systems • New portions of existing buildings and their systems, if the conditioned area or connected load exceeds the scope below • New systems and new equipment in existing buildings • Increase in the electricity load beyond the limit of the scope below	• The ECBC 2023 applies to both residential buildings and commercial building • New commercial building and their systems • New portions of existing buildings and their systems, if the conditioned area or connected load exceeds the scope below • New systems and new equipment in existing buildings • Increase in the electricity load beyond the limit of the scope below
Scope	• Total connected load: 100kW or greater or • Contract demand: 125kVA or greater or • Conditioned area: 900m2 or greater or • Unconditioned buildings of covered area: 1,200m2 or more	• Total connected load: 50kW or greater or • Contract demand: 75kVA or greater or • Conditioned area: 200m2 or greater or • Unconditioned buildings of covered area: $300m^2$ or more
Building Systems Covered	• Building envelopes • Building mechanical systems and equipment, including HVAC (Heating, Ventilating and Air Conditioning) • Service Water Heating • Lighting • Electrical power and motors	• Building envelopes • Building mechanical systems and equipment, including HVAC (Heating, Ventilating and Air Conditioning) • Service Water Heating • Lighting • Electrical power and motors • Others (Energy Management, Passive Design, renewable and geothermal energy, Electric vehicle charging points, water reuse systems)
Exemptions	• Buildings using renewable energy sources • Government-notified heritage buildings • Equipment for manufacturing processes	
Applied Standards	• Follows testing procedures based on ASHRAE 90.1-2004, 2013 standard	• Uses parts of ASHRAE Standard 90.1-2019, ASHRAE Applications Handbook, ASHRAE Standard 111

		• Includes ARI, NEECA, SMACNA, AABC standards	• References ASHRAE, ANSI, ARI, ASTM standards, uses ICC energy conservation code
Climate Classification		• General guidelines, no detailed climate zone classification • A single climate zone for building based on ASHRAE Standard 90.1 – 2013, with Pakistan being designated as Climate Zone1, Centered around Karachi[44]	• Detailed classification into seven climate zones: Hot and Dry, Hot and Humid, Temperate and Humid, Temperate Mixed, Cool and Humid, Cool and Dry, Cold and Humid
Applicable Elements	**Building Envelope Standards**	• U-values for walls and roofs, heat transmission coefficients, shading coefficients, air leakage standards	• Detailed standards, including U-values, SHGC, insulation and air sealing requirements
	HVAC Systems Standards	• Requirements for controls, mechanical ventilation, cooling towers, piping and ductwork, system balancing, minimum equipment efficiencies	• Comprehensive standards for equipment efficiency, ductwork design, and energy-efficient operation
	Service Water Heating Standards	• Standards for piping insulation and equipment efficiency	• Enhanced standards for water heaters, including equipment efficiency and insulation requirements
	Lighting and Electrical Power Standards	• Standards for lighting power density and efficiency of electrical systems and motors	• Updated standards for energy-efficient fixtures, lighting controls, and strategies to reduce energy consumption
	Renewable Energy and EV Charging	• None	• Provisions for renewable energy systems and EV charging infrastructure
	Passive Design	• None	Encouraged to use.. • Passive design techniques such as natural ventilation • Solar gai1n and rejection • Use of geothermal energy
Implementation Plan		• Mandatory compliance, outlined enforcement mechanism	• Structured and detailed plan, compliance documents including energy simulation models required
Administrative Authority		• Relevant local authorities	• NEECA with collaboration from Provincial Designated Agencies (PDAs)
Enforcement Mechanisms		• Compliance mandatory for applicable buildings, guidelines for permits and interpretation of code provisions	• Regular inspections, penalties for non-compliance, maintenance of energy consumption records required
Notable Features		• Basic energy efficiency standards for larger buildings and systems	• Broader scope, detailed standards, sustainable practices, renewable

		energy, modern energy management systems
Update and Revision Cycle	• Initial comprehensive provisions, lacking some areas compared to recent standards	• Regular revisions every three years, interim updates possible, aligns with SDGs and Paris Agreement
Case of any conflict	The relevant provisions of Safety, Health, or Environmental Codes shall prevail.	

Appendix 4. Review Analysis on the Pakistan Green Building Certification - Energy

SUMMARY

Green buildings are gaining widespread recognition as an important pathway for reducing greenhouse gas (GHG) emissions that stem from the construction and building sectors. In a rapidly urbanizing nation of approximately 230 million people, where the construction sector significantly contributes to energy consumption and greenhouse gas emissions, the need for green buildings is extremely critical. The transition to green construction not only aligns with global sustainability practices but also contributes to energy conservation, reduced GHG emissions, and improved living conditions in Pakistan. This report highlights the energy-efficient building practices and challenges in Pakistan, highlighting country's nascent yet much needed transition towards sustainable construction practices. The work navigates through various aspects of green building adoption, including the regulatory landscape, challenges, global comparisons, and technology integration, with a focus on Pakistan's unique climate and building typologies.

Challenges in Green Building Adoption in Pakistan

Pakistan faces several challenges in embracing green building or energy efficient practices due to weak implementation frameworks for building energy codes, limited access to eco-friendly construction materials, shortage of skilled and qualified labor force, high costs associated with low-carbon construction techniques, and the predominance of subpar construction practices, particularly in rural areas. Moreover, there's a lack of awareness about the benefits of green building, and the absence of comprehensive guidelines and policies promoting green construction.

Regulatory Landscape and Governance Structure

The report highlights and provides insights into the governance structure and building regulations in Pakistan indicating the multiple stakeholders at the national, provincial and district levels involved in policy-making and implementation. One of the key areas for intervention is need for enhanced capacity development and robust enforcement mechanisms for implementing stakeholders.

Building Energy Codes

Pakistan's journey in developing and implementing building energy codes is explored, from the establishment of the first Energy Building Code in 1990 to the recent Energy Conservation Building Code 2023. The report emphasizes that these codes are yet to gain widespread adoption at the local government level while citing barriers like legal, regulatory, technical, institutional and financial challenges.

Green Building Technologies

Various green building technologies applicable to Pakistan's hot climate are discussed concentrating on sustainable construction materials, green insulation, efficient windows, cool roofs, low-emitting materials, efficient HVAC systems, solar panels, automation, efficient lighting, and water conservation.

It also underscores the cost considerations for the majority of consumers and the need for a skilled workforce to effectively implement these technologies.

Building Envelope and Energy Efficiency

The role of the building envelope in ensuring energy efficiency is underscored while emphasizing the importance of thermal resistance, vapor control, effective seals, and airflow control.

The building and construction sectors, collectively responsible for approximately 38% of greenhouse gas (GHG) emissions and accounting for 35% of total energy consumption.[8] Developing nations, including Pakistan, are witnessing growing populations and increasing income levels. As a result, the demand for construction and infrastructure development continues its upward trajectory, leading to a surge in GHG emissions within the construction and building sector.

Pakistan's building sector significantly contributes to the nation's energy landscape, accounting for 23% of total energy consumption and a substantial 54% of the country's electricity consumption.[9] Remarkably, the building sector (residential, commercial, and public) of Pakistan is continuously growing for the past two decades, representing a compound annual growth rate of 12.3%. This surge in demand could be attributed to rapid urbanization, resulting in increased construction activity and rising living standards.

While, the construction sector made a substantial contribution to Pakistan's GDP in FY22, amounting to approximately PKR 1,848 billion. This marks a notable growth of around 31.1% compared to the previous fiscal year when it contributed PKR 1,409 billion. On average, the construction sector's contribution to the Pakistan’s GDP stands at around 3%.[10]

Green buildings are gaining widespread recognition as an important pathway for reducing greenhouse gas (GHG) emissions that stem from the construction and building sectors. Green buildings present a holistic approach that prioritizes environmentally friendly materials and processes, while carefully minimizing resource utilization across each phase—from design, and construction to operations and eventual demolition.

This report serves as a review of the current landscape of building construction practices, regulations, standards, and policies in Pakistan. It also delves into barriers impeding the widespread adoption of energy buildings codes within the country and outlines a strategic pathway for their effective

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8 Azhgaliyeva, Dina. and Rahut, D. B., "Promoting Green Buildings: Barriers, Solutions, and Policies", (ADB Report 2022), https://www.adb.org/sites/default/files/publication/812801/adbi-wp1331.pdf

9 National Energy Efficiency and Conservation Authority (NEECA), "Energy Conservation and Building Codes 2023"

10 The Pakistan Credit Rating Agency Limited, "Construction Sector Study, (PACRA 2023) https://www.pacra.com/sector_research/Construction%20-%20PACRA%20Research%20-%20Mar'23_1680249473.pdf implementation. Despite the implementation of various policies and regulatory measures, including the introduction of building energy codes, the adoption of energy-efficient and green building practices remains in its early stages in Pakistan.

The major barriers to effectively adopting energy efficient and green building practices in Pakistan are weak enforcement of building energy codes, lack of awareness of potential benefits, high upfront costs, limited access to environmentally friendly construction materials and a shortage of skilled workers. These challenges are compounded by the higher upfront costs associated with low-carbon construction methods and technologies.

It is within this context that the role of green buildings assumes vital importance, exceeding both economic and environmental perspectives. This align perfectly with Pakistan's ambitious objectives of attaining low carbon growth, as outlined in the Pakistan's Nationally Determined Contributions (NDCs). As Pakistan deals with the multifaceted challenges posed by its demographic changes and growing energy demands, the adoption of green building practices emerges as an opportunity for sustainable progress and harmonious coexistence with the environment.

However, it is also important to acknowledge the ground realities that the construction landscape in Pakistan, particularly in rural areas in most part diverges from established engineering design, construction norms, and standards. This has led to a proliferation of low-quality construction and buildings throughout the country.

Housing in Pakistan can be broadly categorized into three classes: "pukka" houses, which are constructed using substantial and durable materials such as stone, brick, cement, concrete, or timber; "kuchha" houses, characterized by their use of less-durable materials like mud, bamboo, reeds, or thatch, constituting approximately 35% of housing stock; and "semi-pukka" houses (11%), which represent a blend between the two categories. Among these, the better-quality "pukka" houses make up approximately 54% of the total.[11]

Even in urban areas, ramshackle neighborhoods, locally known as "katchi abadis," dominate the landscape and can be found in metropolitan cities across the country.[12] These areas typically lack proper planning and regulation, leading to a dearth of safe drinking water, adequate sanitation facilities (similar to rural areas), and buildings that often exhibit structural weaknesses and safety hazards. Alarmingly, approximately half of all urban residents in Pakistan are residing in such unplanned and underserved areas.

Addressing the disparities in construction practices and housing quality, especially in rural and informal urban settlements, remains a pressing challenge. The promotion of sustainable and green

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[11] Pakistan Bureau of Statistics, "Housing Units by number of rooms and type" https://www.pbs.gov.pk/sites/default/files/tables/housing/HOUSING%20UNITS%20BY%20NUMBER%20OF%20ROOMS%20AND%20TYPE.pdf

[12] Britannica "Housing in Pakistan" https://www.britannica.com/place/Pakistan/Daily-life-and-social-customs

building practices, coupled with improved urban planning and infrastructure development, stands as a crucial step towards ensuring safer and more resilient living conditions for a significant portion of Pakistan's population.

2. GREEN BUILDINGS OVERVIEW

Green building is a holistic concept rooted in the understanding that the built environment can profoundly impact the natural world and its occupants. It strives to amplify positive effects and mitigate negative ones throughout a building's entire life cycle.[13]

GREEN BUILDINGS AND THEIR CORE PRINCIPLES

Green building, also known as sustainable or high-performance building, represents the practice of developing structures and employing processes that prioritize environmental responsibility and resource efficiency.[14] This approach spans the entire life cycle of a building, from initial site selection to design, construction, operation, maintenance, renovation, and eventual demolition. It expands upon and complements the traditional building design considerations of cost-effectiveness, utility, durability, and occupant comfort.

It is important to note that energy efficiency is the first step to green building, and as a principle all green properties should be energy efficient.[15] Green buildings incorporate a range of environmentally friendly and resource-efficient measures throughout their life cycle. The overarching goal of this concept is to minimize a building's negative impact on the environment while maximizing its positive contributions to both the natural surroundings and the well-being of the people who inhabit it. This holistic approach not only supports sustainability but also fosters a healthy built environment. Key areas of emphasis in green building practices include the efficient use of energy, water, and other resources, ensuring high indoor environmental quality, and minimizing adverse impacts on the natural environment.

Broadly, green building adheres to planning, design, construction, and operations with following key considerations:

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13 US Green Building Council, 'What is green building?", (USGBC 2014) https://www.usgbc.org/articles/what-green-building

14 US Environmental Protection Agency, "Green Buildings" (US EPA 2016), https://archive.epa.gov/greenbuilding/web/html/about.html.

15 Energy Star, "Green Buildings and ENERGY STAR" https://www.energystar.gov/buildings/about_us/green_buildings_and_energy_star#:~:text=According%20to%20the%20World%20Green,ensure%20that%20we%20can%20harness

- Prioritize **energy efficiency** and energy-saving technologies and renewable sources.
- Promote **water conservation,** minimizing water use and often incorporating sustainable water management.
- Improve **Indoor Environmental Quality** by enhancing air quality, daylight, and thermal comfort.
- Utilize **Sustainable Construction Materials** while choosing eco-friendly, and locally sourced materials.
- Reduce **environmental impact** and preserving natural surroundings.

Thus, a green building goes beyond construction, promoting sustainability, resource efficiency, and a healthier living environment.

GREEN BUILDINGS VS. ENERGY-EFFICIENT VS. TRADITIONAL: WHAT SETS THEM APART?

Distinguishing between traditional building, energy-efficient and green buildings is important to understand the core principles construction approach and align sustainability goals. Green buildings, energy-efficient buildings, and traditional buildings differ significantly in their approach to construction and their impact on the environment. Green buildings provide a broad spectrum of sustainable practices that extend beyond energy efficiency, while energy-efficient buildings primarily focus on minimizing energy consumption. Whereas traditional buildings lack the sustainability features and efficiency measures found in both green and energy-efficient buildings.

Figure 1: Traditional buildings, energy efficient buildings and green buildings (Source: author)

Green Buildings

Green or Sustainable buildings incorporate holistic approach to reduce their environmental footprint throughout their entire life cycle. While energy efficiency is a significant consideration, green buildings go beyond this and include a range of environmental aspects, including water efficiency, waste management. Green buildings predominantly use sustainable materials in construction and take into consideration for the building's overall impact on the natural environment. Green buildings also prioritize the well-being of occupants, indoor air quality, and minimizing resource consumption for more sustainable and environmentally responsible.

Energy Efficient Buildings

While the entire focus of energy-efficient buildings is to reduce energy consumption and promote efficient energy use. They typically employ efficient technologies and strategies to optimize heating, cooling, lighting and cooking. While these buildings contribute to environmental sustainability by reducing GHG emission and lowering energy costs, their scope is limited in comparison to green buildings. Hence, energy-efficient buildings may not necessarily address other critical environmental concerns like material sourcing.

Traditional Buildings

Traditional or conventional buildings typically follow established practices without specific considerations for sustainability. While they serve their intended purposes, they tend to be less environmentally friendly compared to green or energy-efficient buildings. Traditional buildings may rely on older, less efficient technologies and materials, resulting in higher energy consumption and a larger environmental impact over their lifespan.

GLOBAL LANDSCAPE OF GREEN BUILDINGS

Green building practices have gained significant traction worldwide. With rising concerns of climate change and sustainability considerations, countries across the globe are embracing sustainability practices in construction. While many countries are widely adopting green building practices, it's important to highlight that USA, Europe, China, and India have achieve significant progress in this areas. Over the last few years, the investments in energy efficiency has seen significant growth with an annual investments amounting to over US$ 250 as highlighted in the Figure 2 below.

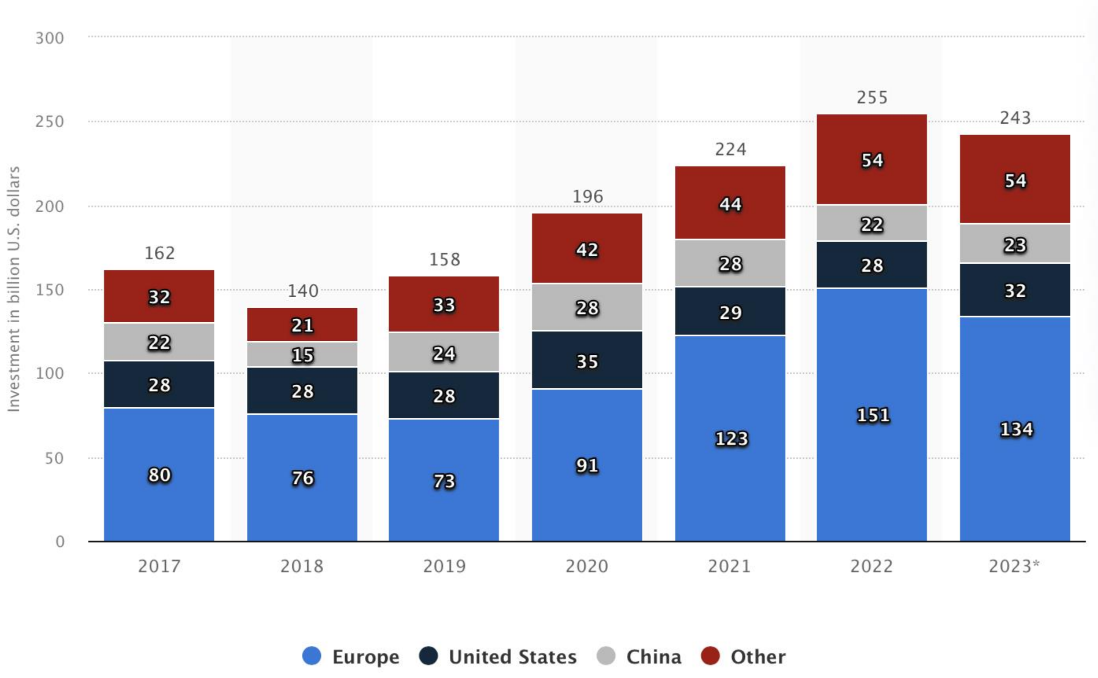

Figure 2: Annual investment in energy efficiency in the buildings sector worldwide from 2017 to 2023, in Europe, U.S. China (Source: Statista 2023)

U.S.A

The United States is the world leader in green buildings by a significant margin. The US has been pioneering and has taken the lead in green building initiatives, thanks to organizations such as the U.S. Green Building Council (USGBC) and their successful implementation of the LEED (Leadership in Energy and Environmental Design) certification system.[16] LEED has become a global standard for sustainable building practices, focusing on energy efficiency, water conservation, and indoor air quality.[17] The US is proud of its diverse range of LEED-certified projects, covering residential, commercial, and public sectors.

The growth of the green building market in the United States is primarily driven by several key factors, including a progressive increase in regulations at the local, state, and federal levels, attractive financial incentives for building developers and owners, and the active role of the U.S. government in

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16 Building Design Construction Network, "The countries with most green buildings" (2021) https://www.bdcnetwork.com/countries-most-green-buildings

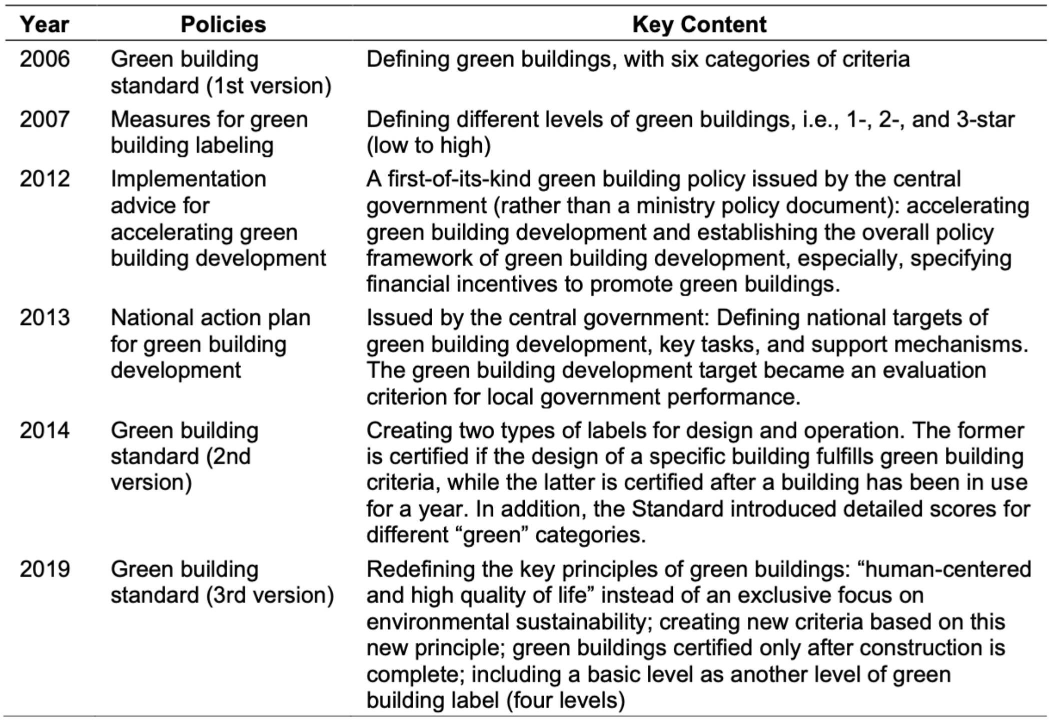
17 US Green Building Council (USGBC), "LEED rating system", (2022) https://www.usgbc.org/leed#:~:text=LEED%20(Leadership%20in%20Energy%20and,rating%20system%20in%20the%20world.

promoting sustainable development practices and reducing carbon emissions. While for the end users, operating cost savings, shorter payback periods and increased asset value in new green buildings and green retrofits are reported to be the key triggers.[18]

CHINA

China has undergone substantial urbanization and economic expansion, resulting in a substantial increase in its building stock. Since 2006, the Chinese government has been promoting green buildings by implementing various measures, including providing information, enhancing skills, setting clear goals and regulations, offering financial incentives, and presenting examples of successful green buildings. The table 1 below outlines some of the main policies in practice to encourage green building development in China.

Table 1: Key policies regarding green buildings in China.[19]



Year	Policies	Key Content
2006	Green building standard (1st version)	Defining green buildings, with six categories of criteria
2007	Measures for green building labeling	Defining different levels of green buildings, i.e., 1-, 2-, and 3-star (low to high)
2012	Implementation advice for accelerating green building development	A first-of-its-kind green building policy issued by the central government (rather than a ministry policy document): accelerating green building development and establishing the overall policy framework of green building development, especially, specifying financial incentives to promote green buildings.
2013	National action plan for green building development	Issued by the central government: Defining national targets of green building development, key tasks, and support mechanisms. The green building development target became an evaluation criterion for local government performance.
2014	Green building standard (2nd version)	Creating two types of labels for design and operation. The former is certified if the design of a specific building fulfills green building criteria, while the latter is certified after a building has been in use for a year. In addition, the Standard introduced detailed scores for different “green” categories.
2019	Green building standard (3rd version)	Redefining the key principles of green buildings: “human-centered and high quality of life” instead of an exclusive focus on environmental sustainability; creating new criteria based on this new principle; green buildings certified only after construction is complete; including a basic level as another level of green building label (four levels)

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[18] US Green Building Council (USGBC), "Economic benefits of green buildings", https://www.usgbc.org/press/benefits-of-green-building#:~:text=The%20top%20two%20triggers%20for,retrofits%20have%20been%20consistently%20reported.

[19] Azhgaliyeva, Dina. and Rahut, D. B., "Promoting Green Buildings: Barriers, Solutions, and Policies", (ADB Report 2022), https://www.adb.org/sites/default/files/publication/812801/adbi-wp1331.pdf

INDIA

Green buildings are a growing trend in India. According to the US Green Building Council, India has the second highest number of green buildings outside of the US region, following only China. It is expected to become more popular as the country moves towards a sustainable future. To promote green buildings, the government has set up various incentives and promotion schemes. The National Buildings Code of India (NBCI) and Energy Conservation Building Code (ECBC) are few of them. These measures aim to promote high-performance and energy-efficient buildings in India. The Indian government provides several incentives to encourage green building and LEED certifications in India[20]. Some examples include:

- **Tax benefits -** The Indian government offers tax benefits to developers of LEED-certified buildings through the Income Tax Act. Developers can claim up to 100% depreciation on the cost of green building assets, such as solar panels, rainwater harvesting systems and waste management systems.
- **Loans** - The Indian government provides low-interest loans through the Indian Renewable Energy Development Agency (IREDA) for building projects with green certifications.
- **Public procurement -** The Indian government has implemented a policy that requires all government buildings to be certified green and meet green building standards.
- **State-level incentives** - Many states in India have their own policies and plans to promote green building certification, such as providing subsidies and tax exemptions to promote energy-efficient buildings and renewable energy projects.
- **Fast-track approvals** - Buildings that are certified green are eligible for incentives such as fast-track approvals, expedited inspections and reduced building fees.
- **Promotion of renewable energy** - The government also provides subsidies and tax benefits to promote renewable energy in the country; this can indirectly promote LEED-certified buildings.

EUROPEAN UNION

The European Energy Performance of Buildings Directive introduced an energy performance label for buildings from “A” to “G,” with “A” being the most energy efficient. Many European Member Countries adopted a decree requiring office buildings to have an energy performance label of “C” or higher by 2023 and an “A” label by 2030. An office building falling short of the requirements can no longer be used, sold, or leased, effectively making it a stranded asset.

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[20] *Tejal Chottai, Green Building Council of India, "Government incentives for green building projects in India" (2023) https://www.gbci.org/government-incentives-green-building-projects-india*

Energy Performance Certificates (EPC) provide information to consumers on buildings they plan to purchase or rent. They include an energy performance rating and recommendations for cost-effective improvements. Certificates must be included in all advertisements in commercial media when a building is put up for sale or rent.

An EPC typically has two ratings: an energy label, which rates the primary energy consumption of the building, and a climate label, which rates the amount of greenhouse gases emitted. Both are given one of the seven classifications from A to G as shown in the Figure 3.

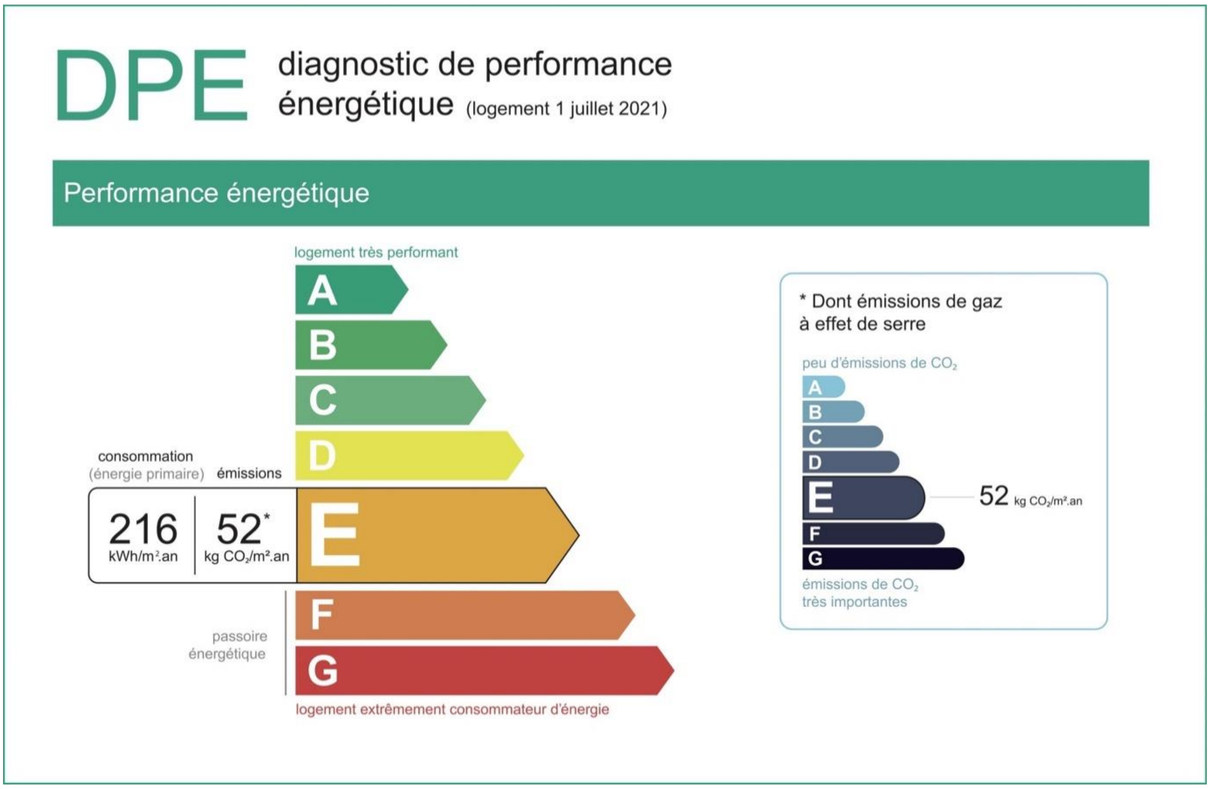

Figure 3: Energy Performance Certificate – energy and climate ratings implemented in France.[21]

Figure 4 provides an overview of the number of green buildings in various countries, as reported by the Leadership in Energy and Environmental Design (LEED) rating system. LEED is a widely recognized certification system for sustainable and green building practices. The United States leads the pack with

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[21] *French Property Need-to-Know: Energy Performance Certificates, French Entrée, (2022) https://www.frenchentree.com/french-property/selling-homes/french-property-need-to-know-energy-performance-certificates/*

a substantial number of green buildings, reflecting the country's strong commitment to sustainability and environmentally friendly construction practices. China follows as the second-largest contributor to green building projects; Canada ranks third on the list. While India emerges as a prominent player in the global green building landscape, The United Arab Emirates (UAE) rounds off the top five.

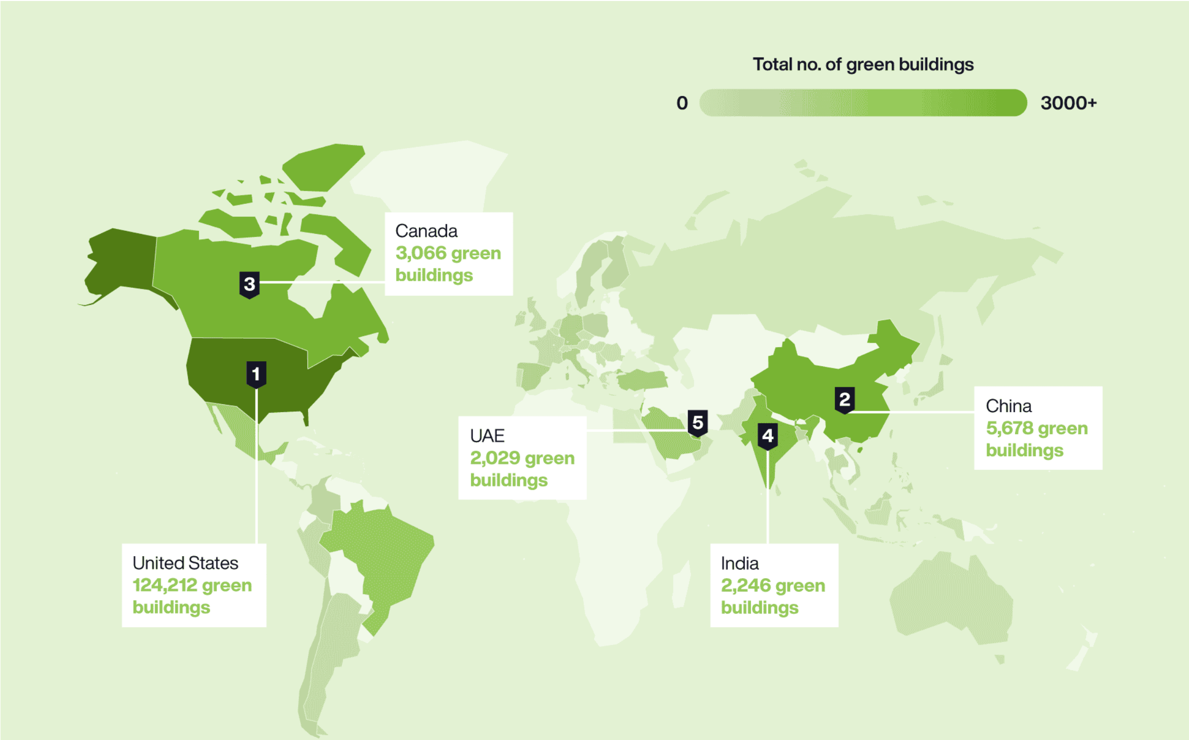

Figure 4: Countries with most green buildings in the world (Source: Uswitch[22])

BARRIERS AND CHALLENGES TO ADOPTION OF GREEN BUILDINGS

The primary challenge that stands out when it comes to scaling the adoption of green buildings is the high upfront cost of implementation. This high cost not only raises rental expenses but also creates hurdles in attracting both investors and tenants, making green buildings less accessible to individuals with limited capital.

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22 Global Green Building Leaders, Uswitch https://www.uswitch.com/gas-electricity/global-green-building-leaders/

While green buildings offer positive environmental benefits and play a crucial role in reducing greenhouse gas emissions, there are several challenges hindering their widespread adoption of green buildings.

Key barriers to financing green buildings include:

6. **Split Incentives** - Within the building market, an issue arises where different parties have conflicting incentives. For instance, developers may be hesitant to invest in green building design due to upfront costs, while the cost savings will primarily benefit future owners.
7. **Developer Hesitance** - Developers may be reluctant to absorb the additional upfront costs associated with green building design, especially when the financial benefits accrue over extended periods, potentially beyond their ownership.
8. **Building Longevity vs. Investment Holding Periods** - Mismatches often occur between the longevity of green buildings and the relatively short holding periods for real estate assets in investment portfolios.
9. **Minimal Landlord Incentives** - In cases where tenants are responsible for utility bills, landlords may have limited incentives to invest in energy efficient equipment.
10. **Subsidized or Government-Controlled Energy Prices** - Subsidized or government-controlled energy prices can affect the motivation to invest in energy efficiency.

In addition, lack of awareness and education is also a key challenge. There is a substantial need for increased awareness, information dissemination, and education regarding the benefits of green building, both for individual well-being and broader public benefits. Besides, limited access to technical resources also hinders the adoption. Limited access to design, construction materials, and skilled workers also impede the construction of green buildings. While in case of Pakistan, the fundamental challenge is the weak enforcement of building codes. The absence of comprehensive building codes, guidelines, standards, and policies that promote and incentivize green building practices can pose a significant challenge to their widespread adoption.

POLICY INSTRUMENTS TO PROMOTE GREEN BUILDINGS

To promote the widespread adoption of green building practices, governments and regulatory bodies worldwide have implemented a diverse array of policies and incentives. These initiatives serve as critical drivers for the integration of sustainable construction methods and the reduction of environmental impacts in the building sector.

6. Codes and Standards

One of the fundamental pillars of green building promotion is the development and enforcement of building codes and standards that prioritize energy efficiency, water conservation, and environmental responsibility. These codes set the benchmark for sustainable construction practices and ensure compliance with eco-friendly building materials and technologies.

7. Tax Incentives

Tax incentives are powerful tools to encourage green building investments. Leading countries in the green building space offer many tax credits or deductions to individuals or businesses that undertake green building projects. These incentives not only reduce the financial burden of green construction but also stimulate economic activity in the sustainable building sector.

8. Grants and Subsidies

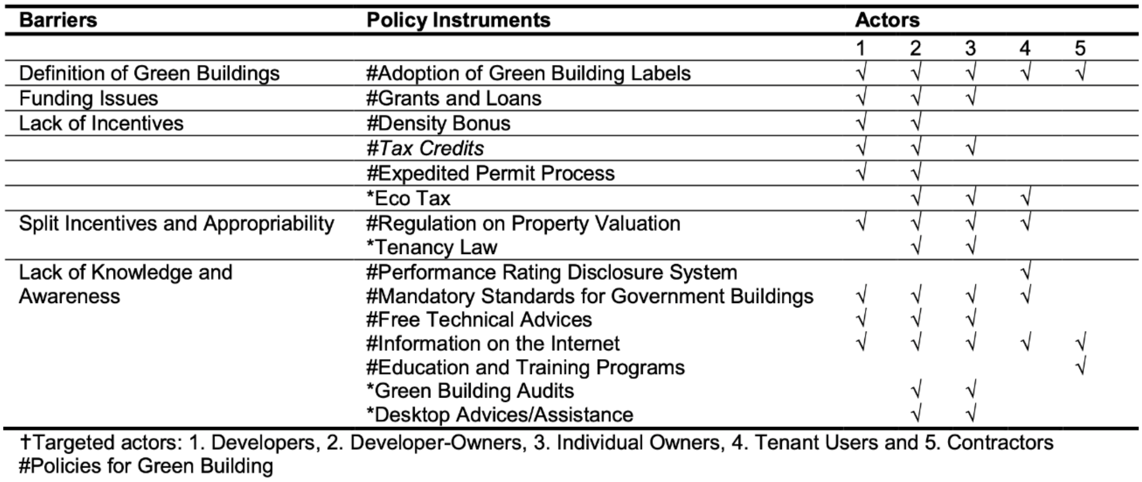
Grants and subsidies are another vital policy instrument. They provide financial support to offset the additional or premium costs associated with green building practices. These incentives are particularly valuable for individuals and organizations looking to invest in environmentally responsible construction.

9. Loans

Accessible loans with favorable terms can significantly impact green building adoption. Low-interest or green-focused loans make it more affordable for builders and homeowners to invest in sustainable construction methods and energy-efficient technologies.

10. Public Investment and Procurement

Governments can lead by example through public investment in green building projects and sustainable infrastructure. Additionally, public procurement policies that prioritize environmentally friendly construction materials and practices can drive demand for green building products and services.



Barriers	Policy Instruments	Actors				
		1	2	3	4	5
Definition of Green Buildings	#Adoption of Green Building Labels	√	√	√	√	√
Funding Issues	#Grants and Loans	√	√	√		
Lack of Incentives	#Density Bonus	√	√			
	#*Tax Credits*	√	√	√		
	#Expedited Permit Process	√	√			
	*Eco Tax		√	√	√	
Split Incentives and Appropriability	#Regulation on Property Valuation	√	√	√	√	
	*Tenancy Law		√	√		
Lack of Knowledge and Awareness	#Performance Rating Disclosure System				√	
	#Mandatory Standards for Government Buildings	√	√	√	√	
	#Free Technical Advices	√	√	√		
	#Information on the Internet	√	√	√	√	√
	#Education and Training Programs					√
	*Green Building Audits		√	√		
	*Desktop Advices/Assistance		√	√		

†Targeted actors: 1. Developers, 2. Developer-Owners, 3. Individual Owners, 4. Tenant Users and 5. Contractors
#Policies for Green Building

Table 2: barriers and policy instruments to promote green buildings by engaging key stakeholders.[23]

Table 2 provides a snapshot of key barriers and corresponding policy instruments with indication of key actors involved in green building practices.

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23 A Review on Barriers, Policies and Governance for Green Buildings and Sustainable Properties https://www.irbnet.de/daten/iconda/CIB_DC26611.pdf

COST OF BUILDING GREEN

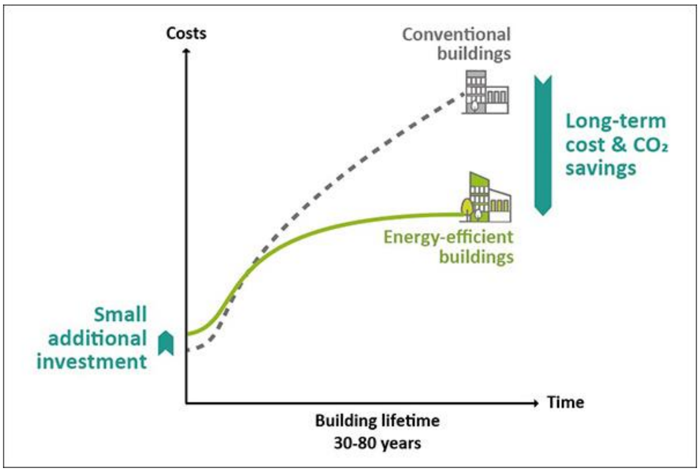

Figure 5: Cost of Green Buildings over Time [25]

The cost of building green is not a one-size-fits-all proposition but varies significantly based on numerous factors, including local climatic conditions, the availability and cost of eco-friendly building materials, the accessibility of energy- and water-efficient equipment, and the presence of technical expertise in green construction. Consequently, determining an exact cost for green building across different countries can be challenging due to these varying influences[24].

Numerous studies suggest that green building projects typically incur an additional cost ranging from 5% to 15% when compared to conventional construction methods. However, what makes green building particularly attractive is the relatively short payback period, usually falling within the range of 3 to 5 years[26]. This means that the upfront investment in green building practices is often recouped through operational cost savings and efficiency gains within a relatively short timeframe.

Due to the limited availability of comprehensive data, determining the precise cost premium associated with green building in Pakistan remains a challenge. The cost dynamics of green building can vary significantly based on local conditions, materials, and practices, making it essential to gather specific and regionally relevant data for accurate assessments. It is reasonable to assume that the additional investment or premium cost associated with building green can pose a primary barrier to the widespread adoption of green buildings in developing countries, particularly in the case of Pakistan.

However, while specific cost premiums may not be readily available, it's important to acknowledge the broader trends and principles associated with green building. Generally, green building practices may involve a high initial upfront investment compared to conventional construction methods, though lower operating costs over the period of building reduces the total cost of ownership as presented in the Figure 5.

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24 IFC - Green Buildings | A Finance and Policy Blueprint

25 Programme for Energy Efficiency in Buildings (PEEB), Green Buildings for Economy and Climate, https://www.peeb.build

26 Cost of Green Building in India: What is the Payback Period?https://www.inhabit.co.in/blogs/post/Cost-of-Green-Building-in-India_What-is-the-Payback-Period

Certified green buildings offer a range of tangible benefits, including lowered operating expenses and enhanced resource efficiency. These benefits manifest in reduced utility bills, decreased waste output, and lower maintenance costs. In terms of energy and water consumption, green buildings can achieve savings exceeding 20% compared to conventional buildings. This translates to substantial savings for green homeowners, typically ranging from 15% to 20% on their utility bills. In the commercial sector, green buildings have demonstrated remarkable cost-effectiveness, with operating expenses falling between 18% and 37% lower than those of traditional buildings.

3: GOVERNANCE STRUCTURE AND BUILDING REGULATIONS IN PAKISTAN

The governance structure and building regulations in Pakistan are multifaceted, involving multiple layers of stakeholders at the national, provincial and district levels. A sporadic regulatory framework of energy efficient buildings in Pakistan is in place, though it is not uniform across different parts of the country. Therefore, the enforcement and compliance to building regulations vary significantly across the country and there are serious governance issues in the construction industry in Pakistan.

NATIONAL LEVEL OVERSIGHT ON BUILDING RELATED POLICY AND REGULATIONS

These are the key stakeholders at National Level in Pakistan and play a significant role in policy formulation and the establishment of regulatory frameworks, although they typically do not directly oversee the enforcement of these standards at the operational level.

5. **Ministry of Housing and Works** - At the national level, the Ministry of Housing and Works plays a pivotal role in setting the governing framework for buildings and construction, particularly for federal agencies. This ministry provides policy guidance and regulatory oversight to promote safe and sustainable building practices for Federal Government owned buildings.

6. **Pakistan Engineering Council (PEC)** - The enactment of a building code comes under the purview of PEC (Act of 1975-Section 25). Thus, PEC is responsible for developing the Building Codes of Pakistan and monitoring construction and engineering works. PEC also plays a critical role in establishing construction standards for engineering and construction firms in Pakistan.

7. **Pakistan Council of Architects and Town Planners (PCATP) -** PCATP is instrumental in regulating and accrediting professionals in the fields of architecture and town planning. Their involvement ensures that building designs adhere to best practices in urban planning and architecture.

8. **National Energy Efficiency and Conservation Authority (NEECA)**: NEECA operates under the Ministry of Energy and is tasked with developing Energy Building Codes to promote energy-efficient construction practices. This authority focuses on achieving energy efficiency goals in the construction sector.

PROVINCIAL AND DISTRICT LEVEL GOVERNANCE AND IMPLEMENTATION

In Pakistan, the building regulations for implementation involve various government entities and building authorities at both the provincial and local levels. These entities have distinct roles and responsibilities pertaining to construction standards and practices, yet their effectiveness in achieving their objectives has faced challenges.

Each province has its own relevant Department of Urban Development and Housing which are tasked with overseeing urban development and housing initiatives within their respective provinces, including the formulation and implementation of building regulations. While Building Control Authorities at the provincial level regulate construction practices, and issue building permits down to the district level and are responsible for ensuring compliance with local building codes.

Moreover, in major urban centers such as Karachi, Islamabad, and Lahore, Development Authorities are responsible for developing and enforcing their own local building by-laws. District Building Control Authorities also play a role in scrutinizing building designs, conducting on-site inspections of construction projects, and issuing occupancy permits. Then there are Municipal and Town corporations with jurisdiction over specific areas and enforce their own building by-laws and regulations. Additionally, there are Cantonment Areas, which maintain their own governance structures and building by-laws, operating independently from municipal regulations.

Despite this multi-layered framework and institutions, the effectiveness of these agencies in delivering their objectives has faced challenges, raising questions about their ability to consistently enforce building regulations and ensure compliance with building codes across the country.

COMPLIANCE AND IMPLEMENTATION OF BUILDING CODES

In Pakistan, compliance with building codes is primarily the responsibility of design professionals, contractors while provincial and building authority officials are responsible for enforcement of the building codes. However, it's important to note that the enforcement framework is still evolving and significantly vary in maturity across different cities.

Compliance mechanisms typically involve verifying proposed designs in alignment with local building by-laws. In some major cities like Karachi, Islamabad and Lahore; there is a growing trend to vet structural designs, although this practice is not yet common in all urban areas.

For government-owned buildings, construction is supervised either by nominated consultants or by the government organization itself, ensuring adherence to approved designs and specifications. While building designs often align with the Building Codes of Pakistan, construction quality may vary and may not always conform to standard specifications[27].

BUILDING ENERGY CODES IN PAKISTAN

PAKISTAN BUILDING ENERGY CODE 1990

The establishment of building energy codes in Pakistan falls within the jurisdiction of the Pakistan Engineering Council (PEC), as outlined in the PEC Act of 1975 (Section 25). Any code pertaining to building construction undergoes review and approval by the PEC. Earlier, energy conservation efforts in Pakistan have been undertaken by the National Energy Conservation Centre (ENERCON), established as part of a USAID project in 1985 under the Ministry of Planning & Development.

Pakistan's first-ever Energy Building Code was introduced in 1990. ENERCON, in collaboration with the Environment and Urban Affairs Division, developed this Building Energy Code for Pakistan as an addendum to the Building Code of Pakistan 1986 (BCP 1987), which served as Pakistan's First National Building Code. It is worth noting that this code operated as an advisory guideline and was not made mandatory.

Over the years, the administrative oversight of ENERCON has shifted. In 1993, it was transferred to the Ministry of Water and Power and subsequently to the Ministry of Environment in 1996. In 1997, ENERCON became an attached department of the Ministry of Environment but was later transferred back to the Ministry of Water and Power in 2011.

In 2007, Pakistan revised and published its second Building Code of Pakistan (BCP 2007), prompted by the devastating earthquake in 2005, with a focus on strengthening seismic provisions. BCP 2007 established minimum regulations for earthquake considerations in building systems. Notably, BCP 2007 draws heavily from the Uniform Building Code (UBC) 1997, with indigenous adjustments primarily in seismic zonation. Buildings designed under BCP 2007 adhere to design specifications closely aligned with UBC 97. Material specifications are referenced to ASTM specifications, governing the quality assurance of materials such as steel, concrete, and bricks.

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[27] World Housing Encyclopedia, Housing Report, Reinforced concrete buildings in Pakistan https://www.world-housing.net/WHEReports/wh100184.pdf

PAKISTAN BUILDING ENERGY CODE 2011 (ENERGY PROVISIONS 2011)

In 2011, ENERCON, in collaboration with the Pakistan Engineering Council (PEC), initiated the development of a new Building Energy Code for Pakistan, referred to as Energy Provisions-2011. This code received official endorsement from PEC and was officially introduced in 2013. Energy Provisions-2011 initially featured a single climate zone for building envelopes, primarily based on ASHRAE Standard 90.1 - 2013, with Pakistan being designated as Climate Zone 1, centered around Karachi[28]. However, recognizing the country's diverse climate conditions, the code did not serve the purpose in terms of climate zoning to address thermal performance across various part of the country.

Energy Provisions-2011 established minimum energy efficiency requirements and was tailored to guide the design and construction of new high-end residential and commercial buildings, as well as specific building clusters meeting defined criteria. These criteria included a total connected load of 100 kW or more, a contract demand of 125 kVA or greater, a conditioned area exceeding 900 m^3, or unconditioned buildings with a covered area exceeding 1200 m^2. Consequently, Energy Provisions-2011 had a limited scope, primarily targeting larger institutional, commercial, and industrial buildings.

In 2016, ENERCON underwent a transformation, evolving into the National Energy Efficiency and Conservation Authority (NEECA) through NEECA Act 2016, functioning as an attached department within the Ministry of Water and Power. It is important to note that while the first energy conservation building code for Pakistan was introduced by ENERCON in 1990, its practical implementation remained voluntary. Following the 18th amendment in Pakistan's constitution, NEECA's provincial responsibilities were transferred to provincial energy departments.

NEECA ENERGY CONSERVATION BUILDING CODE (ECBC) 2023

In 2023, NEECA introduced the Energy Conservation Building Code 2023 (ECBC-2023), representing a revised and updated version of the Building Code of Pakistan (Energy Provisions-2011). ECBC-2023 is designed to incorporate state-of-the-art technologies, facilitating the implementation of energy efficiency and conservation measures. This updated code primarily targets high-end domestic and commercial consumers, aiming to conserve energy while maintaining public safety.

ECBC-2023 includes various aspects, including building envelope optimization, passive building design principles, building insulation, retrofitting of existing buildings for enhanced energy efficiency, energy

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[28] *A Comparative Analysis of Energy Provisions of Pakistan Building Code with Indian and USA Building Energy Codes. Available from: https://www.researchgate.net/publication/327264251_A_Comparative_Analysis_of_Energy_Provisions_of_Pakistan_Building_Code_with_Indian_and_USA_Building_Energy_Codes[accessed August 28 2023].*

analysis through monitoring devices, exploration of renewable and geothermal energy integration within buildings, and the introduction of energy management systems.

The scope of this code has been expanded and applies to buildings and building clusters that meet specific criteria, including a total connected load of 50 kW or greater, a contract demand of 75 kVA or greater, a conditioned area of 200 m² or more, or unconditioned buildings with a covered area exceeding 300 m². It extends its coverage to fully detached, semi-detached, and un-detached residential as well as commercial buildings.

Local authorities play a significant role in the implementation of ECBC-2023, particularly as part of the building construction permit application and approval process. Additionally, the code is designed to undergo periodic revisions every three years to ensure its continued relevance and effectiveness. Its comprehensive coverage includes energy-efficient and low-emission construction materials, passive building design principles, energy appliance monitoring devices, electric vehicle charging infrastructure, energy management systems, building insulation, and the integration of renewable and geothermal energy solutions.

PUNJAB BUILDING ENERGY CONSERVATION BUILDING CODE 2017

As per the provisions of the NEECA Act 2016, provinces were granted the authority to amend, enhance, or develop their own Building Energy Codes tailored to local climatic conditions. Punjab took the lead in establishing the Punjab Energy Efficiency and Conservation Agency (PEECA) in 2016, following the enactment of the National Energy Efficiency and Conservation Act-2016. All provinces were encouraged to establish energy efficiency and conservation bodies. PEECA commenced work on reviewing and modifying the code originally developed by ENERCON/NEECA, known as the Pakistan Building Code (Energy Provisions-2011). Punjab introduced Punjab Building Energy Conservaiton Building Code 2017. In accordance with Energy Provisions – 2011), this code was applicable to buildings and building clusters that have a total connected load of 100 kW or greater, or a contract demand of 125 kVA or greater, or a conditioned area of 900 m^2 or greater, or an unconditioned building of covered area of 1,200 m^2 or more.

PAKISTAN GREEN BUILDING GUIDELINES 2016

Pakistan Green Building Guidelines were established by Pakistan Green Building Council (PGBC). This serves as a reference guide of building design and construction in Pakistan. PGBC is a non-profit organization dedicated to fostering a sustainable future in Pakistan through the promotion of resource-efficient green buildings and communities, emphasizing cost savings, energy efficiency, water conservation, and responsible use of natural resources. Pakistan GBC is currently a prospective member of the World Green Building Council, it serves as the exclusive representative of the World GBC within Pakistan.

Pakistan Green Building Council PGBC has developed its own rating system based on Pakistan-specific Green Building Guidelines. The first version of SEED-Sustainability in Energy and Environmental Development is published in Oct 2016 by PGBC. SEED is aims to address sustainable and socially responsible thinking about how buildings and communities are planned, constructed, maintained, and operated There are four tiers in certification depending on the points achieved by a building. The certifications are silver, gold, platinum, and titanium; the last one being the highest point scored.

PEC GREEN BUILDING CODE OF PAKISTAN 2023

Recently Pakistan Engineering Council (PEC) released the Green Building Code of Pakistan in May 2023 based on the 2021 edition of the International Green Construction Code (IgCC) as reported by International Code Council (ICC)[29] In 2016, EU SWITCH-Asia in collaboration with the Ministry of Climate Change, UN Environment, and UN Habitat-Pakistan launched the Sustainable Consumption and Production (SCP) Programme in Pakistan, focused on the SDG-12 and provided guidelines for the transformation of the conventional built practices into a green built environment across Pakistan.

As part of this program, EU SWITCH-Asia SCP Programme, UN Environment, and UN-Habitat successfully developed Policy Guidelines - Green Building Code for Pakistan, in line with the commitment of the Government to pursue climate resilient and green development initiatives.

The Ministry of Climate Change along with relevant stakeholders including Pakistan Engineering Council is working on the development of the Green Building Code for greening the Building Construction Sector in Pakistan[30].

ASSESSMENT OF BUILDING GROUPS AND TYPES IN PAKISTAN

Access to comprehensive data on building stock presents a considerable challenge in Pakistan, primarily due to the fragmented nature of the construction industry. With numerous stakeholders at the federal, provincial, and district levels, a centralized repository of information is challenging to establish. While the Pakistan Bureau of Statistics is a key resource for such data, it currently offers

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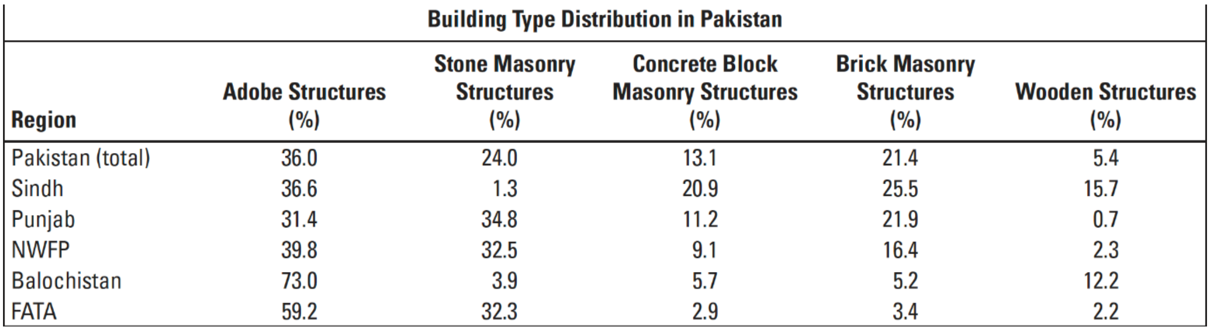
29 Pakistan Engineering Council Releases Green Building Code Based on the International Codes (ICC 2023) (https://www.iccsafe.org/about/periodicals-and-newsroom/pakistan-engineering-council-releases-green-building-code-based-on-the-international

30 EU SWITCH Asia Programme

limited information without a clear breakdown of building types, such as residential, commercial, office spaces, or other categories.

The majority of the building stock consists of non-engineered structures. According to the Pakistan Bureau of Statistics, housing in Pakistan falls into three broad categories: "pukka" houses, constructed using durable materials like stone, brick, cement, concrete, or timber; "kuchha" houses, constructed with less durable materials like mud, bamboo, reeds, or thatch, constituting approximately 35% of the housing stock; and "semi-pukka" houses (11%), representing a hybrid between the two. Among these, the higher-quality "pukka" houses make up approximately 54% of the total housing stock.



Building Type Distribution in Pakistan

Region	Adobe Structures (%)	Stone Masonry Structures (%)	Concrete Block Masonry Structures (%)	Brick Masonry Structures (%)	Wooden Structures (%)
Pakistan (total)	36.0	24.0	13.1	21.4	5.4
Sindh	36.6	1.3	20.9	25.5	15.7
Punjab	31.4	34.8	11.2	21.9	0.7
NWFP	39.8	32.5	9.1	16.4	2.3
Balochistan	73.0	3.9	5.7	5.2	12.2
FATA	59.2	32.3	2.9	3.4	2.2

Table 3: Building Stock Distribution by type of Construction.[31]

The building stock in the Pakistan can be classified into five categories depending upon the material used in walls and roofs. Regarding building types, Pakistan features diverse construction typologies, including brick masonry, block masonry, stone masonry, adobe masonry, reinforced concrete structures, and wooden and timber constructions. The distribution of buildings in Pakistan encompasses adobe structures (36%), stone masonry (24%), concrete block masonry (21%), brick masonry (21.4%), and wooden and timber constructions (5.4%) as highlighted in Table 3. Reinforced concrete (RC) frame structures are predominantly found in urban areas and constitute a relatively small percentage of the overall building stock in Pakistan. Due to their limited prevalence compared to other construction types, RC structures are not separately categorized in the building type distribution. Instead, they are included within the broader classification of brick masonry structures in Table 3.

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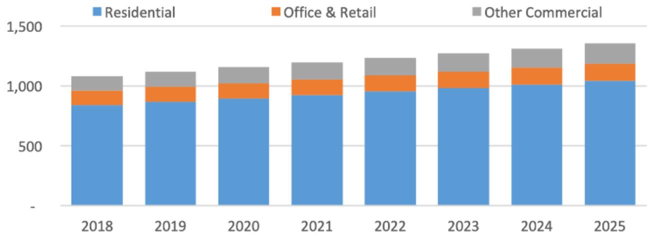
31 Tariq Maqsood and J. Schwarz, "Analysis of Building Damage during the 8 October 2005 Earthquake in Pakistan" (2008), Seismological Research Letters 79(2):163-177

According to the International Finance Corporation, the Pakistani building market consists of 79% residential buildings and 21% commercial buildings as highlighted in Figure 6. In terms of area, residential spaces encompass around 1,000 million square meters, while office, retail, and other commercial spaces occupy over 300 million square meters in Pakistan. The total real estate market size is projected to exceed $290 billion by 2025, with the commercial market accounting for $54 million and the residential market exceeding $234 million. However, the green building market's share remains relatively small, at less than $10 billion, and its growth is expected to be gradual in the coming years.



Market through 2025	Total market	Green market
Commercial	USD 53.45 B	USD 1.55 B
Residential	USD 232.6 B	USD 9.84 B
Total Residential Units	3,100,000	140,000

Figure 6: Composition of Building Market Space in in Pakistan by Commercial, residential and office space. (Source: International Finance Cooperation IFC)

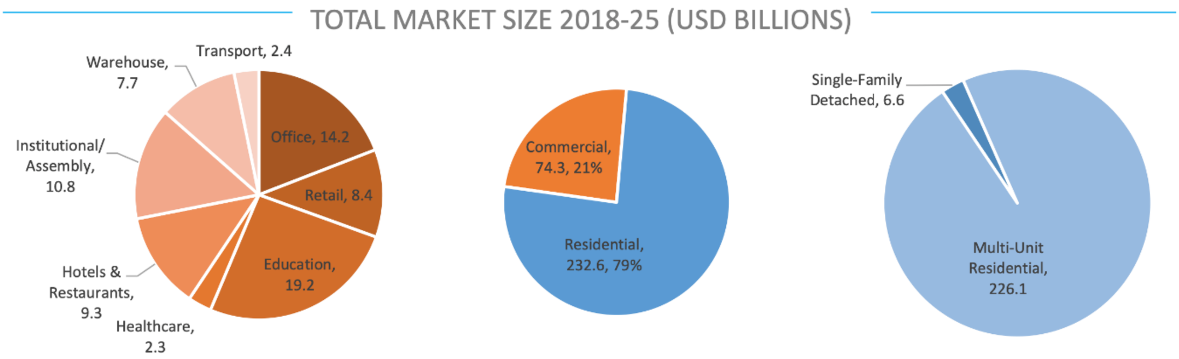
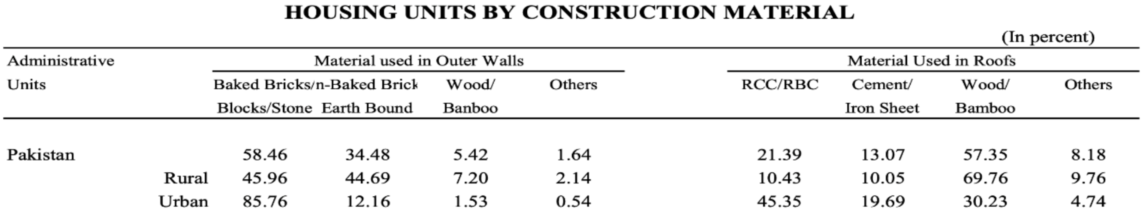


Figure 7: Total Market Size of Buildings in Pakistan (Source: International Finance Cooperation IFC)

Table 5 presents the description of the main load-bearing elements in different building types in Pakistan. Primary elements are the vertical load-bearing members. Secondary elements are the horizontal load-bearing members, while tertiary elements are the floors and roofs.

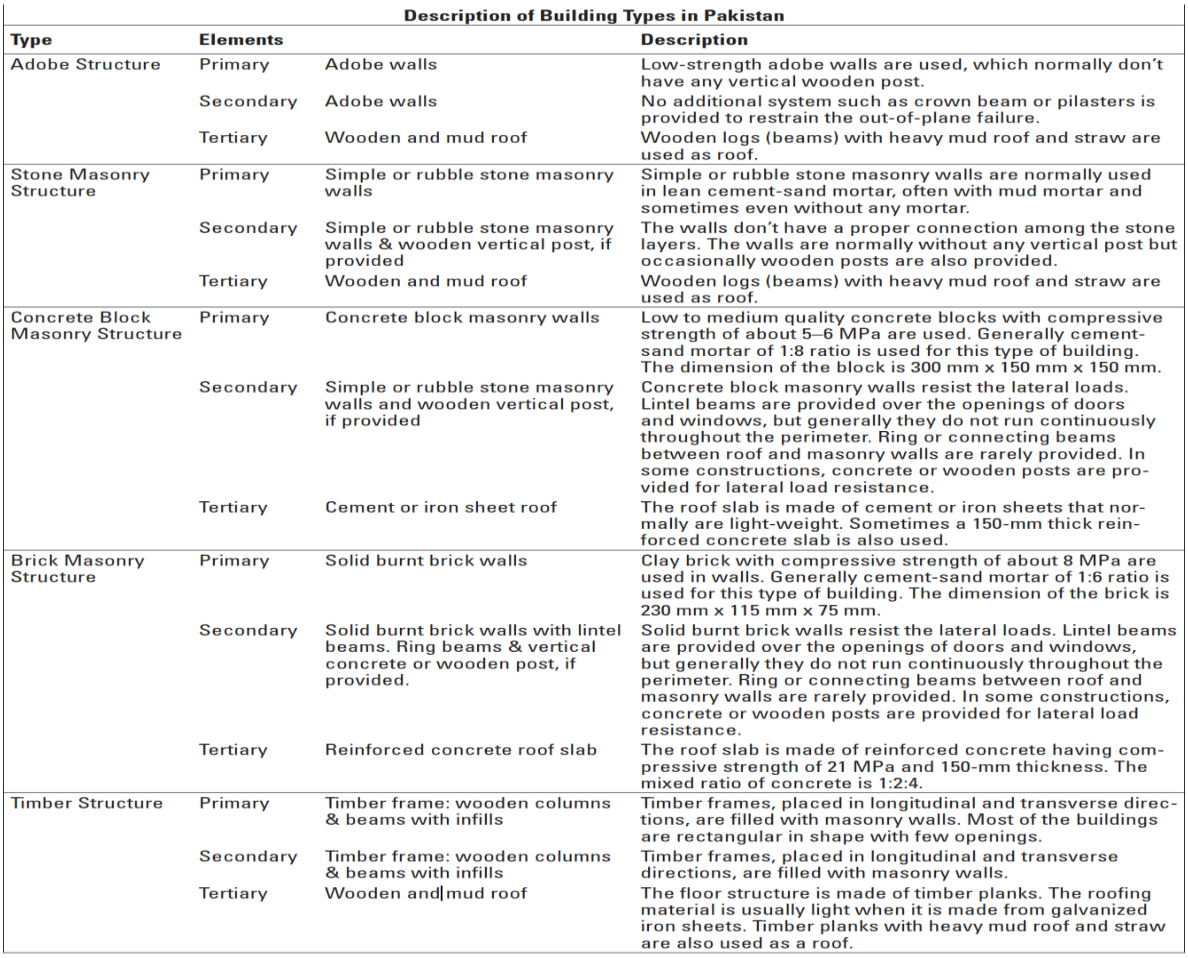


HOUSING UNITS BY CONSTRUCTION MATERIAL

(In percent)

Administrative Units		Material used in Outer Walls				Material Used in Roofs			
		Baked Bricks/ Blocks/Stone	n-Baked Brick Earth Bound	Wood/ Banboo	Others	RCC/RBC	Cement/ Iron Sheet	Wood/ Bamboo	Others
Pakistan		58.46	34.48	5.42	1.64	21.39	13.07	57.35	8.18
	Rural	45.96	44.69	7.20	2.14	10.43	10.05	69.76	9.76
	Urban	85.76	12.16	1.53	0.54	45.35	19.69	30.23	4.74

Table 4: Housing Units in Pakistan by Construction Material (Source: Pakistan Bureau of Statistics)



Description of Building Types in Pakistan

Type	Elements		Description
Adobe Structure	Primary	Adobe walls	Low-strength adobe walls are used, which normally don't have any vertical wooden post.
	Secondary	Adobe walls	No additional system such as crown beam or pilasters is provided to restrain the out-of-plane failure.
	Tertiary	Wooden and mud roof	Wooden logs (beams) with heavy mud roof and straw are used as roof.
Stone Masonry Structure	Primary	Simple or rubble stone masonry walls	Simple or rubble stone masonry walls are normally used in lean cement-sand mortar, often with mud mortar and sometimes even without any mortar.
	Secondary	Simple or rubble stone masonry walls & wooden vertical post, if provided	The walls don't have a proper connection among the stone layers. The walls are normally without any vertical post but occasionally wooden posts are also provided.
	Tertiary	Wooden and mud roof	Wooden logs (beams) with heavy mud roof and straw are used as roof.
Concrete Block Masonry Structure	Primary	Concrete block masonry walls	Low to medium quality concrete blocks with compressive strength of about 5–6 MPa are used. Generally cement-sand mortar of 1:8 ratio is used for this type of building. The dimension of the block is 300 mm x 150 mm x 150 mm.
	Secondary	Simple or rubble stone masonry walls and wooden vertical post, if provided	Concrete block masonry walls resist the lateral loads. Lintel beams are provided over the openings of doors and windows, but generally they do not run continuously throughout the perimeter. Ring or connecting beams between roof and masonry walls are rarely provided. In some constructions, concrete or wooden posts are provided for lateral load resistance.
	Tertiary	Cement or iron sheet roof	The roof slab is made of cement or iron sheets that normally are light-weight. Sometimes a 150-mm thick reinforced concrete slab is also used.
Brick Masonry Structure	Primary	Solid burnt brick walls	Clay brick with compressive strength of about 8 MPa are used in walls. Generally cement-sand mortar of 1:6 ratio is used for this type of building. The dimension of the brick is 230 mm x 115 mm x 75 mm.
	Secondary	Solid burnt brick walls with lintel beams. Ring beams & vertical concrete or wooden post, if provided.	Solid burnt brick walls resist the lateral loads. Lintel beams are provided over the openings of doors and windows, but generally they do not run continuously throughout the perimeter. Ring or connecting beams between roof and masonry walls are rarely provided. In some constructions, concrete or wooden posts are provided for lateral load resistance.
	Tertiary	Reinforced concrete roof slab	The roof slab is made of reinforced concrete having compressive strength of 21 MPa and 150-mm thickness. The mixed ratio of concrete is 1:2:4.
Timber Structure	Primary	Timber frame: wooden columns & beams with infills	Timber frames, placed in longitudinal and transverse directions, are filled with masonry walls. Most of the buildings are rectangular in shape with few openings.
	Secondary	Timber frame: wooden columns & beams with infills	Timber frames, placed in longitudinal and transverse directions, are filled with masonry walls.
	Tertiary	Wooden and mud roof	The floor structure is made of timber planks. The roofing material is usually light when it is made from galvanized iron sheets. Timber planks with heavy mud roof and straw are also used as a roof.

Table 5: Description of the main load-bearing elements in different building types in Pakistan. [32]

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32 Tariq Maqsood and J. Schwarz, "Analysis of Building Damage during the 8 October 2005 Earthquake in Pakistan" (2008), Seismological Research Letters 79(2):163-177

CURRENT PRACTICES IN CONSTRUCTING BUILDINGS IN PAKISTAN.

As emphasized in the previous section, the adoption and enforcement of Building Energy Codes in Pakistan remain non-mandatory and face significant challenges in garnering support from local governments. To date, none of the local councils have officially embraced the adoption of these Building Energy Codes in true sense, which demonstrates the presence of legal, regulatory, technical, institutional, and financial obstacles in construction practices in the country.

In urban centers, there exists a degree of regulatory compliance and enforcement that leads to a notably higher quality of construction compared to other parts of the country. However, the construction practices in rural areas raise substantial concerns. The construction in these areas is often unplanned, illegal, unsafe, and unhygienic.

One of the critical concerns related to such construction practices in Pakistan is their vulnerability to natural disasters, particularly earthquakes and floods. Many buildings in rural areas lack the structural integrity necessary to withstand seismic activity and other natural calamities. This vulnerability leads to tragic consequences, including the loss of human lives, livestock, and valuable resources.

PIONEERING GREEN BUILDING LEED CERTIFICATIONS IN PAKISTAN

The total area covered by Green Buildings as referred as LEED-certified buildings in Pakistan currently stands at an impressive 13.25 million square feet[33]. This encouraging trend in LEED certification becomes evident when comparing the present scenario to that of 2014 when there were merely 10 LEED-certified buildings.[34] Currently, Pakistan has over 60 such certified structures, highlighting a significant upsurge in the adoption of sustainable and environmentally responsible building practices across the country.

The Leadership in Energy and Environmental Design (LEED) is a certification program primarily designed for new commercial building projects, utilizing a point-based system to assess and rate the environmental sustainability of a structure.

The LEED rating is determined by the number of points a building accumulates, reflecting its level of "greenness" in terms of energy efficiency, water conservation, air quality, and the use of environmentally friendly building materials, both during construction and throughout its operational life. LEED-certified buildings are categorized based on their credit points: 40-49 credits for LEED-

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33 Green Building Information Gateway (GBIW), https://www.gbig.org/places/809

34 Green Buildings Market Intelligence Pakistan Country Profile, https://edgebuildings.com/wp-content/uploads/2022/04/Pakistan-Green-Building-Market-Intelligence-EXPORT.pdf certified, 50-59 for LEED Silver, 60-79 for LEED Gold, and 80 or more credits earn the prestigious LEED Platinum designation[35]. Projects seeking LEED certification earn points in various categories, including energy efficiency and indoor air quality.

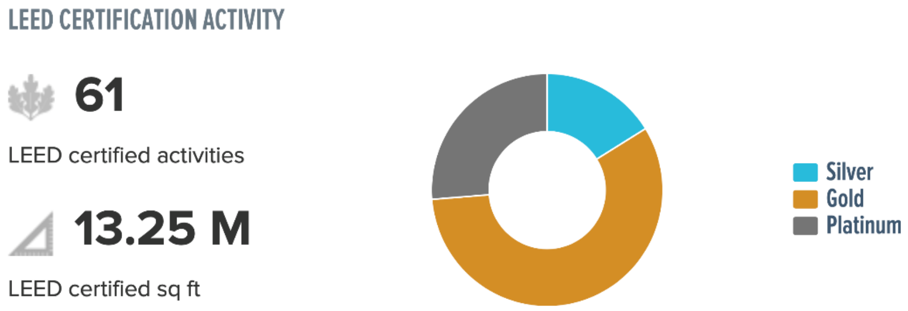

Figure 8: LEED Certification Activity Snapshot in Pakistan

According to the Green Building Information Gateway (GBIG), Pakistan boasts over 60 LEED-certified green buildings recognized by the US Green Building Council, with an additional 2 buildings receiving the Achiever Award. Notably, more than a quarter (26%) of these certified buildings have achieved the highest Platinum rating, followed by Gold-rated buildings comprising 57%, and Silver-rated structures making up 16% of the total. This indicates a significant presence of green building projects in Pakistan that prioritize sustainability and environmental performance across various categories.

5. BUILDING ENVELOPE AND BUILDING PERFORMANCE

A building envelope serves as a protective shield that separates the interior of a building from the external environment, including its walls, roofs, fenestration (doors and windows), and insulation. Its primary function is to ensure the comfort and well-being of occupants by regulating the transfer of heat, air, and moisture between the inside and outside of the building.

What sets energy-efficient building envelopes apart is their ability to do more than just create a barrier; they actively respond to the surrounding environment, leading to significant reductions in energy consumption. These envelopes are designed with advanced features like high-quality thermal insulation, effective vapor barriers, superior seals for windows and doors, and mechanisms to control airflow, thereby minimizing the infiltration of outdoor air. These elements work in unison to maintain a comfortable and energy-efficient indoor environment.

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[35] *The British Council Lahore's Green & Leed Certified Library Building, https://opamss.org.sv/wp-content/uploads/2020/03/BRITISH-COUNCIL-LAHORE-GREEN-AND-LEED-CERTIFIES-LIBRARY-BUILDING.pdf*

Climate type	Design strategies for energy-efficient facades
Heating-dominated	The building envelope receives solar heating. Walls can be used as thermal masses for thermal storage. Better insulation to minimize thermal losses. Natural daylight is used. Facades have increased glazing areas to allow for natural light; light shelves that redirect light into interior spaces are used.
Cooling-dominated	Appropriate shading techniques can be employed to protect from direct solar gain. Use insulation to reduce solar heat gain. Design to facilitate natural ventilation (wing walls). Natural daylight should be used in such a way that solar heat gain is minimized.
Mixed climates	Use shading devices to protect facade from direct solar radiation during warm days. Use passive solar design for heating during cold seasons. Use natural daylight and with increased glazed areas of walls with shading devices.

Table 6: Climate-specific design of energy efficient envelopes.[36]

A building envelope acts as a barrier that separates the interior from the external world. It's similar to the shell of a building, offering defense against the elements outside.

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[36] Getu Hailu,Energy systems in buildings, Energy Services Fundamentals and Financing, 2021

During the winter, the building envelope plays a crucial role in preventing the escape of indoor heat to the cold outdoors. Conversely, in the scorching summer months, it keeps the cool air inside while fending off the sweltering heat.[37]

In a country like Pakistan, where the demand for cooling is high across much of the nation, the design of the building envelope must be carefully orchestrated to cater to these cooling requirements. This involves considering factors that enhance energy efficiency and minimize the need for excessive cooling.

Building envelope systems are typically categorized as either "tight" or "loose." A tight building envelope minimizes air leaks, achieved through meticulous insulation, sealants, and energy-efficient windows. Why strive for such a tight seal? It grants occupants greater control over the indoor environment, ensuring comfort and energy efficiency.[38]

In hot climates like Pakistan's, the design of an energy-efficient building must focus on preventing air and moisture infiltration and reducing heat gains. Achieving this involves creating a tight building envelope, as well as thoughtful considerations such as building orientation, size, shape, and the selection of appropriate windows and doors. These elements together contribute to a building's ability to combat the challenges posed by high temperatures and ensure a comfortable indoor climate.

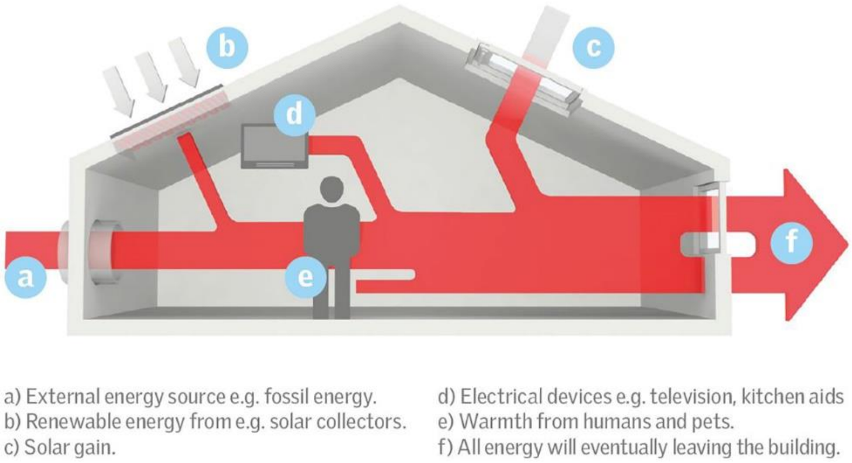

Figure 9: Illustration of the flow of energy through a building. The amount of energy supplied from an external source is less than the total heat loss of the building, because occupants, electrical devices and especially windows add "free" energy.[39]

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37 Energy-Efficient Building in a Hot Climate, https://www.foxblocks.com/a-guide-to-designing-an-energy-efficient-building-in-a-hot-climate

38 What Is a Building Envelope and Why Is It Beneficial? https://www.bigrentz.com/blog/building-envelope

39 Energy use in buildings, Velux (https://www.velux.com/what-we-do/research-and-knowledge/deic-basic-book/energy/energy-use-in-buildings

6. GREEN BUILDING TRANSFORMATION: TECHNOLOGY OPTIONS AND PATHWAYS

In Pakistan, traditional construction practices often avoid the incorporation of efficient and green technologies. Upfront cost is a major consideration when it comes to the selection and integration of sustainable and efficient technologies in Pakistan. For most consumers, especially in a developing economy like Pakistan, the upfront expenses associated with adopting these technologies can be a significant barrier. Many households and businesses operate on tight budgets, making it challenging to justify the initial investment in green technologies, even though they offer long-term savings and environmental benefits.

Green building technologies cover across both the construction and operational phases of green buildings and offers a comprehensive approach to sustainable development. Below are some technology options for Pakistani Green Building Market often used in Green Buildings worldwide.

Sustainable Construction Materials: Green buildings prioritize the use of sustainable construction materials that offer better thermal insulation and reduce heat absorption. Examples include recycled materials, thermal mass construction, and reflective surfaces.

Green Insulation: Green buildings incorporate insulation materials that provide high thermal resistance, helping to maintain cooler indoor temperatures and reduce the need for excessive air conditioning.

Variable Drives: Variable drives and efficient Heating, Ventilation and Air Condition (HVAC) systems enable precise control of air conditioning and ventilation, optimizing energy use.

Efficient Windows: Energy-efficient windows with low solar heat gain coefficients allow natural light while blocking excess heat, reducing the reliance on artificial lighting and cooling systems.

Cool Roofs: Cool roofs are designed to reflect sunlight and absorb less heat and these are highly effective in hot climates. Cool roofs keep buildings cooler, thus reducing the overall cooling load.

Low Emitting Materials: Green buildings prioritize low emitting materials which release fewer volatile organic compounds (VOCs). This not only improves indoor air quality but also reduces the heat generated by off-gassing materials.

Efficient Heating, Ventilation, Air Conditioning (HVAC): High-efficiency HVAC systems with advanced controls ensure precise temperature control, reduce energy consumption and enhance indoor comfort.

Solar Panels (Passive and Active): Solar panels are a key feature in green buildings for both passive and active design elements, such as optimum shading and orientation, maximize natural cooling, while active solar panels harness the solar radiation for onsite energy generation.

Automation, Controls, and Building Monitoring: Advanced automation and control systems help optimize energy use by adjusting lighting, HVAC, and other systems based on occupancy and outdoor conditions.

Efficient Lighting: Efficient lighting solutions, including LED technology and occupancy sensors, reduce electricity consumption.

Water Conservation: Water-efficient fixtures and systems ensure water resources conservation and efficiency. Green buildings incorporate low-flow faucets and rainwater harvesting systems to minimize water consumption.

COST BENEFIT OF ANALYSIS OF GREEN BUILDINGS TECHNOLOGY MEASURES

The majority of research on the advantages of green buildings primarily stems from studies concentrated on developed economies. In contrast, there exists a limited amount of well-structured data regarding green buildings and their economic merits within developing nations, including Pakistan. Green buildings are characterized by their superior efficiency compared to conventional buildings, and have the potential to decrease operational expenses, boost income streams, and mitigate the risks associated with both the physical and transitional aspects of climate change. This section investigates into multiple case studies that underscore the business rationale and economic advantages of adopting green building technologies, particularly the building insulation, solar PV integration and efficient lighting.

BUILDING INSULATION IMPACT ON ENERGY AND COST SAVINGS IN HOT CLIMATES: SAUDI CASE STUDY

Building insulation plays a pivotal role in enhancing the energy efficiency and overall sustainability of structures. In this comprehensive analysis, we evaluate four distinct insulation strategies, ranging from having no insulation to insulating either the roof or walls individually, and a combination of both. The primary focus is on quantifying the benefits of building insulation, particularly in terms of cost and energy savings.

Since there is a limited information and reliable data on case studies on impact of building insulation on energy and cost savings in Pakistan, we have examined a case study in Saudi Arabia, which shares similar climate characteristics with Pakistan. It could provide valuable insights into the impact of building insulation on energy and cost savings in hot climatic conditions. Such case studies can help inform decisions related to insulation strategies for residential buildings in Pakistan and other regions with comparable climates.

Alternative insulation strategies	No insulation (BC)	Insulated roof only	Insulated walls only	Insulated roof and walls
Optimum thickness (cm)	0	8	4	6
Energy consumption kWh/sq.m/y	193.07	156.11	178.57	135.59
Percentage of conserved energy (%)	0	19.14	7.51	29.77
Cost of consumed energy in 30 years	68,926.0	5,5731.3	63,749.5	48,405.6
Cost of conserved energy/year	0	439.8	172.6	684.0
Cost of optimum thickness $/sq.m	0	1642.7	2094.4	4373.7
Cost saving (%)	0	16.8	4.5	23.4
Payback period (years)	0	3.73	12.14	6.39
CO2 emission (kg/year)	12,742.1	10,393.7	11,563.7	8,868.4

Table 7: Cost Benefit Analysis of Building Insulation on energy and cost savings, and corresponding payback period.[40]

This table provides a comparison of different insulation strategies for a building with insulted roof only, insulated walls only and insulations of roof and wall, evaluating them based on various factors such as energy consumption, cost, energy conservation, CO2 emissions, and payback period.

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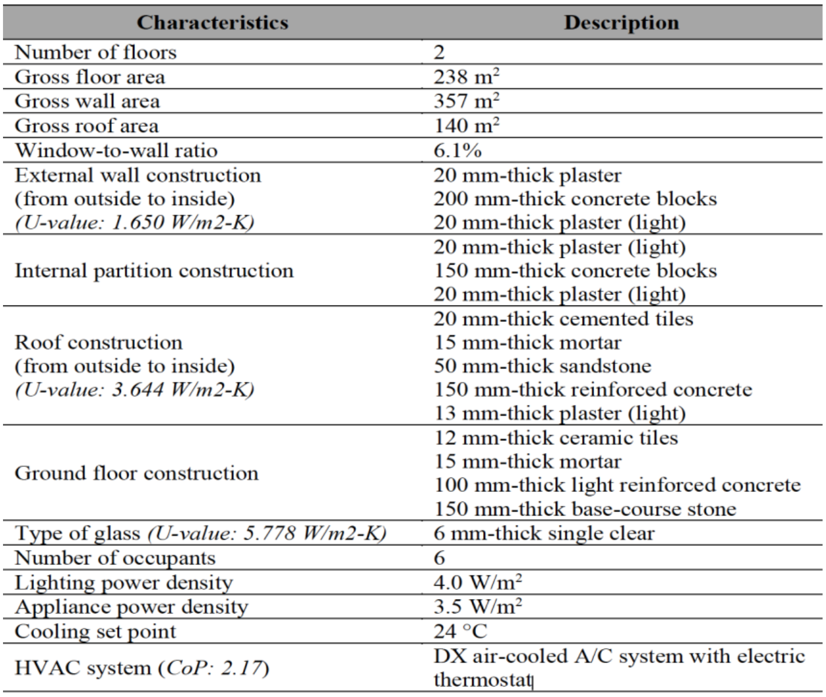
40 Nedhal Al-Tamimi, "Cost Benefit Analysis of Applying Thermal Insulation Alternatives to Saudi Residential Buildings", Journal of Engineering Sciences Assiut University (2021) https://jesaun.journals.ekb.eg/article_147213.html

The building under consideration is a residential building; a detached family house. The residential building consists of two storeys and has a total built floor area of 238 square meters. Additionally, it is situated on a land area measuring 500 square meters.

ELECTRICITY SAVINGS DUE TO IMPROVED BUILDING INSULATION

5. **No Insulation (BC)** Without any insulation, energy consumption is the highest at 193.07 kWh/sq.m/year. This energy inefficiency translates into higher utility bills and increased environmental impact, with CO2 emissions of 12,742.1 kg/year.
6. **Insulated Roof Only** By insulating just the roof with an optimum thickness of 8 cm, energy consumption drops to 156.11 kWh/sq.m/year, resulting in a 19.14% reduction in energy use. This reduction significantly cuts both energy bills and CO2 emissions (10,393.7 kg/year).
7. **Insulated Walls Only** Insulating only the walls (4 cm thickness) reduces energy consumption to 178.57 kWh/sq.m/year, a 7.51% reduction, with corresponding cost and CO2 emission savings.
8. **Insulated Roof and Walls** The most effective strategy is insulating both the roof and walls (6 cm thickness), resulting in the lowest energy consumption of 135.59 kWh/sq.m/year, a remarkable 29.77% reduction compared to no insulation. The CO2 emissions are also the lowest at 8,868.4 kg/year.



Characteristics	Description
Number of floors	2
Gross floor area	238 m^2
Gross wall area	357 m^2
Gross roof area	140 m^2
Window-to-wall ratio	6.1%
External wall construction (from outside to inside) *(U-value: 1.650 W/m2-K)*	20 mm-thick plaster 200 mm-thick concrete blocks 20 mm-thick plaster (light)
Internal partition construction	20 mm-thick plaster (light) 150 mm-thick concrete blocks 20 mm-thick plaster (light)
Roof construction (from outside to inside) *(U-value: 3.644 W/m2-K)*	20 mm-thick cemented tiles 15 mm-thick mortar 50 mm-thick sandstone 150 mm-thick reinforced concrete 13 mm-thick plaster (light)
Ground floor construction	12 mm-thick ceramic tiles 15 mm-thick mortar 100 mm-thick light reinforced concrete 150 mm-thick base-course stone
Type of glass *(U-value: 5.778 W/m2-K)*	6 mm-thick single clear
Number of occupants	6
Lighting power density	4.0 W/m^2
Appliance power density	3.5 W/m^2
Cooling set point	24 °C
HVAC system (*CoP: 2.17*)	DX air-cooled A/C system with electric thermostat

Table 8: Building Characteristics of residential detached house under analysis for examining the impact of building insulation.

COST SAVINGS AND PAYBACK PERIOD

4. **Insulated Roof Only** Insulating the roof reduces the cost of consumed energy to $55,731.3 over 30 years, saving $13,194.7. This represents a cost saving of 16.8%, with a relatively short payback period of 3.73 years.
5. **Insulated Walls Only** While insulating only the walls results in cost savings of $7,176.5 over 30 years, the payback period is longer at 12.14 years. The cost saving percentage is 4.5%.
6. **Insulated Roof and Walls** This strategy yields the highest cost savings, with a total of $48,405.6 saved over 30 years, representing a substantial 23.4% cost reduction. The payback period is also relatively short at 6.39 years.

This analysis demonstrated that insulating both the roof and walls is the most effective strategy in terms of energy conservation, with a 29.77% reduction in energy consumption compared to no insulation. This strategy also leads to the lowest CO2 emissions and the shortest payback period, indicating its environmental and economic benefits. Insulating the roof only is the second-best option, with significant energy savings and a reasonable payback period. Insulating walls only provides moderate energy savings and has the longest payback period. While no insultation results in the highest energy consumption, costs, and CO2 emissions.

COST-BENEFIT ANALYSIS FOR SOLAR PV INSTALLATION ON A COMMERCIAL BUILDING IN PAKISTAN

Solar panels are a key feature in green buildings for both passive and active design elements, such as optimum shading and orientation, maximize natural cooling, while active solar panels harness the solar radiation for onsite energy generation. It is important to underline the financial aspects of installing a solar photovoltaic (PV) system.

Solar PV integration is a key feature of green buildings and aligns perfectly well with global sustainability goals, reducing energy consumption and costs, and contributing to environmental conservation. Many green building certifications such as LEED often requires the inclusion of renewable energy sources like solar PV. As Pakistan continues to address its energy demand and environmental challenges, the adoption of solar PV systems in construction projects holds immense potential to create a more sustainable and resilient built environment while offering economic benefits to building owners and occupants.

The cost benefit analysis of integration of Solar PV is straight forward in Pakistan. We will underline the financial merits of implementing a solar photovoltaic (PV) system in a commercial building located in Pakistan as an integrated feature of green building. Our proposal suggests the installation of a 50 kW as grid connected solar PV system will require an initial investment of US$50,000. We assume the cost of solar system, including installation at US$1,000 per kW. Considering Pakistan's solar PV capacity factor, averaging around 25%, a 50-kW solar PV system is projected to generate 107,310 kWh of electricity annually.

The first step in our cost-benefit analysis is to determine the annual savings realized through the solar PV system. Given that the system generates 107,310 kWh of electricity annually at 25% capacity factor, the annual cost savings can be calculated as follows:

- Annual Savings = Solar PV Electricity Production × Cost of Electricity from Grid
- Annual Savings = 107,310 kWh × $0.15/kWh (PKR 45/kWh) = $16,096.50 (or 4,819,950 PKR at US$-PKR exchange rate of 300)

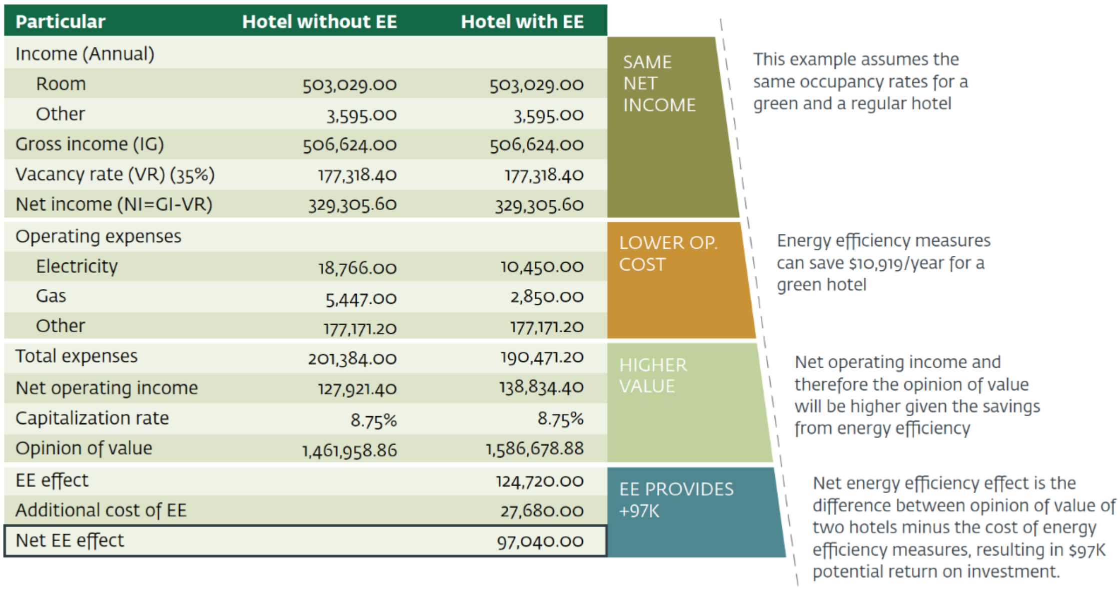
Hence, the solar PV system is expected to deliver annual savings of approximately US$ 16,096.50 or PKR 4,819,950 by reducing the need for grid electricity assuming the average cost of US$ 0.15 per kWh of grid electricity.

The payback period is a crucial metric that indicates when the initial investment is recovered through the annual savings. In this scenario, the payback period for installing a 50-kW solar PV system is calculated as follows:

- Payback Period = Initial Investment / Annual Savings
- **Payback Period** = $50,000 / $16,096.50 ≈ **3.10 years**

Generally, the expected lifespan of a solar PV system is 25 years, the total savings could accumulate to several hundred thousand dollars over 25 years duration, underscoring the long-term financial advantages of this solar PV system. Hence, this demonstrates that substantial economic benefits of incorporating solar PV technology into commercial buildings in Pakistan as an integrated feature of a green building. Not only does it contribute to sustainability efforts, but it also yields impressive cost savings, making it an attractive and environmentally responsible investment option for commercial property owners.

Likewise, widespread use of LED lighting will have a substantial impact on energy savings, as they offer substantial savings in comparison to incandescent lighting. Hence, installing LEDs is one of the most cost-effective options for reducing energy intensity in buildings with shortest payback period within the range of 1-2 years.



Particular	Hotel without EE	Hotel with EE
Income (Annual)		
Room	503,029.00	503,029.00
Other	3,595.00	3,595.00
Gross income (IG)	506,624.00	506,624.00
Vacancy rate (VR) (35%)	177,318.40	177,318.40
Net income (NI=GI-VR)	329,305.60	329,305.60
Operating expenses		
Electricity	18,766.00	10,450.00
Gas	5,447.00	2,850.00
Other	177,171.20	177,171.20
Total expenses	201,384.00	190,471.20
Net operating income	127,921.40	138,834.40
Capitalization rate	8.75%	8.75%
Opinion of value	1,461,958.86	1,586,678.88
EE effect		124,720.00
Additional cost of EE		27,680.00
Net EE effect		97,040.00

SAME NET INCOME

This example assumes the same occupancy rates for a green and a regular hotel

LOWER OP. COST

Energy efficiency measures can save $10,919/year for a green hotel

HIGHER VALUE

Net operating income and therefore the opinion of value will be higher given the savings from energy efficiency

EE PROVIDES +97K

Net energy efficiency effect is the difference between opinion of value of two hotels minus the cost of energy efficiency measures, resulting in $97K potential return on investment.

Figure 10: Green hotel value example (India) Effects of energy efficiency (EE) on the value of a hotel (USD)

Figure 10 above demonstrates a case of hotel value chain in India with lower operating costs due to energy savings can help increase the valuation of green buildings. It demonstrates as to how energy efficiency could increase the valuation of a green hotel by 6.6 percent.

CULTIVATING A GREEN-TECH WORKFORCE FOR GREEN BUILDING IN PAKISTAN

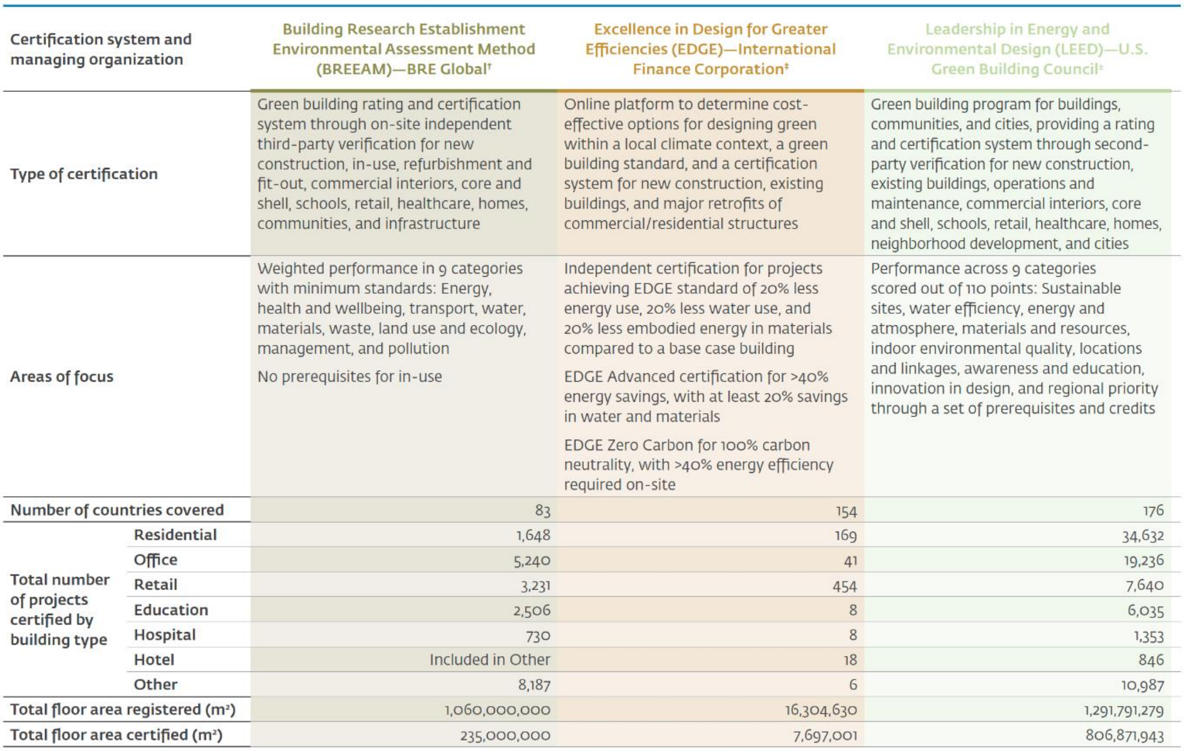
It is essential to emphasize the critical need for capacity development and skills enhancement in Pakistan's construction industry. To effectively incorporate the green building technologies mentioned above, there is a significant requirement for a proficient cadre of technical human resources. This would require providing a continuous, rigorous and adequate training and education to architects, engineers, contractors and other construction professionals who play pivotal roles in the design, development, and implementation of these technologies.

Building a skilled workforce capable of deploying the potential of sustainable construction materials, energy-efficient systems, and eco-friendly practices would be critical in the successful adoption of green building technologies. These measures would not only enhance the Pakistan’s technological capabilities but also develops a culture of innovation and excellence in the construction sector leading to contributing to a greener and sustainable built environment.

7. GREEN BUILDING CERTIFICATIONS IN PAKISTAN: FINDING THE RIGHT FIT

Green building certification programs have played an important role in expanding the market for sustainable and green construction practices. They accomplish this by evaluating and benchmarking building achievements across various dimensions of sustainability, including energy efficiency, design, construction, and operational performance. These programs offer an essential layer of validation through third-party verification and certification.

Globally, notable certification programs like Leadership in Energy and Environmental Design (LEED), Building Research Establishment Environut Assessment Method (BREEAM), and Excellence in Design for Greater Efficiencies (EDGE) have gained widespread adoption in the building and construction industry. Besides, many countries have developed their own building certification systems gaining inspiration from BREEAM and LEED while tailoring them to address local priorities and market conditions. Over 85 countries have adopted national or local building certification programs, which can be voluntary or mandatory for all or part of the buildings sector. Figure 11 provides a comparative overview of three prominent international certification programs: LEED, BREEAM, and EDGE. It illustrates the diversity in their approaches, areas of focus, and the extent of their adoption across different systems.



Certification system and managing organization		Building Research Establishment Environmental Assessment Method (BREEAM)—BRE Global[†]	Excellence in Design for Greater Efficiencies (EDGE)—International Finance Corporation[‡]	Leadership in Energy and Environmental Design (LEED)—U.S. Green Building Council[§]
Type of certification		Green building rating and certification system through on-site independent third-party verification for new construction, in-use, refurbishment and fit-out, commercial interiors, core and shell, schools, retail, healthcare, homes, communities, and infrastructure	Online platform to determine cost-effective options for designing green within a local climate context, a green building standard, and a certification system for new construction, existing buildings, and major retrofits of commercial/residential structures	Green building program for buildings, communities, and cities, providing a rating and certification system through second-party verification for new construction, existing buildings, operations and maintenance, commercial interiors, core and shell, schools, retail, healthcare, homes, neighborhood development, and cities
Areas of focus		Weighted performance in 9 categories with minimum standards: Energy, health and wellbeing, transport, water, materials, waste, land use and ecology, management, and pollution No prerequisites for in-use	Independent certification for projects achieving EDGE standard of 20% less energy use, 20% less water use, and 20% less embodied energy in materials compared to a base case building EDGE Advanced certification for >40% energy savings, with at least 20% savings in water and materials EDGE Zero Carbon for 100% carbon neutrality, with >40% energy efficiency required on-site	Performance across 9 categories scored out of 110 points: Sustainable sites, water efficiency, energy and atmosphere, materials and resources, indoor environmental quality, locations and linkages, awareness and education, innovation in design, and regional priority through a set of prerequisites and credits
Number of countries covered		83	154	176
Total number of projects certified by building type	**Residential**	1,648	169	34,632
	Office	5,240	41	19,236
	Retail	3,231	454	7,640
	Education	2,506	8	6,035
	Hospital	730	8	1,353
	Hotel	Included in Other	18	846
	Other	8,187	6	10,987
Total floor area registered (m^2)		1,060,000,000	16,304,630	1,291,791,279
Total floor area certified (m^2)		235,000,000	7,697,001	806,871,943

Figure 11: Selected widely used international green building certification programs. (Source: International Finance Cooperation – IFC)

In case of Pakistan, the Pakistan Green Building Council (PGBC) has introduced its own rating system known as SEED (Sustainability in Energy and Environmental Development), which was first published in October 2016. SEED is a localized and tailored version, inspired by the LEED certification system for Pakistan and is designed to promote sustainable and socially responsible practices in the planning, construction, maintenance, and operation of buildings and communities. SEED offers four tiers of certification based on the points earned by a building: silver, gold, platinum, and titanium, with titanium being the highest achievable certification level, indicating the highest level of sustainability and environmental performance. PGBC has certified a couple of iconic buildings in Pakistan with SEED certification, which include the Parliament House and President House in Islamabad.

CHALLENGES IN GREEN BUILDING CERTIFICATION FOR PAKISTAN

The limited adoption of PGBC's SEED certification system can be attributed to a lack of a coherent and integrated approach among various policy and regulatory stakeholders. One significant reason for this limited adoption is that PGBC, as a non-state entity, has not gained the necessary support and recognition from major industry players and regulators. It's worth noting that successful certification systems, such as the Indian Green Building Council operate as non-governmental and not-for-profit institution.

Another challenge in the building industry is the proliferation of various institutions attempting to develop their own building codes and guidelines. This has resulted in multiple codes being established but with little to no enforcement. To address this issue, it is essential to establish a framework where key stakeholders share responsibilities and collaborate effectively.

A robust institutional arrangement is required, where policy and regulatory organizations like NEECA, PEC, and relevant ministries work closely with implementing agencies to develop a unified building certification system. The responsibility for enforcing these building codes rests with implementing agencies such as municipal corporations, metropolis development authorities, provincial building control departments, and real estate developers.

The Pakistan Green Building Council (PGBC) could play a crucial role by serving as an accredited body for certifying green buildings and acting as a bridge between policy and regulatory institutions and implementing agencies. Additionally, there is a need for capacity building at both the policy and regulatory levels, as well as within implementing agencies to ensure the effective implementation of green building practices and codes.

BRIDGING THE GAP BETWEEN BUILDING REGULATIONS AND IMPLEMENTATION IN PAKISTAN

In Pakistan, the challenge of promoting building energy efficiency and green construction practices lies not in the development of regulations but in their effective enforcement. Despite various initiatives to establish energy-efficient building codes and green building frameworks, these efforts have often failed to translate into on-ground implementation.

Key institutions like the National Energy Efficiency and Conservation Authority, Pakistan Engineering Council and relevant Ministries of Energy and Climate Change have made strides in creating these codes, but they remain largely unimplemented at the local level, where construction projects are carried out. The top-down approach taken by these policy interventions has overlooked the practical challenges and complexities faced by local developer.

To address this issue, a more pragmatic approach is needed, focusing on direct collaboration with local authorities in major cities like Islamabad, Lahore, or Karachi. Initiating pilot programs in collaboration with the Capital Development Authority in Islamabad, for example, can serve as a valuable testing ground for green building codes. Successes and lessons learned from these pilots can then be extended to other urban areas in Pakistan, ensuring that energy efficiency and green construction practices are not just words on paper but integral components of the country's building sector.

FROM GENERIC TO SPECIFIC: ENERGY EFFICIENT AND GREEN BUILDING CODE FOR PAKISTAN

One of the limitations in developing green building and energy-efficient codes is their one-size-fits-all approach. These regulations often attempt to apply the same standards to all building types, whether they are schools, commercial offices, high-rises, residential apartments, or single-family homes. This lack of differentiation can hinder the effectiveness of these codes.

Looking to the Indian Green Building Construction Industry as a model, we can see how they have evolved by developing distinct ratings for different building types. They have created separate rating systems for green homes and low-income housing to cater to specific needs. Moreover, they have gone even further by developing separate rating standards for various commercial building types, including new buildings, existing buildings, healthcare facilities, data centers, schools, and offices. Pakistan can benefit from this approach by creating case-specific green building codes for each building type.

To achieve this, a bottom-up approach to developing green building codes is essential. Urgent action is needed to not only adopt policies requiring existing and new buildings to meet green building criteria but also to establish and enforce relevant laws and regulations for their effective implementation. These laws should offer incentives to commercial builders, such as tax benefits and expedited permits, while penalties should be imposed where necessary to ensure compliance with green building standards. This comprehensive approach is crucial to drive the adoption of green building practices in Pakistan.

Figure 12: Green Building Certification of Parliament House of Pakistan. Source Pakistan Green Building Council.

THE NEED FOR BUILDING ENERGY USE BENCHMARKS IN PAKISTAN

One crucial step in promoting energy efficiency in buildings is establishing baseline energy use benchmarks for different building types. Unfortunately, Pakistan has yet to conduct a comprehensive benchmark analysis for energy use in various types of buildings.

Benchmarking when applied to building energy use, serves as a valuable tool to measure a single building's energy performance over time, relative to similar buildings, or to modeled simulations of a reference building built to specific standards like energy codes. This practice offers benefits to regulators, building owners, facility operators, managers, and designers.

Benchmarking facilitates energy accounting, allowing facilities to compare their energy use with similar ones to identify opportunities for improvement and quantify or verify energy savings. In the commercial building sector, energy performance benchmarking has become a standard practice, especially as rising energy costs and environmental concerns emphasize the importance of energy management. To effectively manage energy use, it's essential to measure and benchmark it accurately.

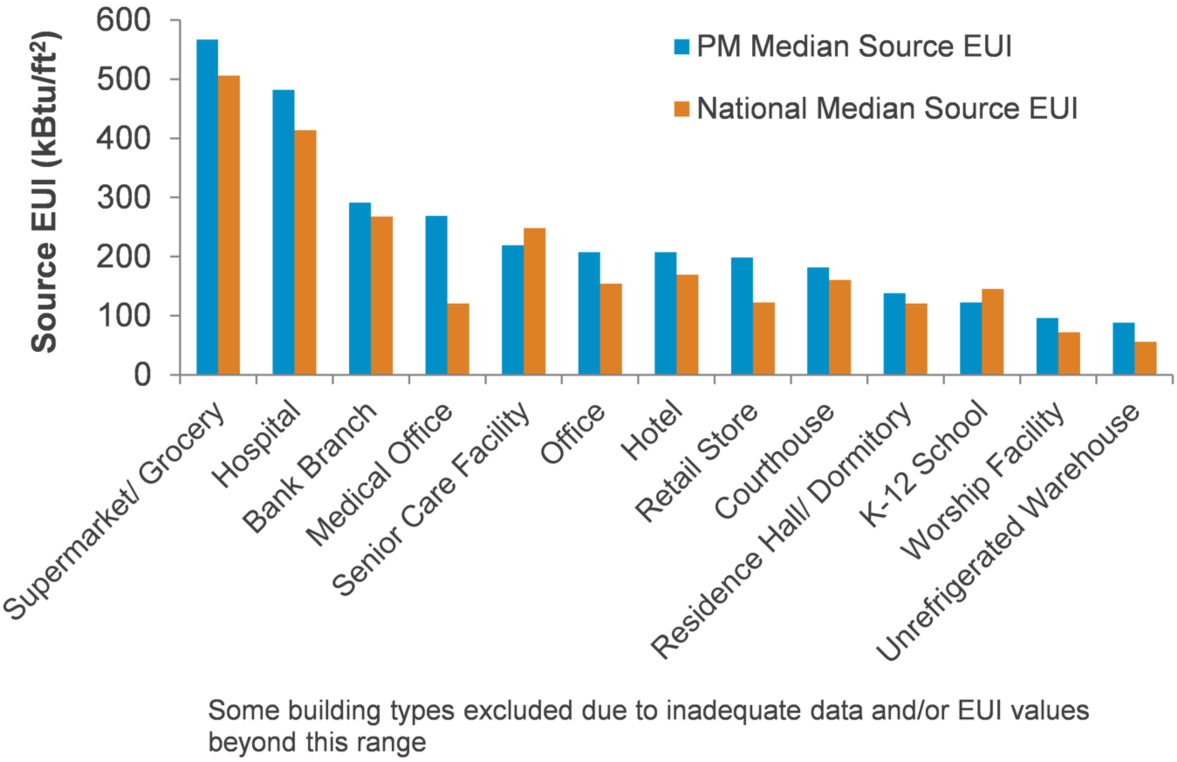


Figure 10: Typical EUI for selected buildings. This graph is based on research EPA conducted on more than 100,000 buildings (Source: https://duanetilden.com/2016/12/19/benchmarking-buildings-by-energy-use-intensity-eui/)

After implementing effective benchmarking and acquiring comprehensive data on the energy use intensity of various building types, this valuable information can serve as a baseline for assessing energy efficiency. Building upon this foundation, the establishment of a performance-based energy efficiency rating system becomes both feasible and beneficial.

This rating system would allow for a robust evaluation of a building's energy performance, taking into account factors such as energy consumption patterns, sustainability practices, and resource efficiency. By moving beyond simplistic metrics and adopting a performance-based approach, regulators in Pakistan could provide building owners and stakeholders with a more accurate and comprehensive assessment of their buildings' energy efficiency. This, in turn, can incentivize further investments in green technologies and practices, ultimately driving the adoption of energy-efficient building solutions across the country

POLICY RECOMMENDATIONS ON PROMOTING GREEN BUILDING CERTIFICATION IN PAKISTAN

13. **Benchmarking and Data Collection**
    Benchmarking is a foundational step toward managing and improving energy efficiency before we begin developing any further green building codes or energy efficiency codes. NEECA, PEC, and PEECA along with development authorities and building control units should work together to develop a comprehensive benchmarking program to assess the energy performance of different building types. This will require establishing a baseline and collecting data on energy use in various sectors.
14. **Tailored Green Building Codes and Certification Programs for Pakistan's Specific for Building Types**
    Instead of adopting generic international codes and green building certification programmes, develop customized green building codes specific to different building types (e.g., residential, commercial, industrial) building upon the existing international codes and guidelines. We can learn from international best practices, such as the Indian Green Building Council's approach, and apply a bottom-up methodology for code development.
15. **Enforcement of Building Energy Codes by empowering Implementing Agencies**
    The foremost challenge in Pakistan lies in the enforcement of existing building energy codes. Policy makers should prioritize and ensure the effective implementation of these regulations at the local level. This requires collaboration with development authorities and building control departments at local and provincial levels to make compliance mandatory for all new construction and renovations.
16. **Pilot Green Building Programs using Bottom-Up approach with key implementing agencies and institutions.**
    Launch pilot programs focused on green building initiatives in major urban centres like Islamabad, Lahore, and Karachi. These areas can serve as testing grounds for implementing and refining green building codes and practices. Successful outcomes can then be scaled up to other regions.
17. **Incentives and Penalties**
    Introduce financial incentives for developers and builders who adhere to green building standards. This could include tax benefits, expedited permit approvals, and other rewards. Simultaneously, impose penalties for non-compliance with energy efficiency and green building regulations to create a stronger deterrent.
18. **Local Green Building Product Manufacturing**
    Collaborate with the green building construction industry to promote the local production of green building products and materials. Support research and development efforts to innovate sustainable construction materials that align with the specific needs and climatic conditions of Pakistan. Establish partnerships with local manufacturers to ensure the availability and affordability of these eco-friendly materials.
19. **Sourcing Green Materials**

Work with industry experts, builders, manufactures and academia to establish green supply chain with local manufacturers and facilitate the sourcing of green building materials through sustainable supply chains. Encourage builders and developers to prioritize the use of locally sourced and environmentally friendly materials in their projects. Provide guidance and incentives for incorporating recycled, renewable, and low-impact materials into construction practices.

20. **Capacity Building and Training**
    Invest in capacity development and skills training to build a proficient workforce capable of designing, implementing, and maintaining green building technologies. Collaborate with educational institutions and industry associations to offer relevant training programs.
21. **Public Awareness and Education**
    Launch public awareness campaigns to educate the general population about the benefits of green buildings and energy-efficient practices. Foster a culture of sustainability and encourage individuals to make eco-conscious choices in their homes and workplaces.
22. **Stakeholder Collaboration is the key to promoting green and sustainable buildings.**
    Collaborate closely with stakeholders at all levels, including government agencies, industry associations, environmental organizations, and international partners. Formulate a cohesive strategy that leverages the strengths and resources of each stakeholder group.
23. **Robust Monitoring and Evaluation Framework for Energy Efficient and Green Buildings**
    Establish a robust monitoring and evaluation system to track the impact of energy efficiency and green building policies. Periodically assess the effectiveness of these policies and make data-driven adjustments if needed.
24. **International Collaboration and Learning from other successful regional initiatives.**
    Engage in international collaboration and knowledge sharing with countries that have successfully implemented energy efficiency and green building initiatives. Learn from their experiences and adapt relevant strategies to the Pakistani context.

8. CONCLUSION

Green buildings are gaining widespread recognition as an important pathway for reducing greenhouse gas (GHG) emissions that stem from the construction and building sectors. In a rapidly urbanizing nation of approximately 230 million people, where the construction sector significantly contributes to energy consumption and greenhouse gas emissions, the need for green buildings is extremely critical. The transition to green construction not only aligns with global sustainability practices but also contributes to energy conservation, reduced GHG emissions, and improved living conditions in Pakistan.

Pakistan's construction and building sector plays a pivotal role in the nation's economic landscap. The sector faces both challenges and opportunities in its transition towards green building practices and energy-efficient construction.

With a burgeoning population, rapid urbanization, and increasing energy demands, the need for sustainable and environmentally responsible building practices has never been more pressing. Green buildings, which prioritize energy efficiency, resource conservation, and environmental responsibility across their entire lifecycle, offer a promising solution to mitigate the environmental impact of the construction industry.

However, several hurdles impede the widespread adoption of green building practices in Pakistan, primarily due to high initial costs, limited access to sustainable construction materials, a shortage of skilled labor, and an overarching emphasis on energy efficiency and comprehensive green building practices in existing policies.

Robust green and sustainable building policies are vital to incentivize the production and use of low-carbon construction materials, aligning with Pakistan's ambitious carbon neutrality goals outlined in its Nationally Determined Contributions (NDCs).

The construction and building sector, with its significant contribution to energy consumption and GHG emissions, requires strong policy support for the adoption of green building practices. The journey towards a greener and more sustainable built environment demands collaboration among policymakers, industry stakeholders, civil society, and the public.

Efforts must focus on strengthening regulatory frameworks, including building energy codes, raising public awareness, improving access to sustainable materials, enhancing skills through capacity development, and offering financial incentives to offset initial costs. Monitoring, evaluation, and local government engagement would also be vital to enforce building energy codes and promote green practices at the grassroots level.

Furthermore, research and development initiatives should be encouraged to tailor cost-effective green building technologies to Pakistan's diverse climate and building typologies. International collaboration and public-private partnerships could provide valuable insights and investment opportunities.

In achieving these goals, Pakistan can expedite its transition to a greener, more sustainable built environment, contributing to global sustainability objectives while reaping economic, environmental, and societal benefits. As the nation continues to experience the rapid urbanization and high energy demands, the adoption of green building practices emerges as an opportunity for Pakistan towards sustainable economic and development growth.

Appendix 5. Review Analysis on the Pakistan Green Building Certification – Architecture

1. INTRODUCTION

PURPOSE OF THE REVIEW AND ANALYSIS

The purpose of this review and analysis is to comprehensively examine the current state of building design practices in Pakistan, with a focus on identifying existing situations, challenges, and opportunities within the construction sector of the country. The analysis focuses mainly on residential, commercial, and public buildings in Pakistan. Through a thorough examination of relevant literature, industry trends, and case studies, this document seeks to provide a detailed assessment of the key factors influencing current building design in Pakistan such as building orientation, window-to-wall ratio (WWR), biophilic design elements, and renewable energy integration. By doing so, it aims to shed light on the strengths and weaknesses of existing approaches, pinpoint areas in need of improvement, and uncover opportunities for improvement. The value of the design phases is given below in Figure 1, the analysis is conducted keeping the value chain under consideration.

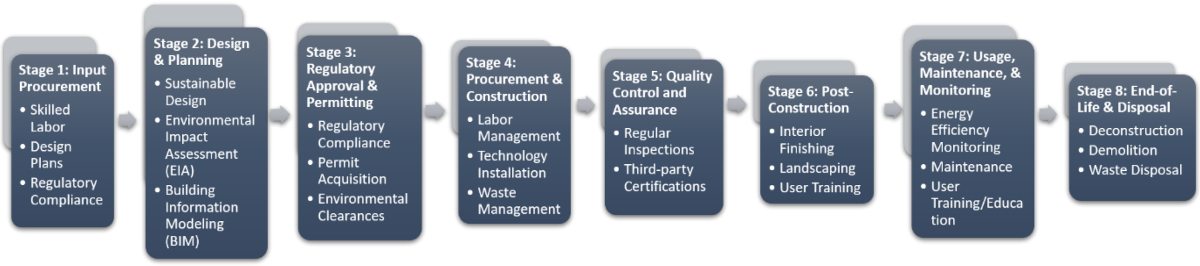


Figure 26- Value Chain Analysis of the Design Phases of Green Buildings in Pakistan

This analysis will serve as a valuable resource for architects, designers, and stakeholders in the construction industry of Pakistan, enabling them to make informed decisions and strategically leverage emerging trends to enhance future building designs' efficiency, sustainability, and functionality.

BACKGROUND (PAKISTAN INFRASTRUCTURE AND GREEN BUILDINGS)

Pakistan is rapidly becoming more urbanized, expecting more than 40 million additional people to reside in urban areas by 2025 due to better living standards and the availability of more job opportunities in urban areas. Pakistan has consistently faced an energy crisis due to high demand during peak summer months and inadequate electricity supply. Many regions in the country experience temperatures exceeding 40 degrees Celsius during summers which leads to extensive use of air conditioners and other cooling appliances increasing the energy demand of the country in summer. This requires the country to prioritize demand-side management and energy cost-saving design practices.

Efforts are needed to improve building design, internal conditions (heating and cooling), energy consumption, and energy efficiency and to reduce the overall environmental impact, which is where green buildings come in. Green building design offers a lot of benefits from an architectural and design perspective. Architects and designers focus on energy efficiency by incorporating features such as well-insulated walls, natural ventilation, and efficient heating, ventilation, and cooling systems (HVAC), which not only reduce utility costs but also lower the building's environmental footprint. These designs also emphasize occupant health and well-being, utilizing low-VOC (Volatile Organic Compound) materials and proper indoor air quality measures to create comfortable and healthy indoor environments. Additionally, green building designs often draw inspiration from nature, leading to aesthetically pleasing structures that harmonize with their surroundings and mitigate the urban heat island effect.

Implementing green architecture in Pakistan will lead to many different areas which the country can benefit from such as energy conservation through energy-efficient building design features and the incorporation of renewable energy systems into the building design to reduce the use of non-renewable sources of energy that leads to a reduction in the carbon footprint of the building. Analysis of the current situation is required to better understand the challenges and opportunities in green buildings from a design perspective in Pakistan.

2. PRESENT SITUATION

Pakistan has a rich culture and traditional infrastructure such as traditional mosques, forts, and shah gardens. This document however focuses on three major types of buildings that currently exist in the country:

- **Residential Buildings:** Residential buildings in Pakistan vary from modern urban apartments to traditional rural houses with courtyards. These prioritize comfort and privacy, with diverse room types and materials ranging from brick and mud to concrete and steel.
- **Public Buildings:** Public buildings in Pakistan, such as government offices, schools, hospitals, religious structures, and transportation hubs, often reflect cultural and historical contexts, accommodating large crowds with spacious interiors and accessibility features.
- **Commercial Complexes:** Commercial buildings, including offices, retail stores, malls, hotels, restaurants, and warehouses, have architectural styles that reflect branding, with modern designs in urban areas and traditional elements in older structures.

The building sector is responsible for most of the energy consumption in Pakistan, with the residential sector currently being the largest in energy consumption consuming about 49.2%, and the commercial sector consuming about 7% of the total electricity produced in the Country.[41] With a constantly increasing population and urbanization rate, demand

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[41] *https://unfccc.int/documents/470405 (BUR1)*

for this sector is expected to rise even further. Therefore, it is important to introduce energy-efficient design techniques that can overcome the increase in the energy consumption of buildings in Pakistan.

BUILDING CODES AND LEGISLATION

The government of Pakistan has acknowledged the significance of sustainable building design and has taken measures to encourage its adoption. An illustration of this commitment is the establishment of the Pakistan Green Building Council (PGBC) in 2012, dedicated to advancing sustainable building design and construction practices in the country. As an esteemed member of the World Green Building Council, the PGBC strives to foster a sustainable built environment in Pakistan by advocating for green building approaches. Additionally, the Pakistan Engineering Council's (PEC) 2021 building codes emphasize key architectural considerations, including ventilation, lighting, and roof drainage. These guidelines stress the significance of natural ventilation in occupied spaces, with provisions for accessible windows, doors, louvers, or other openings to the outdoors. When air infiltration rates are low, compliance with the International Mechanical Code is required. The NEECA National Energy Conservation Code 2023 also mentions specific guidelines on sustainable building design practices, such as Green roofing, Window-to-Wall Ratio, Orientation, and integration of Renewable energy, while focusing on the energy saving that these design features can bring. Adequate lighting, both natural and artificial, is mandated to ensure safety and comfort, achieved through strategic design and illumination systems. Biophilic design elements such as green roofs are essential for rainwater management and must adhere to specified standards to safeguard the building's structural integrity and longevity. These comprehensive regulations prioritize the creation of healthier, more functional, and sustainable building environments while enhancing occupant well-being.

Pakistan is lacking in the implementation of these building codes and regulations. Reasons include lawlessness, lack of awareness of the general public on the benefits of green design and workforce on building codes related to design, green design technology unavailability in the country, and financial issues that lead to low or no investment in energy-efficient design features such as integration of renewable energy.

Green building design offers a lot of benefits in terms of cost saving, energy efficiency, and environmental benefits by only incorporating a few changes into the building design, orientation, and architecture. In terms of energy saving, the building sector offers a potential of 30%,[42] which is why Pakistan needs to shift towards green building design by addressing all the gaps that are present in the construction sector. A detailed analysis of the green building design aspect in Pakistan is necessary to utilize the energy and cost savings potential that the building sector has to offer.

3. ARCHITECT ANALYSIS

Architects are responsible for planning and implementing building design during the construction phase of a building. This section analyses building design in Pakistan from an architectural point of view.

ARCHITECTURAL DESIGN REVIEWS

Architecture plays an important role in the energy efficiency, building aesthetics, and health of the inhabitants through a focus on certain areas such as building orientation, window-to-wall ratio, and energy-efficient building features.[43] The current building design practices

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[42] Baig, A. (2018). Green Buildings as a Solution for Sustainable Housing: Role of Private Housing Schemes, Lahore, Pakistan. Research Gate. https://www.researchgate.net/publication/327267222_Green_Buildings_as_solution_for_Sustainable_Housing_Role_of_Private_Housing_Schemes_Lahore_Pakistan

[43] https://en.wikipedia.org/wiki/Pakistani_architecture#:~:text=Pakistani%20architecture%20is%20intertwined%20with,which%20have%20many%20regional%20varieties.

in Pakistan will be discussed in the architectural design reviews segment along with suggestions for improvement in design practices.

EVALUATION OF BUILDING DESIGN CONCEPT

Building design in Pakistan is intertwined with the architecture of the broader Indian subcontinent. The major architectural styles popular in the past were Temple, Indo-Islamic, Mughal, and Indo-Saracenic architecture, all of which have many regional varieties. Urban areas of Pakistan are moving towards modern architecture that focuses more on the aesthetics of the building and rural areas have the traditional building style that focuses on the use of natural materials and design elements such as mud, clay bricks, and openings for passive energy use in a building.

Residential building design practices in Pakistan are rather purely traditional or purely modern which can be seen from the study conducted in Lahore, where the two building styles (Figure 2 and Figure 3) were compared to observe the overall design.[44] After comparing both buildings, it was seen that neither traditional nor modern house designs in Lahore are inherently better than the other. Each has its merits based on environmental considerations, for example, traditional houses involve more nature-based elements that help in reducing GHG emissions and providing a healthy environment, and on the other hand, modern buildings focus on the inclusion of renewable energy sources into the building design which reduces their reliance on fossil fuel-based energy.

However, a balanced approach that combines traditional and modern elements, such as the use of eco-friendly design features, utilization of passive energy for lighting and heating purposes, inclusion of renewable energy design systems, and good aesthetics can create a rich house design, preserving heritage while improving energy efficiency, improving heating and cooling mechanisms, and providing good environmental benefits.

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[44] *QURESHI, R.A. (2011) THE TRADITIONAL COURTYARD HOUSE OF LAHORE: AN ANALYSIS CONCERNING DEEP BEAUTY AND SUSTAINABILITY, Thesis.*

Figure 27 - Traditional House

Figure 28 - Modern House

Commercial buildings in Pakistan majorly follow modern architecture neglecting sustainable design features into the building. However, some examples exist, such as the Telenor 345 Head office (Figure 4 and Figure 5) located in Islamabad, which is a good example of green architecture. The building has natural airflow through the use of meshes, the orientation of the building is such as to reduce the overall energy consumption and use natural light as much as possible. The design is also highly energy efficient with active chilled beams, LED lights, thermal insulation, and occupancy sensors. The Telenor 345 Head Office was found to have achieved **up to 13% of energy cost savings** and 11% of its energy consumption was shifted to solar energy.[45]

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[45] *https://www.telenor.com/binaries/investors/reports-and-information/annual/annual-report-2022/Annual%20Report%202022.pdf*

Figure 29 - Telenor 345 Head Office, Islamabad, Pakistan **Figure 30** - Drone view of Telenor 345 Head Office

Green architectural practices can play an important role in energy conservation and GHG emissions reduction. The cost-saving potential of green building design features can be assessed from the study focused on residential buildings in Pakistan. The analysis of conventional buildings shows that a major heat loss of 29.3 kWh/m^2 and 18.3 kWh/m^2 takes place across external walls and roofs respectively while a loss of 5.2 kWh/m^2 was observed through windows. Commutatively, the annual heating demand of conventional buildings was calculated to be 44.2 kWh/m^2 but for energy-efficient buildings, with design features such as building orientation, window-to-wall ratio, nature-based solution, and renewable energy, the losses were significantly reduced consequently leading to 1/10th of annual energy demand. For **annual heating, a 32 % energy improvement** was observed while for **cooling, a 38% energy improvement** was observed.[46]

The analysis of the building design concept in Pakistan shows that building design practices are different in urban and rural areas and green architectural practices are not very common in the country but the potential savings can be seen from the analysis and should be utilized. There are some good examples such as the Telenor 345 Head Office, which can be set as a best practices example to follow in residential areas as well. There is still a need for improvement in different areas of green design in Pakistan, which needs to be addressed.

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[46] M. Mahboob, T. u. Rashid and M. Amjad, "Assessment of Energy Saving Potential in Residential Sector of Pakistan through Implementation of NEECA and PEC Building Standards," 2019 15th International Conference on Emerging Technologies (ICET), Peshawar, Pakistan, 2019, pp. 1-6, doi: 10.1109/ICET48972.2019.8994750.

Areas of Improvement

The following possible options were identified which Pakistan can implement to make good progress in green architecture:

1. Balanced Approach to Traditional and Modern Design: Traditional designs in Pakistan focus fully on natural lighting, passive heating, and cooling, which leads to energy efficiency, but the aesthetics and incorporation of technology in the building are overlooked. On the other hand, modern buildings focus more on aesthetics and the latest technology, and other factors such as passive energy use and the incorporation of nature-based elements are overlooked. Building design features such as natural lighting and airflow, integrating modern technology such as renewable energy along with nature-based solutions, and overall good aesthetics can be used together for a green building design in Pakistan. This design practice is not only for residential buildings, it can be implemented for commercial, and public buildings as well.

2. Awareness of the Public: The local community in Pakistan does not pay much attention to building design aspects during the planning or construction phase of a building which is due to a lack of awareness of the benefits of green building design. The government can take initiatives for capacity building of the general public as well as the workforce including training sessions and workshops on the negative impacts and benefits of using green design features.

3. Implementation of Building Codes: Building codes exist in Pakistan such as PEC Building Codes 2021 and NEECA National Energy Conservation Code 2023, which contain detailed segments on the architecture and design-related aspects of buildings but they lack implementation which is where Pakistan is struggling to move towards green buildings. The government should ensure enforcement of these codes through dedicated departments, capacity building should be done for the stakeholders involved.

BUILDING ORIENTATION AND WINDOW-TO-WALL RATIO (WWR)

Building orientation and window-to-wall ratio (WWR) play a vital role in the overall energy use of the building as they can provide options for passive heating in winter, and use of wind in summer, and increasing the window-to-wall ratio decreases the lighting demand of the building.

ASSESSMENT OF ORIENTATION'S IMPACT ON BUILDING PERFORMANCE

Concepts like building orientation are often overlooked during the construction of residential public or commercial buildings in Pakistan due to a lack of awareness of the architect and the general public. According to NEECA National Energy Conservation Building Code 2023, a compact building shape and appropriate building orientation can reduce the energy consumption for heating and cooling systems by up to 50% to 80% depending on the geographical conditions where the building is located. The identification of such an improvement in building codes is not enough unless these codes are disseminated widely and backed with information on the long-term economic benefits for dwellers. Along with this, the government’s role in the early adoption of these practices is pivotal.

The concept of building orientation in residential, public, and commercial buildings in Pakistan is not very common but there are some examples in Pakistan where building orientation was considered during design. A study was done for a public building (Mosque) in Pakistan, where Faran mosque located in Karachi was analyzed from the building orientation perspective and it was found that the overall design and orientation facilitated the building wind flow and use of natural light which improved the energy efficiency of the building by reducing the use of appliances for cooling and heating. Sprinklers were also used in the building which were placed in the windward direction to maintain a cool temperature in summers.[47] Using passive sunlight and natural wind flow reduces the overall energy use and improves the building's air quality as well in all seasons.

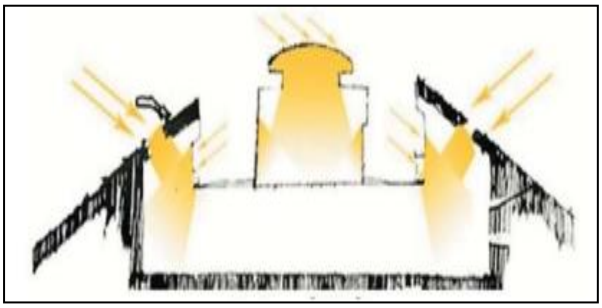

Figure 31 - Section showing light paths into the mosque[6]

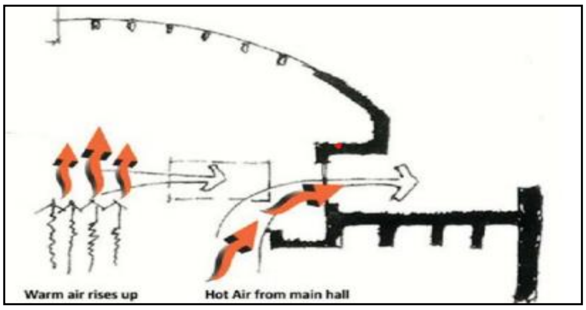

Figure 32 - Wind flow inside the mosque[6]

Pakistan can also take the concept of building orientation from the best practices in other parts of the world. In Iraq, a study was conducted using BIM (Building Information Modelling) in which different types of building shapes and orientations were simulated using an application called Revit, which showed that the T-shape model is the least consuming energy model at a rotation angle of 285˚, as its energy consumption amounted to 40,495 kWh for 964$ per year. 48 The U-shape model is one of the most energy-consuming at the angle of rotation is 270˚, where its energy consumption amounted to 73,880 kWh at a cost of 1758$per year, which equals almost 56% difference in the overall energy cost of both models, keeping other properties such as area and capacity the same.

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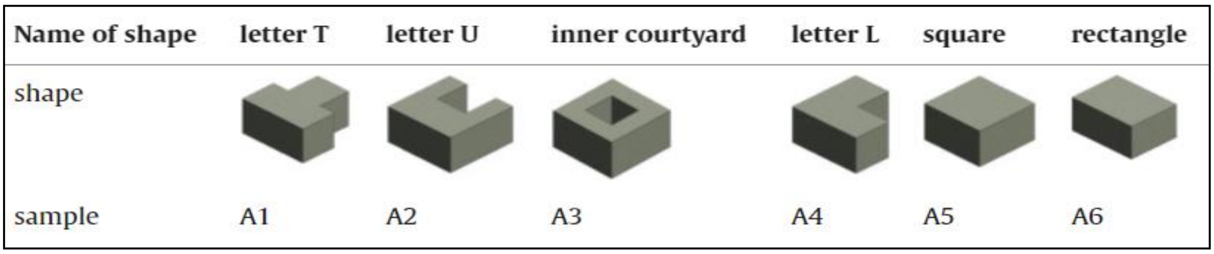
47 Naqvi, Z.A. and Asghar, Q. (2020) Architectural Analysis: distinctive building features in Pakistani architecture, Journal of Research in Architecture and Planning. Available at: https://www.academia.edu/43730064/Architectural_Analysis_Distinctive_Building_Features_in_Pakistani_Architecture

48 Qubad Sabah Haseeb, Sumbul Muhammed Yunus, Anas Attellah Ali Shoshan, Adil Ibrahim Aziz,

A study of the optimal form and orientation for more energy efficiency to mass model multi-story buildings of Kirkuk city, Iraq, Alexandria Engineering Journal, Volume 71, 2023, Pages 731-741, ISSN 1110-0168, https://doi.org/10.1016/j.aej.2023.03.020.



Name of shape	letter T	letter U	inner courtyard	letter L	square	rectangle
shape						
sample	A1	A2	A3	A4	A5	A6

Figure 33. Shapes of Models

Building orientation plays a key role in the energy cost-savings of a building. A study done in Egypt shows that a building oriented with a south facade can save energy costs up to 26% over a building with a western facade.[49] According to the Bonneville Power Administration and the City of San Jose, California, homes re-oriented toward the Sun without any additional solar features save between 10% and 20% in cold regions and some can **save up to 40% in hot regions**.[50] Another study in Jamaica shows that correctly oriented buildings can save up to **30-40% of their electricity**.[51]

Further, the cost savings will calculated by using the annual utility expenses in Pakistan. The utility expenses in Pakistan vary from season to season. The average household electricity bills in Pakistan based on an evaluation for the year 2022 are as low as 2000-3000/- PKR in winter and in the Summer season, as electricity consumption increases, the electricity bills can go up to 7,000/- PKR. 52 It was analyzed that an average of 30% cost savings in summers and 15% in winters, can be achieved from building

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49 Elghamry, Rania & Azmy, Neveen. (2017). Building orientation and its impact on energy consumption. Available at https://www.researchgate.net/publication/327623184_Buildings_orientation_and_it's_impact_on_the_energy_consumption

50 https://www.nachi.org/building-orientation-optimum-energy.htm

51 https://buildbetterja.com/

52 https://www.graana.com/blog/cost-of-living-in-pakistan/#:~:text=Utilities%20(Monthly)&text=2000%2D3000%20in%20winter%20(October,7%2C000%20(%2445)%20plus.

orientation alone. 53 The following is a calculation of the total cost savings that can be achieved through the use of proper orientation in buildings in Pakistan:

Table 25 - Cost Savings due to building orientation in an Average Household in Pakistan

Season	Average Household Electricity Cost (PKR)	Percentage Savings (%)	Cost after Orientation Correction (PKR)	Cost Savings (PKR)
Winter	3000	15	2550	450
Summers	7000	30	4900	2100

The calculation shows that a maximum energy cost savings can be **2,100/- PKR per month in Summer** and **450/- PKR per month in winter** in an average household thus energy cost savings can be achieved by orienting the building properly. The cost-saving opportunity should be utilized in Pakistan to relieve the economic stress of utilities of the homeowners.

The Government acknowledges the importance of building orientation in a building design, which is why building codes contain guidelines on building orientation. According to the NEECA Energy Conservation Building Code 2023, the longer axis of any commercial, residential, or public building should not face east or west as they receive constant sunlight at a low angle all over the year and summers can be very difficult for the inhabitants of the building.

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53 https://www.graana.com/blog/cost-of-living-in-pakistan/#:~:text=Utilities%20(Monthly)&text=2000%2D3000%20in%20winter%20(October,7%2C000%20(%2445)%20plus.

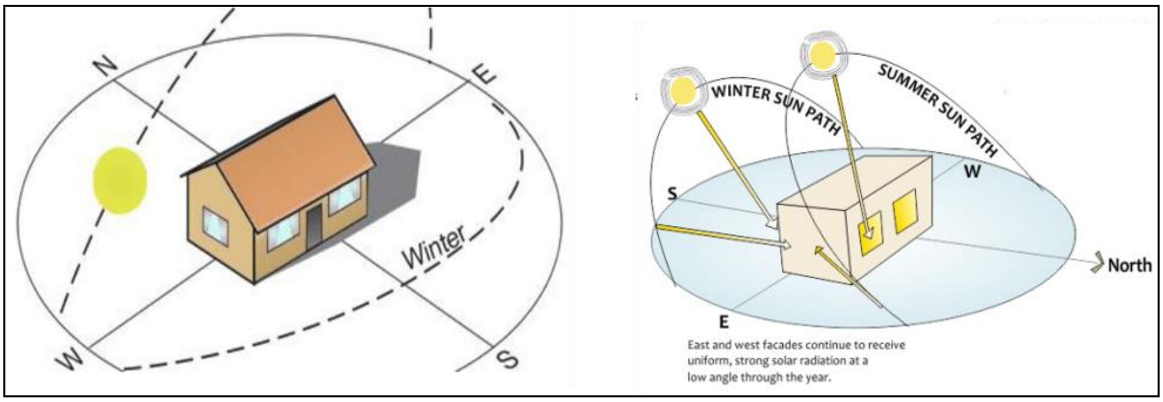

Figure 34 – Longer side of the building should be towards north and south (NEECA)

Overall, it can be seen that Pakistan is lacking in building design from the perspective of building orientation which can reduce energy costs by up to 30% in summers and winters, and maintain healthy internal conditions with good air flow. Building codes do exist in this area but they have improper implementation which can be ensured to cater to this issue.

Areas of Improvement

1. Best Practices as an Example: Faran Mosque in Karachi, as explained in section 3.2.1, is a very sound example of how the building should be oriented to utilize passive sunlight and maintain good airflow during hot seasons. Practices like this need to be promoted and discussed frequently in Pakistan by organizing training programs for the public and professionals, collaborating with universities for workshops and seminars for youth, and carrying out demonstration projects to make the engineers, architects, laborers, and the public aware of these factors.

2. Climate-Responsive Design: Architects should be encouraged by providing incentives, recognition, training programs, and regulatory support to adopt climate-responsive design strategies, such as the use of sun shades, overhangs, and windbreaks, to harness sunlight for passive heating in winter while minimizing heat gain in summer. These features can significantly contribute to overall sustainability.

3. Promote the Use of Simulation Tools: The case studies used in the analysis involved the use of a simulation tool such as Revit for analyzing the impacts of the building orientation on energy cost savings. The use of such software should be normalized and architects and engineers should be proficient in using this kind of software, which can help them build and design better.

4. Lack of implementation in Building Codes: A Detailed Energy conservation building Code exists as mentioned earlier on how the building shall be oriented to improve energy efficiency but it lacks implementation at the local level due to low awareness of the general public and labor. If the NEECA Energy Building Code 2023 guidelines are followed, it can decrease the energy demand and cater for a large portion of the energy shortage by only improving the building orientation. The government should ensure the implementation of building codes to make Pakistan shift towards green design.

ANALYSIS OF WINDOW-TO-WALL AREA RATIO ON ENERGY PERFORMANCE OF THE BUILDING

Around 50% of the energy that buildings lose goes through their windows. The best WWR is the amount of window space that uses the least energy over the entire year for cooling, heating, and lighting. The window-to-wall area ratio (WWR) is a critical factor in building design, especially in the context of achieving optimal daylighting and energy efficiency in Pakistan. The baseline WWR[54] in residential buildings in Pakistan showing an average **WWR of 20%** as used in a study is given below:

Table 26 - Baseline Window-to-Wall Ratios in Residential Buildings in Pakistan

Walls	Baseline Windows Area

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[54] *Ahmad, Khurshid, et al. "Effect of Windows Area Reduction and Glazing Type on Energy Consumption of Residential Buildings in Islamabad." Research Gate, 2012, www.researchgate.net/figure/2-Window-to-wall-percentages-of-residential-building_tbl1_262449976.*

East Wall	0%
West Wall	17.50%
North Wall	22.30%
South Wall	27%

The high cost of electricity is a major issue in Pakistan and the demand for artificial cooling systems is increasing in Pakistan, which was analyzed in an example where in commercial complexes in Lahore, a study was conducted due to the increase in the demand for cooling appliances.[55] It was analyzed by using a simulation software called "COMFEN" that WWR and heat gain are in a linear relation with each other and an average WWR of 20-30% showed a reduced amount of heat gain while keeping the required amount of passive lighting to the building of the commercial buildings. A public sector building i.e., PAK Secretariat, was analyzed for the impacts of WWR on energy savings and it showed a **286.7 kWh in annual energy savings** when the WWR was reduced from **38% to 33%**. The cost of the energy savings comes out to be **12,328/- PKR per year**,[56] which is not a huge cost saving but it can be improved by further improving the WWR.[57]

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[55] Rasheed, M. (2016). Effect of Window Wall Ratio (WWR) on heat gain in commercial buildings in the climate of Lahore. https://www.researchgate.net/publication/307863044_Effect_of_Window_Wall_Ratio_WWR_on_heat_gain_in_commercial_buildings_in_the_climate_of_Lahore

[56] Masood, A. K. (2014). Impact of windows to wall ratio on energy consumption in building ... Research Gate. https://www.researchgate.net/publication/308731869_Impact_of_windows_to_wall_ratio_on_energy_consumption_in_building_sector_of_Pakistan

[57] Rasheed, M. (2016). Effect of Window Wall Ratio (WWR) on heat gain in commercial buildings in the climate of Lahore. https://www.researchgate.net/publication/307863044_Effect_of_Window_Wall_Ratio_WWR_on_heat_gain_in_commercial_buildings_in_the_climate_of_Lahore

Further, energy cost saving through the optimization of the window-to-wall ratio can also be seen from the example where BIM was used to optimize the WWR from an average of 40-45% to **an average WWR of 25-30%**. The study shows that there was a decrease in the mean energy cost from the **cost of 229 kWh/m^2/year to the cost of 160 kWh/m^2/year** for the residential building, which equals a **reduction of 30%** in the energy costs.[58]

The energy cost savings of a building due to the optimization of the WWR from 28% to 14% were found to be **9.4% to 13.3% in cold regions** and **34.3% to 44.2% in hot regions** due to a major reduction in the use of air conditioning systems.[59] An average of these cost-saving ranges can be used to calculate the cost savings in an average household in Pakistan by using the average utility expense in a building. The following is a calculation of energy cost savings in the average household in Pakistan:

Table 27 - Cost Savings Due to WWR in an Average Household in Pakistan

Season	Average Household Electricity Cost (PKR)	Percentage Cost Savings (%)	Cost after optimizing WWR (PKR)	Cost Savings (PKR)
Winter	3000	11.5	2655	345
Summer	7000	39.5	4250	2750

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[58] Zhang, J., Zhu, X., and Khan, A.M. (2023) BIM-based architectural analysis and optimization for Construction 4.0 (a comparison), Research Gate. Available at: https://www.researchgate.net/publication/367523278_BIM-based_architectural_analysis_and_optimization_for_construction_40_concept_a_comparison

[59] Ruihua Ma, Ruijiang Ma, Enshen Long, Analysis of the rule of window-to-wall ratio on energy demand of residential buildings in different locations in China, Heliyon, Volume 9, Issue 1,2023,e12803, ISSN 2405-8440, https://doi.org/10.1016/j.heliyon.2023.e12803

It can be seen that in winter, an energy **cost saving of 345/- PKR per month** can be achieved, and on the other hand, a substantial **cost saving of 2,750/- PKR per month** can be achieved by optimizing the WWR of a building. These benefits are recognized by the Government of Pakistan, which is why building codes contain guidelines on these design elements. The Energy Conservation Building Code 2023 contains a detailed section on the WWR by the Solar Heat Gain and Solar Glazing Coefficients but it lacks implementation due to the low awareness of the public and professionals and also low or no use of simulation software by architects or engineers in the planning phase of the building.

Hence WWR can have a good impact on the energy performance of a building while also ensuring the effective use of passive sunlight and air flow into the building. WWR has a linear relation with the heat gain of a building leading to an increased use of cooling appliances in the summer. However, It can lead to cost savings of up to 2,750/- PKR per month in summer, and 345/- PKR per month in winter for the average household electricity expense in Pakistan. Pakistan needs to utilize the savings potential for this aspect of building design and make it normal practice in the building sector. The government has already focused on this aspect which is shown by the building codes.

Areas of Improvement

1. Promote the Use of Simulation Tools: The study mentioned earlier involved the use of a simulation tool called COMFEN for analyzing the impacts of the window-to-wall ratio on heat gain. The use of such software should be normalized and architects and engineers should be proficient in using this kind of software, which can help them build and design better.

2. Awareness of the Public: The residential building WWR baseline is around the optimum WWR of 20-30%, but commercial buildings are not catering to this issue which shows that the architects and the local public still do not have any awareness of the importance and benefits of WWR on energy conservation and energy cost-saving of a building. The government can ensure awareness by doing media campaigns and providing technical and regulatory support for including WWR in building design.

3. Strengthen the implementation of Building Codes: Building codes do exist regarding window-to-wall ratio linking it with other factors. As Pakistan is a country with intense weather conditions, these building design features should be implemented on a priority basis to enhance energy efficiency and improve the overall health of the inhabitants of the buildings. The government can provide, capacity-building training to the public as well as labor, technical support, and guidance in design aspects, and certifications for building design related to WWR.

NATURE-BASED SOLUTIONS AND ARCHITECTURAL BEAUTY

Nature-based solutions incorporate biophilic elements in the building design to solve problems of increase in energy consumption, health and well-being, and emission reductions in a building. These solutions help sustainably tackle various issues, making the world more eco-friendly, resilient, and better for people, while also opening up opportunities for businesses and innovation such as for the production of green roofing systems and living walls inside buildings that reduce emissions and create a healthy environment.

ASSESSMENT OF BIOPHILIC DESIGN ELEMENTS

Biophilic design recognizes the inherent human need for nature together with sustainable and universal design strategies to create environments that truly enhance life. In urban and rural areas of Pakistan, residential buildings include certain biophilic elements such as gardens, lawns, pot plants, and in some cases, trees as well but commercial complexes do not focus that much on biophilic design elements.

In contrast, commercial buildings in Pakistan do not focus on introducing nature into the building design. Most commercial buildings and modern residential houses focus more on the inclusion of the latest technology and ignore the importance of biophilic design elements in buildings lacking the use of natural elements.

However, there are some initiatives such as the inauguration of Forest Town as a biophilic city by Green Woods Developments in Pakistan (Islamabad), whose concept was taken from a biophilic city named Tengah located in Singapore. It is a great step in addressing this issue aiming to transform urban living through eco-sustainability and biophilic principles with the mission to re-establish a profound connection between real estate and the natural world.[60]

Figure 35 - Forest town Concept (Tengah, Singapore)

These types of initiatives boost resilience by reducing the urban heat island effect, the risk of flooding, and improving the air quality, and enhancing residents' quality of life by maintaining good air quality. They also help in blending heritage with modern sustainable

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60 Forest Town Reconnecting with Nature. https://foresttown.com.pk/what-is-biophilia-and-biophilic-design-an-in-depth-guide/

design, creating attractive spaces that showcase Pakistan's culture and attract both residents and tourists.

The importance of the introduction of biophilic elements can best be calculated by reviewing the cost savings through the inclusion of a green roofing system in a household. A study shows that the energy consumption for their base case was 169 kWh/m^2, while the energy consumption due to the application of green roofing on the entire roof surface came out to be 110 kWh/m^2 and the **energy savings were found to be 35%**,[61] which can save a lot in terms of energy cost.

Comparing this with Pakistan, the energy cost-saving potential of a green roofing system installed in a household in Pakistan can be calculated as follows:

Table 28 - Cost Savings due to green roofing system in an Average Household in Pakistan

Season	Average Household Electricity Cost (PKR)	Percentage Saving (%)	Cost after Green Roofing System (PKR)	Cost Savings (PKR)
Winter	3000	35	1950	1050
Summer	7000	35	4550	2450

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[61] Mahmoud, A. S., Asif, M., Hassanain, M. A., Babsail, M. O., & Sanni-Anibire, M. O. (2017, March 29). Energy and economic evaluation of green roofs for residential buildings in hot-humid climates. MDPI. https://www.mdpi.com/2075-5309/7/2/30#:~:text=The%20case%20study%20showed%20that,of%2024%25%20to%2035%25.

Energy cost savings due to the installation of green roofing systems can be up to **2,450/- PKR per month for summers** and in **winters it can be up to 1,050/- PKR per month**. The installation cost of such systems can be high but the return on investment can cover the initial cost of the system, which shows that the installation of green roofs in a building is economically feasible.

However, biophilic elements such as green roofing systems are very uncommon practices in Pakistan the fact that NEECA National Energy Conservation Building Code 2023 mentions that 50% of horizontal exposed roof slabs of Buildings shall have a green roofing system, to manage water run-off from rooftops, to control internal temperatures within the top floors, and to reduce the energy consumption and carbon footprint of the building but these guidelines need to be implemented to get positive results. Pakistan lacks the implementation of building codes on the inclusion of biophilic design elements.

The analysis of nature-based solutions in a building design shows promising energy cost-saving potential such as **2,450/- PKR per month for summers** and **1,050/- PKR per month for winters**, and the government has also advised the inclusion of biophilic elements such as green roofing systems through the NEECA National Energy Conservation Building Code 2023 but there is a lack of implementation of buildings codes, and lack of awareness among the public, and professionals also.

Areas of Improvement

1. Promoting green features in building design: Commercial buildings in Pakistan mainly focus on the materials, windows, and other features for energy conservation but the introduction of several green and natural elements such as living walls, indoor plants, biophilic arts, lawns, gardens, and courtyards for a better indoor environment, natural cooling, energy conservation and reducing the carbon footprint is required. People who are living in apartments or do not have space for lawns can opt for living walls and small plant pots inside their buildings. This can be done by raising awareness among the public and educating them about the economic and health benefits of such systems.

2. Lack of Awareness of the Architects and Labor: The labor and design experts lack awareness and knowledge on the benefits of incorporating biophilic elements into the building design. Biophilic elements ensure well-being, emissions reduction, and good aesthetics in a building. Relevant individuals must be educated and trained to implement these features in the buildings. Relevant professionals should be given training on the inclusion of nature-based solutions in building design in Pakistan.

3. Review and Implementation of Building Codes: NEECA Energy Conservation Building Code 2023 contains a whole segment on the introduction of green roofing systems into the building design to reduce the overall carbon footprint as well as to improve the energy efficiency of the building. Building codes should also be reviewed to contain guidelines on the use of natural elements in courtyards, lawns, gardens, etc. to improve the carbon footprint and energy ever further. To ensure implementation, the Government can provide, training programs to professionals as well as to youth, certifications, and campaigns on the health benefits and emissions reduction caused by to inclusion of biophilic elements.

ENERGY PERFORMANCE AND USE IN ARCHITECTURE

At present, buildings account for roughly 40% of the total energy consumed globally and the construction sector consumes 50% of the total energy of Pakistan.[62] If this energy consumption trend persists while factoring in the expected increase in population, and with limited new sources of fossil fuels, all the natural resources of Pakistan could be exhausted within a short period. The field of construction holds a significant potential of

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[62] Baig, A. (2018). Green Buildings as a Solution for Sustainable Housing: Role of Private Housing Schemes, Lahore, Pakistan. Research Gate. https://www.researchgate.net/publication/327267222_Green_Buildings_as_solution_for_Sustainable_Housing_Role_of_Private_Housing_Schemes_Lahore_Pakistan

30% for lessening its environmental footprint by integrating energy-efficient technologies into the planning, building, and maintenance of both new and existing structures.[63]

INTEGRATION OF RENEWABLE ENERGY IN THE DESIGN

Renewable energy technology can play a vital role in optimizing energy efficiency and reducing the carbon footprint of the building. In Pakistan, Solar PV systems are becoming more common in practice in modern residential houses and large commercial complexes in urban areas. In contrast, houses in rural areas do not focus much on technology because of the high installation cost of the systems.

Commercial buildings in Pakistan focus a lot on the integration of renewable energy sources to fulfill their energy demands. One of the examples of a commercial building with solar energy integration is the Telenor 345 Head Office in Islamabad, whose 11% of the total energy consumption is fulfilled by solar energy. An array of PV Solar cells is installed on the roof of the building used to convert the solar energy into electrical energy. [64]

Figure 36 - PV Solar Panels, Telenor 345 Head Office

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[63] *Sangeetha, Sripiya & Rishisha, (2017). A Review of Energy Efficiency in Building Construction. Journal of Industrial Pollution Control.*

[64] *https://www.telenor.com.pk/static/2019/06/Sustainability-Report-2019-2020.pdf*

The cost of solar systems is very high but the return on investment and payback period make it quite cost-effective, which can be seen from the study where the payback period for household solar systems of 5kW was calculated to be **3.98, 2.33, 3.99 & 6.78 years** in Sindh, Balochistan, Punjab and KPK, respectively. Other than that, there is a reduction in the carbon footprint of the building due to the solar systems as according to the Lawrence Berkeley National Laboratory, an acre of solar panels producing zero-emissions electricity saves between **121 to 138 metric tons, of carbon dioxide** per year. Solar systems are used commonly in Pakistan but there is still a lack of other renewable energy technology use in Pakistan.[65]

The integration of other types of renewable energy systems is also an option in a building design, a recent UK study part funded by the Carbon Trust study shows that small wind turbines can be used on top of high-rise buildings with an estimated potential **annual carbon dioxide savings to be in the range 0.75- 2.2 Mt CO_2 per year**.[66] The biomass energy system can also be integrated as explained in this example where biomass boilers were used for heating purposes. Biomass offers substantial advantages, including a significant reduction in CO2 emissions when compared to fossil fuels, resulting in emissions reductions of up to **95.25% for single-family units and 91.18% for multi-family units**. Additionally, the use of biomass enhances energy ratings, and leads to substantial economic savings, with **potential cost reductions of up to 70%** when compared to gasoil,[67] which shows the benefits of using other renewable energy sources in Pakistan.

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[65] Mahmoud, A. S., Asif, M., Hassanain, M. A., Babsail, M. O., & Sanni-Anibire, M. O. (2017, March 29). Energy and economic evaluation of green roofs for residential buildings in hot-humid climates. MDPI. https://www.mdpi.com/2075-5309/7/2/30#:~:text=The%20case%20study%20showed%20that,of%2024%25%20to%2035%25.

[66] https://www.sciencedirect.com/science/article/abs/pii/S1471084606705455

[67] Carpio, M., & Costa, M. (2013, August 6). Impact of using biomass boilers on the energy rating and CO2 emissions of Iberian Peninsula residential buildings. Energy and Buildings. https://www.sciencedirect.com/science/article/abs/pii/S0378778813004702

Figure 37 - The Swift Turbine[19]

Figure 38 - Biomass Boiler[68]

The government has already advised about the integration of solar systems as a renewable energy resource for buildings in the NEECA National Energy Conservation Code 2023, which contains a chapter on the design and integration of Renewable energy systems into buildings. However, the code only focuses on solar energy as a renewable source of energy for generating power. It states that the solar system should be designed at a minimum of 10 kW for 1000 units (kWh) for average monthly consumption. Average consumption must be based on the technical analysis of the solar capacity potential of the building by considering the surrounding buildings and their shades on the concerned building. Other options such as wind energy and biomass energy can also be used as renewable energy sources for buildings but there are no guidelines for them in the building codes of Pakistan.

The analysis of renewable energy sources in building design shows the importance of integrating renewable energy systems such as solar systems, wind energy systems, and biomass boilers in buildings. Buildings in Pakistan have shown the integration of solar systems in their design to fulfill their energy needs. Other renewable energy sources can also be used in the building design to utilize their cost-saving and emissions-reduction potential.

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68 https://finbra.co.uk/renewables/biomass-boilers/

Areas of Improvement

1. Diversification of Renewable Sources: There are various renewable energy sources used in different parts of the world but in Pakistan, the focus is mainly on solar energy. There's a need to explore and integrate a wider variety, especially in regions with high potential for wind energy, and biomass energy. The best practices from other countries can be utilized in this regard.

2. Awareness and Education among Builders and Public: There should be increased awareness and education about the benefits of renewable energy technologies among builders, architects, and the general public because if people are not aware of the benefits of using renewable energy and the negative impacts of using fossil fuel-based energy, they will not be willing to integrating this type of technology into buildings. The government should provide capacity-building training to the relevant professionals and general public, certifications should be introduced, and technical and regulatory support should also be ensured.

3. Financial Incentives: Government incentives and subsidies should be expanded to make renewable energy systems more affordable and attractive for building owners as renewable energy technology comes with high installation costs, which can put a lot of financial pressure on the homeowner. Incentives such as tax reductions, low-interest loans, and grants can be provided to homeowners to integrate renewable energy systems in their buildings.

4. Implementation and improvement of Building Codes: Building codes do exist on renewable energy but they focus only on solar energy integration. Also, the building codes are not followed with regularity in Pakistan, which needs to be addressed. Federal and provincial governments can play a crucial role by assuring the implementation of regulations ₩to promote the widespread use of renewable energy sources in buildings.

COST ANALYSIS OF BUILDING DESIGN FEATURES

The existing building selected for the case study is the double-story Automotive Centre of the University of Engineering and Technology Lahore (UET Lahore). It has a total area of 6903.6 m2 (74312.16 ft2).[69]

Figure 39 - Automotive Centre of University of Engineering and Technology Lahore

Further details of the building have been provided in Table 5.

Table 29 - Detailed Information on Building

Parameter	Value/Description
Building Orientation	Long Axis facing North-South
Number of *stories*	2
Total Area	6903.6 m2
Total Volume	10666 m3

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[69] *Ahsan, Muhammad Mubashir, Muhammad Zulqernain, Hassaan Ahmad, Basit Ali Wajid, Saqib Shahzad, and Muzamil Hussain. "Reducing the operational energy consumption in buildings by passive cooling techniques using building information modelling tools." International Journal of Renewable Energy Research (IJRER) 9, no. 1 (2019): 343-353.*

Total Area of Exposed Walls	640 m2
Total Windows Area	368.6 m2
Window-to-Wall Ratio	0.58
Floor Height	9.15 m (30 ft.)
Indoor Design Temp.	260 C
Operating Schedule	8 am- 8 pm (260 Days)
Occupancies	250 persons
Infiltration Rate	0.25 EACH
Lighting Level	400 lux
Appliances (Computer)	80 (Heat Output 160W/PC)

BASELINE DESIGN

The materials under consideration include brick plaster for wall finishes, single-glazed aluminum frames for windows, brick tiles for roofing, exterior paving for the flooring, and hollow-core plywood for the doors.

Applying Retrofitting Techniques

The following techniques are applied to convert a normal/ conventional building into a green one.

- Replacement of Single Glazed Windows with Double Glazed
- Modification of Window-to-Wall Ratio
- Application of Insulation
    - Selection of the most efficient insulation

    - Selection of optimum insulation thickness

- Application of Energy-Efficient Lighting

Assuming that all the previously single-glazed windows in the building are replaced with brown-tinted double-glazed windows while maintaining other parameters unchanged. This is considered because double-glazed windows' benefits reduce energy consumption and enhance indoor comfort levels. It's worth noting that substantial energy savings can be achieved through envelope insulation and energy-efficient lighting.

Additionally, the notably large WWR is optimized to fall within the range of 0.33 to 0.37, by the recommendations set forth by the Building Energy Codes of Pakistan. Furthermore, the existing 40W fluorescent tube lights are assumed to be replaced with 25W LED lights of the same luminous intensity.

REPLACEMENT OF SINGLE-GLAZED WINDOWS WITH DOUBLE-GLAZED

Replacement of single-glazed windows with brown-tinted double-glazed ones, while maintaining all other factors unchanged, can result in a 4.17% reduction in annual thermal loads.

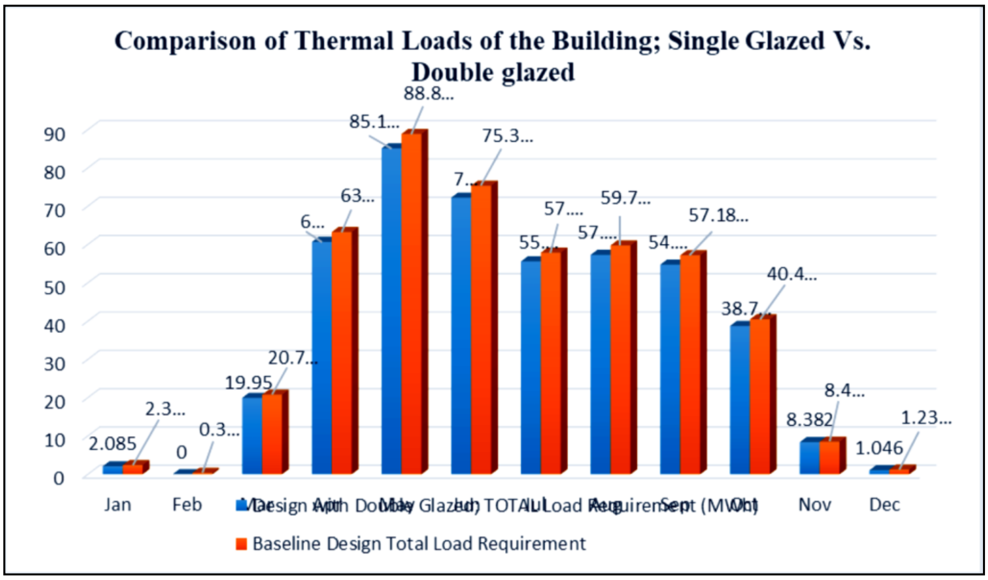

Figure 40 - Comparison of Thermal Loads for Single Glazed and Double Glazed Window

- Annual Load with Single Glazed Windows = 476.024 MWh

- Annual Load with Brown Tinted Double Glazed Windows = 456.150 MWh
- Load Saving = 4.1683%

MODIFICATION OF WINDOW-TO-WALL RATIO

In alignment with the guidelines stipulated by the Building Energy Codes of Pakistan, we have undertaken the reduction of the total window area from 368.6 m2 to 237 m2, accompanied by the implementation of shading measures on the remaining windows. This intervention has revealed an optimal window-to-wall ratio of 0.37, a configuration that minimizes thermal loads.

Subsequently, when comparing the total thermal loads post-optimization with the baseline design, our findings indicate a notable decrease in energy consumption, specifically amounting to 1.96%.

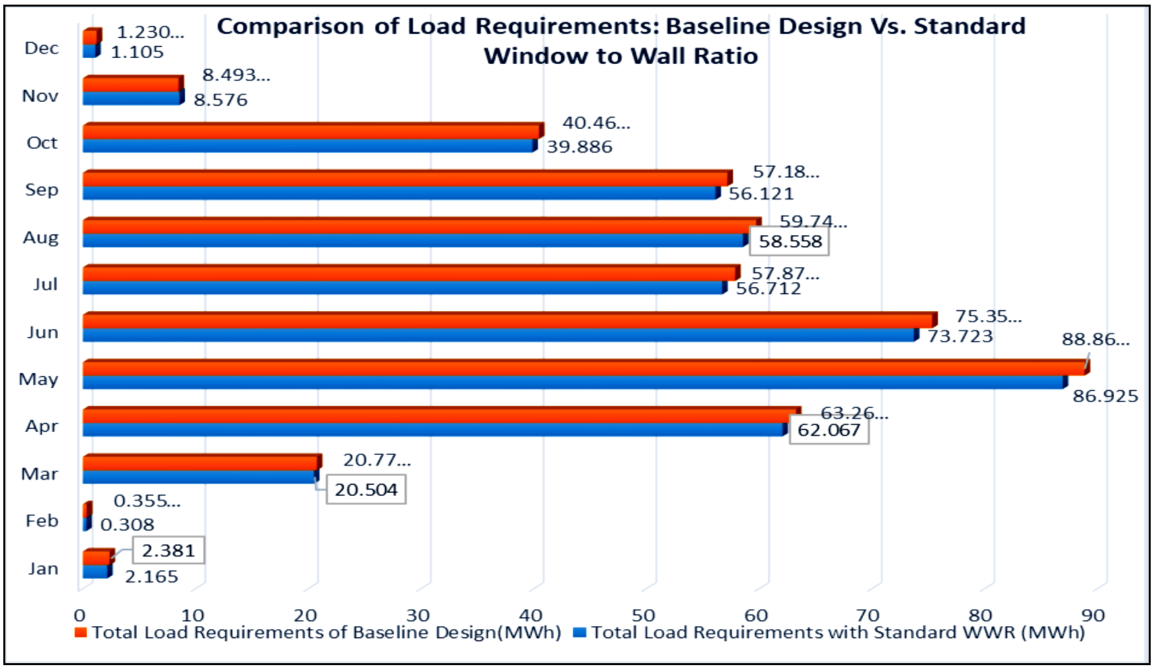

Figure 41 - Baseline Design (Actual) vs Standard Window-to-Wall Ratio for Green Building

- Annual Load with WWR of 0.58 (existing) = 476.024 MWh
- Annual Load with WWR of 0.37 (after retrofitting) = 466.651 MWh
- Load Saving = 1.962%

APPLICATION OF INSULATION

Roof Insulation

The roofing system has been insulated to minimize heat gains and reduce the cooling load of the building. To achieve this objective, the optimal insulating material has been selected, employing four types: cellulose, polystyrene, polyurethane foam, and rock wool. For the sake of comparison, a uniform insulation thickness of 2 inches has been applied on both the exterior and interior sides of the roof.

Findings indicate that polystyrene foam (high density) stands out as the most effective insulating material. However, it's important to note that due to its high flammability, it necessitates an additional layer of fireproof coating material. Typically, this involves the application of a fireproofing chemical known as Hexabromocyclododecane.

On the other hand, rock wool lacks additives that confer fire resistance, making it less suitable for use in extremely hot conditions, though it is inherently non-combustible whereas polyurethane foam employs CFC gas as a blowing agent, which contributes to ozone layer depletion.

Table 30. Insulations and their U values

Type of Insulation	U value (W/m2. K)	Density (kg/m3)	Specific Heat (J/kg. K)	Conductivity (W/m. K)
Cellulose	0.38	43	1,380	0.042
Polystyrene Foam	0.08	46	1,130	0.008
Polyurethane Foam	0.37	60	1,757	0.042
Rock Wool	0.31	200	710	0.034

Table 31. Total Load and Load Saving Using Each Insulation

Month	**Total Load (MWh)**			
	Cellulose	**Polystyrene Foam**	**Polyurethane Foam**	**Rock Wool**
Jan	0.36	0.309	0.358	0.343
Feb	0.003	0.959	0.003	0.002
Mar	15.29	15.011	15.288	15.21
Apr	45	43.91	44.8	44.551
May	62.17	60.884	62.17	61.81
Jun	52.8	51.714	52.8	52.497
Jul	42.275	41.524	42.275	42.065
Aug	44.301	43.557	44.301	44.093
Sep	42.075	41.347	42.075	41.871
Oct	29.953	29.442	29.953	29.809
Nov	7.933	7.837	7.933	7.906
Dec	0.361	0.367	0.361	0.122
Grand Total	342.317	336.861	342.317	340.279
Percentage Load Saving	28.132%	29.293%	28.132%	28.50%

Cellulosic insulation is the most eco-friendly insulating material, fire resistant and suitable thus it is finalized.

Optimizing Insulation Thickness

Analysis for optimizing insulation thickness has been conducted, involving the variation of insulation thickness from 0.25 inches to 8 inches in increments of 0.25 inches. It encompassed the evaluation of both annual load savings and the associated costs of insulating materials, with the final selection of the optimum thickness predicated upon cost considerations.

The graph given below (Figure 17) reveals a noteworthy surge in annual load savings, peaking at 10%, up to a thickness of 4 inches. Subsequently, the rate of increase in load savings diminishes significantly, causing a mere 0.6% increase up to 8 inches. This latter trend entails an increase in insulation costs. Consequently, 4 inches of thickness is selected as the optimized insulation thickness.

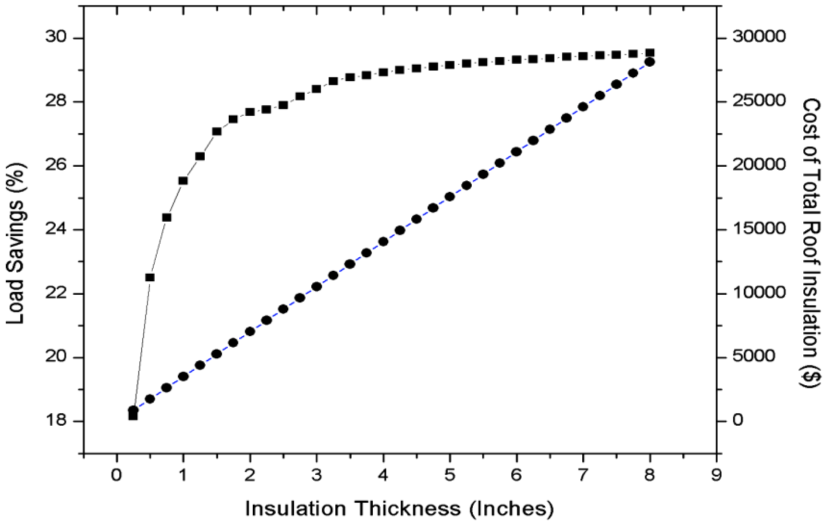

Figure 42 - Annual Load Saving and Insulation Cost Varying

APPLICATION OF ENERGY-EFFICIENT LIGHTING

The fluorescent tube lights used in the conventional building (40W) when replaced with 25W LED lamps to make it green (same luminous intensity), give a total 1.91% load saving.

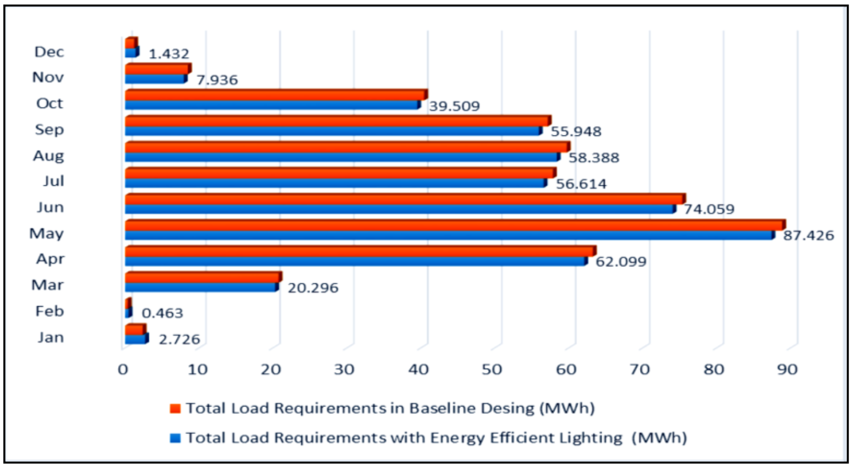

Figure 43. Thermal Loads by using energy-efficient lighting compared with the actual baseline design

OVERALL HEATING AND COOLING LOAD SAVINGS BY ALL TECHNIQUES

The effects of all the considered retrofits on the reduction of cooling and heating load requirements of the building are given below.

Table 32 - Overall Heating and Cooling Load Savings

Component	**Composition After Retrofitting**	**Parameter**	**Actual Value**	**After Retrofitting**
Walls	Ceramic Tiles 0.5", Cement	U value of Walls	1.882 W/m2. K	1.882 W/m2. K

	Plaster 3/8″, Brick Masonry 9″, Paint Coat 1/4″			
Windows	Glass Standard 5/8″, Air Gap 1″, Glass Standard 5/8″	U value of Windows	6.065 W/m2. K	2 W/m2. K (Double Glazed)
Roof	Paint Coat 1/4″, Cellulosic Insulation 4″, Cement Plaster 3/8″, Roof Tile 1″, Cement Plaster 3/8″, Cellulosic Insulation 4″, Paint Coat 1/4″		4.921 W/m2. K	0.115 W/m2. K (Insulated)
Window to Wall ratio	Standard	WWR	0.58	0.37
Roof Insulation	Cellulosic Insulation	Insulating Material	No Insulation	4 Inch Cellulosic Insulation
Lights	L.E.D. Lights	Lights Power Rating	40 W	24 W

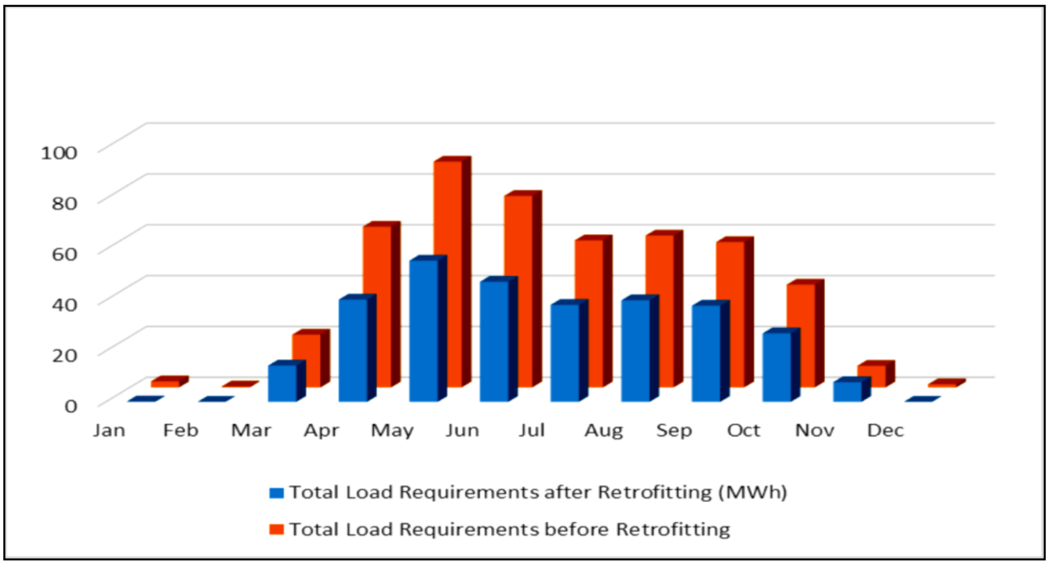

Figure 44. Load Requirements Before and After Retrofitting

OVERALL COST OF FEATURES

The cost of retrofitting techniques and electricity has been calculated and is given below. The table given below summarises the unit cost (Table 9).

Table 33. Uni Costs for Retrofitting and Electricity

Attribute	Unit Price ($)
Electricity price per kWh for commercial connections (inc' GST)	0.153
Cost of cellulose Insulation per square foot	0.408
Double glazed windows	5.1
23 W LED bulbs (Osaka Lightings)	3.1314
The price of a Cement bag of 50 kg	4.3044

The electricity cost is based on Lahore Electric Supply Company's general supply Tariff (2018) for commercial connections while the cost of cellulose insulation per square foot and that of windows per square foot are calculated with the help of quotes available online.

Note: The 2% inflation rate is adjusted to convert the cost in 2018 into 2023

Table 34. Costs and Savings of Green Building

Retrofitting Technique	Details of Cost	Unit Price ($)	Total Area to be retrofitted (ft^2) or Number of Parts/pieces Required	The total cost of the technique ($)	Annual Load Saving (kWh)	Energy Efficiency	Estimated Price of electricity per (kWh)	Annual Electricity Saving (kWh)	Annual saving in terms of electricity ($)
Cellulosic Insulation		0.408	50209.3365	20485.409	167506	3	0.153	55835.33	8542.805
Double Glazed Windows		5.1	2551	13010.1	19841	3	0.153	6613.667	1011.891
Energy Efficient Lighting (Thermal Load Saving)		3.13140	120	375.768 0	9083	3	0.153	3027.667	463.2331

Energy Efficient Lighting (Direct Electricity Saving)							0.153	5920	905.76
Modification in Window to Wall Ratio and Shading	Bricks cost per piece	0.0816	5000	408	9339	3	0.153	3113	476.289
	50 kg Cement bag	4.3044	20	86.088					
	Estimated Labor cost			1958.4					
Total Cost/Saving				**36323.765**	205769			74509.67	**11399.98**

PAYBACK PERIOD

- Payback Period = Total cost of retrofitting for converting into green building / Total annual saving
- Payback Period = 36323.765/ 11399.98
- Payback Period = 3.18 years
- Payback Period = 3 years 2 months

The cost analysis of different design features used in a building shows that the overall initial cost of incorporating green design is high but the payback period is **3 years and 2 months**, which makes green architecture an economically feasible alternative.

DEMAND AND REFLECTION OF GREEN ARCHITECTURE

Limited adoption of environmentally friendly and energy-efficient building designs in Pakistan is primarily caused by low awareness of innovative building design features such as simulation software, window-to-wall ratio, nature-based solutions, and renewable energy systems among the general public and professionals, resulting in low demand for green buildings nationwide. Nevertheless, numerous advantages and opportunities make the adoption of green buildings environmentally friendly and cost-effective for Pakistan. The graphical representation of the analysis of the value chain and the challenges and opportunities that exist in the value chain of green building design in Pakistan are illustrated below in Figure 20.

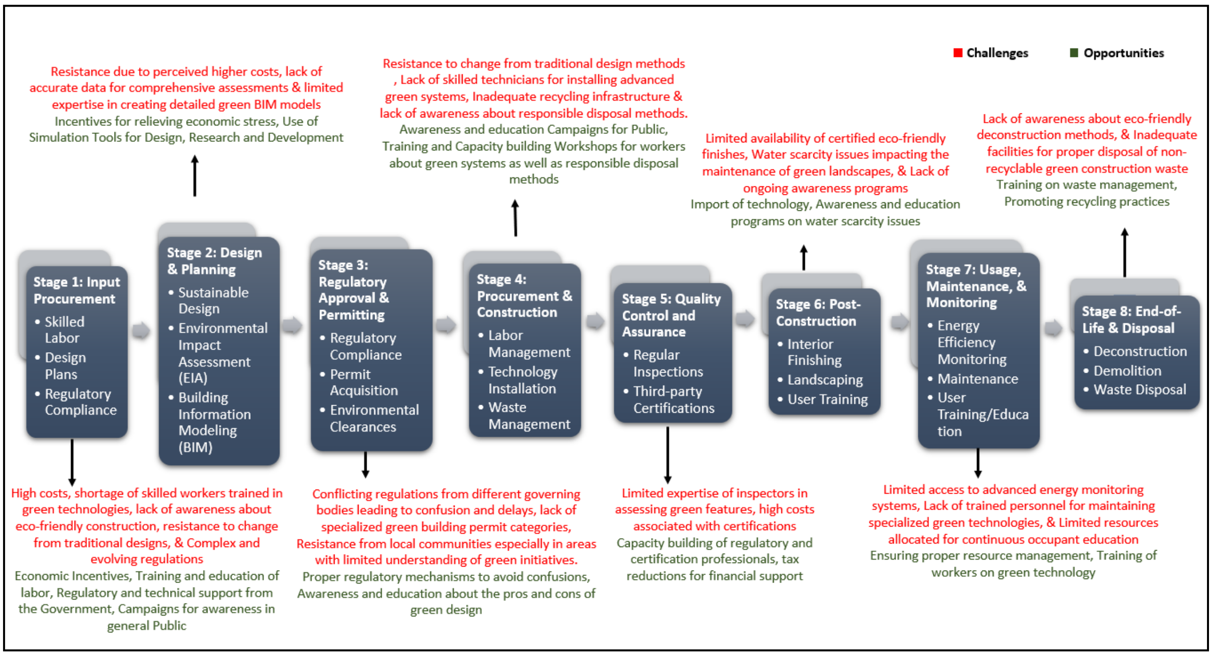

Figure 45 - Challenges and Opportunities in the Design Stages of green buildings in Pakistan Value chain

CHALLENGES IN IMPLEMENTING GREEN ARCHITECTURE

Pakistan is a developing country and lacks sustainable green building design in its construction sector. The reasons for the low demand for green architecture are as follows:

1. Lack of Awareness of Workforce and Public

In Pakistan, there is a significant lack of awareness among architects, owners, builders, and the general public about the benefits of green building practices. Many individuals may not fully understand the advantages of sustainable architecture or may be unaware of the available eco-friendly design options such as WWR, building orientation, biophilic design, or renewable energy integration. Also, many individuals have a strong preference for traditional practices and aesthetics, making it challenging to introduce new green building design concepts.

2. Weak Enforcement of Green building codes and policies

Building codes such as the PEC Building Code 2021 and the NEECA National Energy Conservation Code 2023 have detailed sections on guidelines about building design principles such as Orientation, WWR, Green roofing systems, and solar system integration but these guidelines are not being followed in the country. There are no proper mechanisms for ensuring the implementation of these building codes.

3. Economic Constraints

Economic considerations play a crucial role in the construction industry. Green building design features and technologies can be more expensive upfront compared to conventional options such as renewable energy, and green roofs. In a country like Pakistan, where cost-effectiveness is a significant concern, the higher initial costs of green design can deter potential investors.

4. Limited Access to Technology

The availability of green building design technologies such as wind energy systems, biomass boilers, Green roofing systems, and other biophilic design elements such as living walls are either limited or not present in most regions of Pakistan. The lack of easy access to these materials leads builders to opt for conventional alternatives.

5. Lack of Skilled Professionals

Pakistan faces a shortage of professionals with expertise in sustainable building design strategies. Without a sufficient number of architects, designers, and builders who understand green construction principles, the effective implementation of eco-friendly designs becomes difficult. The skilled professionals also lack knowledge on the use of simulation software such as Revit, COMFEN, and, other BIM modeling software, which has become mandatory to understand the applicable design strategies in a building.

STRENGTHS OF EXISTING BUILDING DESIGN IN PAKISTAN

The existing infrastructure in Pakistan has the following strengths which can be utilized and channeled for implementing green buildings and promoting green architecture in Pakistan.

1. Cultural Heritage and Architectural Diversity

Pakistan's rich cultural and architectural heritage, showcased by landmarks like the Badshahi Mosque and Lahore Fort, can serve as a wellspring of inspiration for contemporary building design. The nation's diverse regional influences have given rise to an array of architectural styles, offering architects a unique palette to create culturally resonant and visually captivating structures.

2. Craftsmanship and Resilient Practices

Pakistan possesses a longstanding heritage of proficient craftsmanship within the domain of architectural design. These skills can be strategically used to formulate building designs that are not only energy-efficient but also ecologically sustainable. Furthermore, traditional construction techniques prioritize resilience in the face of natural disasters, incorporating earthquake-resistant designs and locally sourced materials, which can be utilized during the use of green building design.

3. Adaptability and Community Engagement

Local builders and designers in Pakistan possess a remarkable ability to work with available resources while adapting designs to suit the local climate and cultural preferences, which can be beneficial for green architecture. In many cases, involving the community in building projects fosters a sense of ownership and ensures harmonious integration with the surroundings.

4. Geographical Advantages and Investment Opportunities

Situated at a crucial crossroads of trade routes, Pakistan's strategic geographical location holds immense potential for the development of modern infrastructure and transportation networks. This, in turn, can attract substantial domestic and foreign investment, fuelling the nation's growth.

5. Natural Integration and Technological Innovation

Pakistan's breathtaking natural landscapes provide a unique opportunity to seamlessly integrate nature into architectural designs, resulting in visually appealing and sustainable buildings. Moreover, as technology continues to advance, Pakistan has the chance to incorporate cutting-edge innovations in construction materials, renewable energy solutions, and smart building technologies into its architectural repertoire.

6. Educated Professionals in Modern Infrastructure

The country benefits from a pool of highly educated professionals in the fields of architecture, engineering, and related disciplines. These experts can be trained to shift towards sustainable design strategies.

OPPORTUNITIES IN ADOPTING GREEN ARCHITECTURE IN PAKISTAN

The following opportunities exist in Pakistan's construction sector which can be utilized by shifting toward sustainable and green architecture:

1. Addressing the Energy Shortage in a Nation Struggling with Frequent Power Outages

Pakistan faces a growing energy crisis, with buildings consuming about 50% of Pakistan’s energy. To address this, Pakistan can embrace green building practices, like building orientation, optimal WWR, biophilic design elements, and green roofs, to reduce energy use and improve comfort, which can lead to energy cost savings of up to 30-40% on average. This aligns with sustainable development goals, such as Goal 7 (Affordable and Clean Energy), Goal 13 (Climate Action), and Goal 11 (Sustainable Cities and Communities). Given ample sunlight, integrating solar panels and other renewable energy sources into buildings can also promote renewable energy and reduce greenhouse gas emissions, further supporting sustainable development goals.

2. Cost Savings in Operations

Integrating sustainable building design practices into a building can offer a vast amount of energy cost-saving potential from different aspects such as **WWR saving up to 12-40% of energy cost**, **orientation saving up to 10-40% of energy cost, green roofing systems saving up to 35% of energy cost**, and renewable energy integration which can shift the whole energy consumption to renewable sources.[70, 71] Given the circumstances, the potential for substantial growth offers a positive outlook for the green building industry to thrive, promising sustained rental income in the long run. This growth aligns with Goal 11 (Sustainable Cities and Communities) by ensuring accessible and sustainable housing for all.

3. Enhanced Quality of Life

Traditional building design methods in Pakistan often result in cramped living spaces with limited ventilation and poor indoor air quality for occupants. In contrast, green buildings prioritize fresh and healthy indoor air quality as a fundamental design element. Green buildings achieve improved indoor air quality by utilizing good orientation, nature-based solutions, and windows for heating and cooling. Consequently, green building practices

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70 Ruihua Ma, Ruijiang Ma, Enshen Long, Analysis of the rule of window-to-wall ratio on energy demand of residential buildings in different locations in China, Heliyon, Volume 9, Issue 1,2023,e12803, ISSN 2405-8440, https://doi.org/10.1016/j.heliyon.2023.e12803

71 Mahmoud, A. S., Asif, M., Hassanain, M. A., Babsail, M. O., & Sanni-Anibire, M. O. (2017, March 29). Energy and economic evaluation of green roofs for residential buildings in hot-humid climates. MDPI. https://www.mdpi.com/2075-5309/7/2/30#:~:text=The%20case%20study%20showed%20that,of%2024%25%20to%2035%25.

offer a distinct advantage over conventional design techniques by creating a better and healthier lifestyle for occupants.

4. Promoting Sustainable Design Practices

Transitioning from these conventional design practices to energy-efficient alternatives holds the potential not only to conserve energy but also to curtail greenhouse gas emissions wind energy systems can save emissions up to **0.75- 2.2 Mt CO_2 per year** and the use of biomass boilers can save **95% to 99%** emissions as compared to fossil fuel-based energy.[72] Additionally, the use of sustainable design practices aligns with Pakistan's goal of promoting responsible consumption and production, a crucial aspect of the Sustainable Development Goals (SDGs).

5. Utilizing the labor in an effective way

Pakistan boasts a substantial labor force of 68.75 million individuals.[73] This surplus of labor resources can lend support to the adoption of green building practices. Leveraging this circumstance presents an opening to promote the use of affordable labor for the integration of green building practices. This aligns with Goal 8 (Decent Work and Economic Growth) of the SDGs by creating employment opportunities.

6. Integration of Cultural design and modern technology

Building designs can be enhanced by integrating cultural elements and architectural heritage specific to Pakistan. This not only preserves cultural identity but also creates a sense of place in modern designs. By promoting a connection between modern

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72 Emma Dayan, Wind energy in buildings: Power generation from wind in the urban environment - where it is needed most, Refocus, Volume 7, Issue 2, 2006, Pages 33-38, ISSN 1471-0846, https://doi.org/10.1016/S1471-0846(06)70545-5.

73 https://www.pbs.gov.pk/sites/default/files/labour_force/publications/lfs2020_21/LFS_2020-21_Report.pdf architecture and cultural roots, sustainable design practices can contribute to Goal 11 (Sustainable Cities and Communities) by fostering community cohesion.

4. CONCLUSION AND WAY FORWARD

The building sectors such as the residential and commercial contribute most to the energy consumption in Pakistan. The analysis of building design in Pakistan shows a lack of sustainable design practices in the residential, commercial, and public sectors due to lack of awareness of architects and the public, lack of technology, and lack of implementation of building codes being the major reasons. The NEECA National Energy Conservation Code 2023 contains detailed guidelines on building orientation, WWR, green roofing systems, and renewable energy use. Integrating sustainable building design practices into a building can offer a substantial amount of energy cost-saving potential from different aspects such as WWR saving up to 12-40% of energy cost, orientation saving up to 10-40% of energy cost, green roofing systems saving up to 35% of energy cost, and renewable energy integration, which can shift the whole energy consumption to renewable sources. The cost analysis showed that by transitioning conventional buildings into green buildings from a design perspective payback can be received in about 3 years from energy savings. This demonstrates that embracing green building practices is cost-effective and environmentally friendly. There exist enormous strengths and opportunities in the construction sector that can be used to assist in the shift towards greener and sustainable design practices in Pakistan.

Looking ahead to the future of green buildings in Pakistan, there are both challenges and opportunities to consider. Pakistan faces energy shortages and environmental concerns. Green buildings emerge as a promising solution to address these issues and promote economic growth, social well-being, and ecological balance. By incorporating energy-efficient technologies and innovative design methods, green buildings can transform Pakistan's construction sector.

However, there are some hurdles to adopting green building practices. These include concerns about high initial costs, economic realities, and the need to raise awareness among all stakeholders. It's important to review and improve the green building principles outlined in building codes and policies. In essence, a promising future awaits green buildings in Pakistan through collaboration, the sharing of knowledge, and an environment that supports green buildings and sustainable building design practices. By envisioning a future where buildings harmonize with nature and enhance people's well-being, Pakistan can pave the way for resilience, sustainability, and overall vitality.

Appendix 6. Analysis of Situation and Opportunities in Building Construction Material

1. INTRODUCTION

PURPOSE OF THE REVIEW AND ANALYSIS

The report evaluates the structural integrity of the existing infrastructure in Pakistan, with a focus on the materials used and their impacts. This document however focuses on three major types of buildings that currently exist in the country

- **Residential Buildings:** In Pakistan residential/domestic buildings range from modern apartments to traditional houses with courtyards. These buildings use various construction materials such as brick, mud, concrete, and steel.
- **Commercial Buildings:** Commercial buildings mainly consist of offices, retail stores, malls, hotels, restaurants, and warehouses. These buildings employ a variety of construction materials including steel, concrete, wood, aluminum, and glass, to ensure durability and functionality.
- **Public Buildings:** Public buildings in Pakistan are of various types such as government offices, schools, hospital buildings, religious places, and transportation hubs. These buildings accommodate large crowds with accessibility features.

The evaluation has considered various aspects of the building's structural integrity and has identified the structural enhancements necessary for the transition from conventional buildings to green buildings. This includes an assessment of conventional materials used in the construction of the building sector and the potential of green materials that can replace the current materials. Moreover, it compares the cost of the buildings calculates the energy savings that can be obtained by using sustainable materials, and computes the payback period for the transition of conventional buildings into green buildings. Along with addressing the critical issue of the supply chain for green construction materials, the report recommends measures to promote green construction practices within Pakistan.

BACKGROUND

The construction industry is experiencing a significant boom and is estimated to grow by 35% as compared to the previous decade. The global construction market is expected to expand from US$4.5 in 2021 trillion to US$15.2 trillion in 2030, with China, India, US, and Indonesia accounting for 58.3% of the forecasted growth. According to the World Bank, the construction industry is the largest global consumer of raw materials with the construction environment accounting for 25% to 40% of the world's total GHG emissions.

Construction materials used in Pakistan are mostly conventional such as steel, cement, glass, bricks, and wood. These are not always economical, environmentally friendly, and health-conscious. However, by using sustainable alternatives many of these drawbacks can be mitigated. Cement is commonly used in Pakistan but cement production is an energy-intensive process that leads to substantial expenses replacing it with fly ash cement can offer a more cost-effective and environmentally friendly alternative. Glass can be really expensive when it is used in large and intricate designs but it can be substituted by insulated glass that is cost-effective in long term due to energy efficiency. Traditional bricks are affordable but less sustainable thus fly ash bricks can be a sustainable alternative.

Furthermore, these construction materials result in carbon emissions for instance steel is a widely favored metal selection for constructing buildings in Pakistan but its production is associated with significant carbon emissions. By choosing sustainable alternatives such as bamboo or recycled steel, environmental impact can be significantly reduced. In Pakistan, traditional glass is a commonly utilized building material. However, it keeps the building warm in summer and thus requires more cooling resulting in carbon emissions. By using low emissivity windows or insulated glass units, buildings keep cool in summer and warm in winter hence the energy consumed by the Heating, Ventilation, and Air Conditioning (HVAC) system resulting in reduced carbon emissions. Similarly, replacing conventional bricks with fly ash bricks conserves natural resources and minimizes the environmental footprint.

Moreover, sustainable materials such as rammed earth or bamboo do not emit harmful chemicals contributing to a healthier indoor environment. Likewise, fly ash cement is durable and safe benefiting the safety of residents. Bamboo and low-VOC paint ensure better indoor air quality, and green roofs and galvanized sheet roofing offer improved insulation and provide a better indoor environment resulting in health benefits for occupants.

However, it is difficult to meet the ever-growing demand for buildings by adopting only sustainable materials and construction methods. Hence, there is a need for optimum utilization of available energy resources and raw materials to produce simple, energy-efficient, environment-friendly, and sustainable building alternatives and techniques to satisfy the increasing demand for buildings.

2. PAKISTAN GREEN BUILDING SCENARIO

Currently, Pakistan lacks the adaptation of sustainable materials in the building construction sector, primarily because of the high initial costs, the lack of awareness regarding the benefits of using these materials, and the absence of a dedicated supply chain. According to Green Building Information Gateway (GBIG), Pakistan contains 17 LEED-certified green buildings with 13 registered with the US Green Building Council and 1 with an achiever award, making a list of 31 total green buildings in the country.[74] This number is quite low compared to other developing countries; where India has 323 certified LEED buildings[75] and Turkey reported 518 certified green buildings.[76]

Additionally, in Pakistan, the green building approach suffers from market barriers, for instance, there is a lack of government intervention in the market and inadequate tax incentives for green building materials. Besides, Pakistan's construction industry lacks training for sustainable material usage resulting in lesser awareness about the benefits of using these materials at the micro level. Also, the supply chain for sustainable materials is weak in Pakistan, consequently increasing the costs of materials. Although some green and recyclable materials such as fly ash bricks, bamboo, and recycled steel are gaining popularity in building construction but are in a nascent state. Hence, the phenomenon of using green building materials is very novel and not widely practiced in Pakistan.

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74 Azeem, S., Naeem, M.A., Waheed, A. (2020). Adoption of Green Building Practices in Pakistan: Barriers and Measures. In: Gou, Z. (eds) Green Building in Developing Countries. Green Energy and Technology. Springer, Cham. https://doi.org/10.1007/978-3-030-24650-1_11

75 https://www.usgbc.org/articles/top-10-countries-leed-demonstrate-green-building-truly-global-movement

76 Akcay, E. C. (2023). Barriers to Undertaking Green Building Projects in Developing Countries: A Turkish Perspective. Buildings, 13(4), 841. MDPI AG. Retrieved from http://dx.doi.org/10.3390/buildings13040841

BUILDING CODES AND FRAMEWORKS IN PAKISTAN

The latest **Building Code of Pakistan (2021)** provides a minimum benchmark to ensure seismic resilient building design based for all new buildings. It has comprehensive guidelines on traditional constructional materials (concrete, steel, wood, and glass), but these guidelines are mainly focused on the structural strength aspects of these materials to make the structure robust against **seismic threats** in the future. Furthermore, it lacks guidelines about material usage in buildings from the point of view of energy savings in buildings.[77]

On the other hand, The Energy Efficiency of Buildings section is not included in **Building Code 2021**. as they were covered in Building Code of Pakistan-Energy Provisions 2011.[78] [79] However, Energy Provisions 2011 is no longer used in Pakistan and has been replaced by **the Energy Conservation Building Code 2023 (Pakistan) (ECBC-2023).** The codes focusing on energy-efficient building materials are being prioritized because energy demand in the country has enhanced substantially. To further increase the future adaptation of sustainable materials reducing electricity consumption and carbon footprints should be included in future provisions of the building code because it will provide a legal framework for the adaptation of sustainable materials in the construction of buildings.

Moreover, SWITCH-Asia-EU – EU, in collaboration with the Ministry of Climate Change (MoCC), Pakistan Engineering Council (PEC), UN-Habitat, and the International Code Council (ICC), has successfully developed the **Green Building Code Provisions**. These provisions are based on the 2018 International Green Construction Code (IgCC-2018), ASHRAE 90.2 2018, and various research projects (Arif 2022/NRPU 9626) conducted in

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77 https://www.pec.org.pk/downloads-documents/building-code-of-pakistan/

78 https://www.pec.org.pk/downloads-documents/building-code-of-pakistan/

79 https://codes.iccsafe.org/content/PKBC2021P1/chapter-13-reserved

Pakistan.[80] Chapter 5 of this green building code discusses **materials** and **resources** that need to be incorporated into buildings. This document was prepared for the Naya Pakistan Housing scheme and addresses the need for transition to green materials and provides suggestions for incorporating sustainable materials employing recycling waste, replacing hazardous materials, and usage of insulation to reduce energy requirements. Although it does not provide comprehensive guidelines to transit completely on these materials it can be used as initial guidelines for incorporating sustainable materials in new housing schemes.

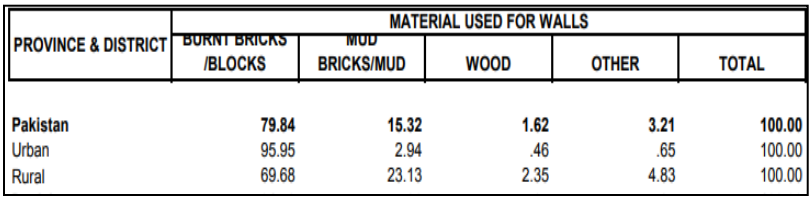
Buildings in Pakistan can adopt green materials and strategies that comply with the Energy Conservation Building Code 2023. The code was developed to improve energy efficiency in buildings. ECBC provides minimum requirements for energy-efficient designs and construction of buildings and includes international best practices appropriate to Pakistan's environment. This document can be utilized as a useful framework for encouraging the adaptation of green materials. It covers materials that can be replaced and used instead of conventional materials in the construction phase and the materials that can help in opting energy energy-efficient designs to enhance the operational phase of buildings.

9. CONSTRUCTION MATERIALS PRACTICES IN PAKISTAN

In Pakistan construction industry primarily relies on a variety of materials. The energy conservation pattern exhibited by these materials is still lacking as compared to other countries because hardly any appropriate measure has been taken for heating, cooling, leakage, or orientation.

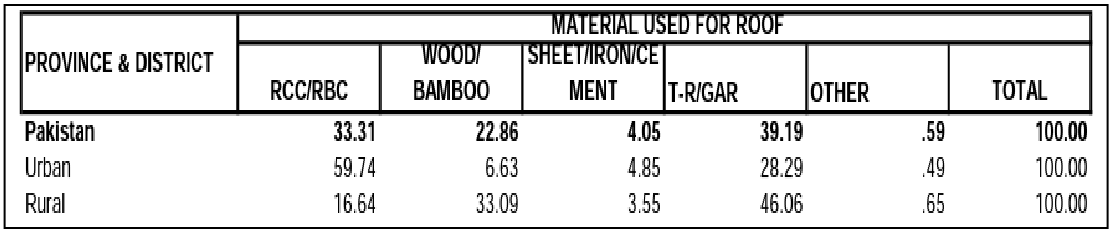
The figures given below represent the distribution of construction material according to the material used for walls.

80https://www.switch-asia.eu/site/assets/files/3619/model_green_building_code_pakistan.pdf



PROVINCE & DISTRICT	MATERIAL USED FOR WALLS				
	BURNT BRICKS /BLOCKS	MUD BRICKS/MUD	WOOD	OTHER	TOTAL
Pakistan	**79.84**	**15.32**	**1.62**	**3.21**	**100.00**
Urban	95.95	2.94	.46	.65	100.00
Rural	69.68	23.13	2.35	4.83	100.00

Figure 46: Housing Units in Pakistan by Construction Material (Source: Pakistan BUREAU of Statistics 2019-20)

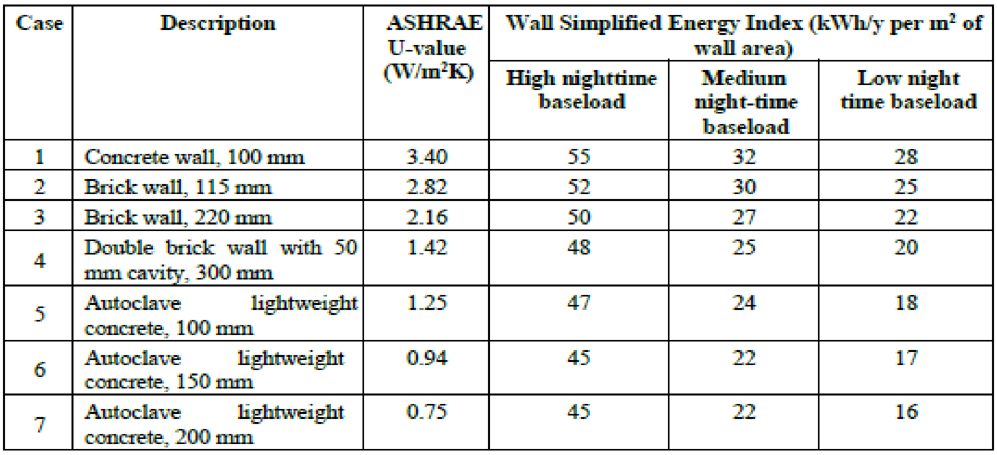


PROVINCE & DISTRICT	MATERIAL USED FOR ROOF					
	RCC/RBC	WOOD/ BAMBOO	SHEET/IRON/CEMENT	T-R/GAR	OTHER	TOTAL
Pakistan	**33.31**	**22.86**	**4.05**	**39.19**	**.59**	**100.00**
Urban	59.74	6.63	4.85	28.29	.49	100.00
Rural	16.64	33.09	3.55	46.06	.65	100.00

Figure 47: Percentage Usage by Material Used in Roofs (Source: Pakistan BUREAU of Statistics 2019-20)

The statistics show intensive usage of concrete and bricks in urban construction while the usage of bamboo and gar is quite prevalent in rural areas. With increasing urbanization, the utilization of bricks and concrete is expected to mount up in urban areas, the higher consumption of this material will consequent in the heat island effect due to the adoption of concrete, and needs to be mitigated by using sustainable materials. Although bamboo and gar are used in higher percentages in rural areas with increasing urbanization fewer people prefer them so the adoption of these and other sustainable materials should be enhanced in both urban and rural areas. In addition, modern techniques should be used to make them resilient and aesthetically appealing

Furthermore, Pakistan lies in a temperate climate zone and according to **Energy Conservation Building Code 2023**, in a temperate climate zone, using appropriate building materials with insulating properties can substantially decrease energy consumption. Hence it is essential to identify the varying energy-saving potential of wall materials with different coefficients of heat transfer (U-values). The estimated values are provided below in Figure 3, these values are based on an energy simulation study outlined in the report of **Building Sector Energy Efficiency Project-2021 (BSEEP)**.



Case	Description	ASHRAE U-value (W/m^2K)	Wall Simplified Energy Index (kWh/y per m^2 of wall area)		
			High nighttime baseload	Medium night-time baseload	Low night time baseload
1	Concrete wall, 100 mm	3.40	55	32	28
2	Brick wall, 115 mm	2.82	52	30	25
3	Brick wall, 220 mm	2.16	50	27	22
4	Double brick wall with 50 mm cavity, 300 mm	1.42	48	25	20
5	Autoclave lightweight concrete, 100 mm	1.25	47	24	18
6	Autoclave lightweight concrete, 150 mm	0.94	45	22	17
7	Autoclave lightweight concrete, 200 mm	0.75	45	22	16

Figure 48: Estimated Electricity Reduction for Wall Materials (Source: Public Works Department Malaysia-2021)

The model considered in the above study was designed using a square building without external shades, with a service core located in the building's center. The high, medium, and low night-time baseloads are associated with night baseloads of 50%, 35%, and 10% of the daytime peak load, respectively. It shows that by reducing the wall material's U-value, the simplified energy index can be decreased. Additionally, the U value of lightweight concrete walls is lower thus energy saving potential increases with reducing concrete in the wall.

Materials that have been traditionally used in Pakistan's construction industry are discussed below along with their impacts.

8. Brick

Clay brick has high energy consumption in the operational phase of buildings because of its low insulation properties[81]. Clay bricks however can be replaced with ash blocks that are 3 times costlier and considerably decrease the requirement of cooling resulting in

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[81] https://ieeexplore.ieee.org/document/9972735

reduced size of the air conditioning system. Hence ash blocks can be an effective substitute for clay bricks.[82]

9. Cement

Cement is a widely used construction material in Pakistan which has multiple negative impacts on the building's operational phase. Cement-based buildings often have high thermal mass, tending to take a long time to heat up or cool down. This results in increased energy consumption, especially in regions with extreme temperature variations. Although the majority of carbon emissions associated with cement occur during its manufacturing, there is still an ongoing carbon footprint during the operational phase due to the energy required for the HVAC system.[83] Alternatively, fly ash cement is an efficient material to reduce the use of cement. Blocks of cement from fly ash have high insulation and a lower carbon footprint which mitigates the negative impacts of cement.

10. Concrete

The use of concrete is problematic in buildings as it adds to the heat-island effect by absorbing the warmth of the sun and trapping gases from car exhausts and air-conditioner units installed in a building.[84] Concrete is widely used in both urban and rural buildings in Pakistan hence energy energy-efficient alternative blends or materials can help to reduce these negative effects. Rammed Earth is a viable alternative that has high insulative properties and high durability against earthquakes.

11. Steel

Steel-framed buildings often require more energy for heating and cooling compared to well-insulated structures. Steel has high thermal conductivity, which results in significant heat loss or gain, depending on the climate. Moreover, steel structures can corrode over time, especially in humid or coastal environments such as Sindh and Balochistan. The corrosion leads to maintenance requirements, including repainting or even structural repairs, which can be costly and resource-intensive.[85] A

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[82] Kumar, Ashok & Buddhi, D. & Chauhan, D. (2011). Indexing of Building Materials with Embodied, Operational Energy and Environmental Sustainability with Reference to Green Buildings. J. Pure Appl. Sci. Technol. 2.

[83] L. Barcelo, J. Kline, G. Walenta, E. Gartner, Cement and carbon emissions. Mater. Struct. 47, 1055–1065 (2014).

[84] P. J. M. Monteiro, S. A. Miller, A. Horvath, Towards sustainable concrete. Nat. Mater. 16, 698–699 (2017).

[85] https://northern-weldarc.com/blog/advantages-disadvantages-structural-steel-structures

sustainable alternative for Pakistan can be a galvanized steel sheet that has high heat resistance and low operational cost making it a more appealing choice.

12. Wood

Pakistan has limited forest cover, encompassing less than 6 % of its total land area.[86] The usage of wood in the building further results in **deforestation** causing loss of carbon sink, reduced biodiversity air quality degradation, and soil erosion. Thus, it is an urgent requirement to replace wood with an alternative material. In addition, wood treatments, finishes, or adhesives emit volatile organic compounds (VOCs), which can affect indoor air quality and occupant health.[87]According to **Energy Conservation Building Code 2023**, wood framing exhibits a lower R-value, allowing heat to conduct more easily compared to insulated regions which increases the energy demand of buildings to cool them. To replace wood works in a building bamboo should be used in Pakistan because of its higher insulation and renewability factor.

13. Traditional Roofing Materials (Asphalt and Metal Tiles)

Asphalt and metal tiles are some of the materials used in the roofing of buildings in Pakistan. They do not provide adequate insulation, leading to higher energy consumption for cooling or heating buildings.[88] Hence, to reduce energy consumption, sustainable insulation materials such as galvanized sheets and bamboo can be viable options for roofing.

14. Non-insulated Glass Windows

Non-insulated windows are less energy-efficient, leading to higher energy consumption for heating and cooling. Unlike insulated glass doors and windows, they do not resist heat.[89] Their insulation ability is not resistant enough to protect the room or building from hot weather. This allows heat to enter more than it would from an insulated glass. In summer or regions where temperatures can be extreme, this can result in significant energy wastage. In Pakistan due to its cost-effectiveness, it's preferred over the other options but it is not suitable in long-term scenarios because energy losses from its usage result ultimately in higher costs. Alternative double-glazing windows with low emissivity are a viable sustainable alternative that can be used instead of non-insulated windows.

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[86] *https://www.wwfpak.org/our_work_/forests/*

[87] *Roffael E. Volatile organic compounds and formaldehyde in nature, wood and wood-based panels. Holz Roh-Werkst. 2006;64:144–149. doi: 10.1007/s00107-005-0061-0*

[88] *https://www.zameen.com/blog/type-roofing-tiles-pakistan.html*

[89] *https://thearchitectsdiary.com/difference-between-insulated-and-non-insulated-glass-doors-and-windows/*

Pakistan continues to grow and modernize, and a strategic shift toward sustainable construction materials is a pressing necessity. The shortcomings in the traditional materials seek the intervention of sustainable alternatives to enhance the overall energy efficiency of the buildings and move towards greener buildings. The construction industry in Pakistan stands at a pivotal state where the adoption of sustainable materials can bring a multitude of benefits. Not only it will address environmental concerns but it will significantly contribute to energy efficiency financial benefits and a resilient future .

10. SUSTAINABLE CONSTRUCTION MATERIALS FOR GREEN BUILDINGS IN PAKISTAN

A large number of viable alternative building technologies have been developed and disseminated over two and half decades. The materials are currently used at a micro-scale in Pakistan but their increased adoption is necessary for a sustainable future. [90]

Table 35: Traditional Materials and Available Sustainable Alternatives In Pakistan

Traditional Materials	Sustainable Alternatives
Clay Bricks	Fly Ash Brick
Traditional Paint	Low VOC Paint
Insulated Glass Window	Low Emissivity Window /Insulated Glass Units
Concrete	Rammed Earth/ Bamboo
Cement	Fly Ash Cement
Wood	Bamboo/PVC flooring
Traditional Roofing Material	Green Roofs/Bamboo/Galvanized Sheet

A comprehensive detail of these alternative materials and some additional green building materials is discussed below:

9) Fly Ash Bricks

Fly ash bricks are made from waste materials produced by coal-fired power plants. They are strong, durable, and environmentally friendly, as they help reduce waste by recycling ash and save energy through high insulative properties. Furthermore, fly ash bricks have excellent insulation properties resulting in less HVAC energy consumption.

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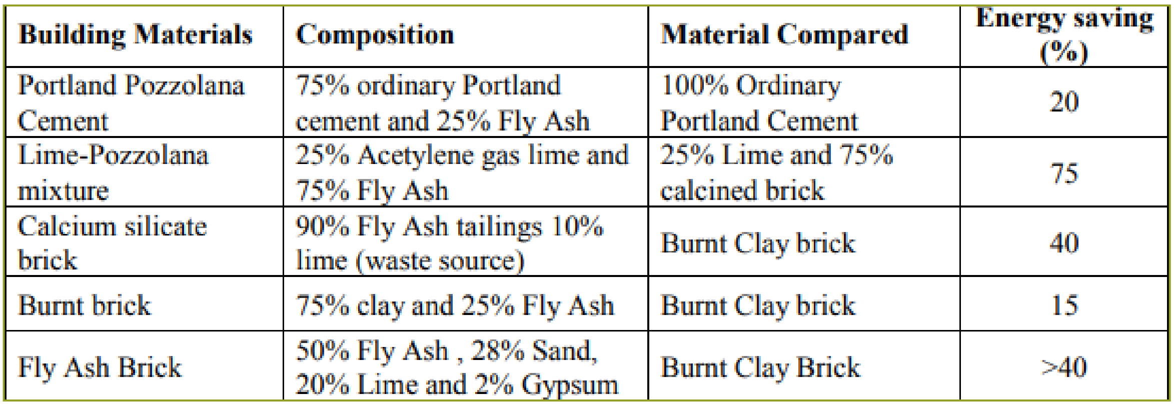
[90] https://www.linkedin.com/pulse/sustainable-materials-construction-muhammad-umar/

Fly ash bricks are a sustainable building material because they have a lower carbon footprint compared to traditional clay bricks. They are also cheaper than traditional bricks, making them an affordable option for construction in Pakistan.

Figure 49: Fly Ash Bricks[91]



Building Materials	Composition	Material Compared	Energy saving (%)
Portland Pozzolana Cement	75% ordinary Portland cement and 25% Fly Ash	100% Ordinary Portland Cement	20
Lime-Pozzolana mixture	25% Acetylene gas lime and 75% Fly Ash	25% Lime and 75% calcined brick	75
Calcium silicate brick	90% Fly Ash tailings 10% lime (waste source)	Burnt Clay brick	40
Burnt brick	75% clay and 25% Fly Ash	Burnt Clay brick	15
Fly Ash Brick	50% Fly Ash , 28% Sand, 20% Lime and 2% Gypsum	Burnt Clay Brick	>40

Figure 50: Energy Savings using Fly Ash [92]

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[91] https://dailycivil.com/advantages-and-disadvantages-of-fly-ash-bricks/

[92] Kamal, Mohammad Arif. (2016). Recycling of Fly Ash as an Energy Efficient Building Material: A Sustainable Approach. Key Engineering Materials. 692. 54-65. 10.4028/www.scientific.net/KEM.692.54.

Moreover, according to the guidelines of **Green Building Code Provisions by MoCC Pakistan,** recycled materials shall be utilized in green housing projects to promote a circular economy and divert material from landfills. The recycled material needs to be a specified percentage of the total material, preferably by cost. Thus, using fly ash bricks is aligned with the provisions.

10) Insulative Material

The heat gain in hot climates can be fairly reduced by well-planned insulation of walls resulting in less (HVAC) and annual energy costs. The kind of insulative material that is available in Pakistan and can be used to lower energy conservation are insulated glass and cellulose insulation.

- **Insulated Glass**

Insulated glass unit (IGU), more commonly known as double glazing, consists of two or three glass window panes separated by a vacuum or gas-filled space to reduce heat transfer across a part of the building envelope. It is a very effective way to reduce air-to-heat transfer through the glazing. When used in conjunction with low-emissivity and/or reflective coatings, IGU performs even better for conserving energy and complying with international standards.[93]

Double glazing greatly reduces the amount of heat transmitted through a building's windows, by **20-25 %** and perhaps as much as **50 %**. This means that less energy will be needed to heat or cool the building, saving the cost to the owner as well as reducing the building's carbon footprint. [94]

However, the **Energy Conservation Building Code 2023**[95] has provided guidelines that glazing shall be used very carefully a balance between natural light, ventilation, and heat gain should be maintained properly. The windows must be appropriately shaded and insulated to minimize the heat exchange. These insulated glasses are highly valuable for the compliance of **ECBC.**

- **Cellulose insulation**

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93 https://greentechglass.com/insulated-glass/

94 Energy efficiency of double glazed windows (2017) Majestic Glass. Available at: https://majesticglass.com.au/energy-efficiency-double-glazed-windows/

95 https://neeca.gov.pk/NewsDetail/ZDY0NTY2MzAtNDBjNi00ODIyLWFkMzgtN2MzMTBmNGNhYTc3

This material is endorsed by the **ECBC (2023)** to be used as insulation material in roofs. One of its significant uses in Pakistan is for thermal insulation. The low thermal conductivity of cellulose foam makes it an excellent choice for insulation purposes.

A comparative evaluation between various sustainable materials has been done and the total load savings by each material is shown below.96

Table 36: Total Load and Load Saving Using Each Insulation[89]

Month	Total Load (MWh)			
	Cellulose	Polystyrene Foam	Polyurethane Foam	Rock Wool
Jan	0.36	0.309	0.358	0.343
Feb	0.003	0.959	0.003	0.002
Mar	15.29	15.011	15.288	15.21
Apr	45	43.91	44.8	44.551
May	62.17	60.884	62.17	61.81
Jun	52.8	51.714	52.8	52.497
Jul	42.275	41.524	42.275	42.065
Aug	44.301	43.557	44.301	44.093
Sep	42.075	41.347	42.075	41.871
Oct	29.953	29.442	29.953	29.809
Nov	7.933	7.837	7.933	7.906
Dec	0.361	0.367	0.361	0.122

Grand Total	342.317	336.861	342.317	340.279
Percentage Load Saving	**28.132%**	**29.293%**	**28.132%**	**28.50%**

Findings indicate that polystyrene foam (high density) stands out as the most effective insulating material. However, it's important to note that due to its high flammability, it necessitates an additional layer of fireproof coating material. Typically, this involves the application of a fireproofing chemical known as Hexabromocyclododecane.

On the other hand, rock wool lacks additives that confer fire resistance, making it less suitable for use in extremely hot conditions, though it is inherently non-combustible. Whereas polyurethane foam employs CFC gas as a blowing agent which contributes to ozone layer depletion.[96]

Cellulosic insulation is found to be the most eco-friendly, fire-resistant, and suitable insulating material. Using cellulose insulation helps to keep spaces comfortable and energy-efficient, contributing to a more sustainable environment. This is beneficial, especially for Pakistan, where energy conservation and temperature control are important, whether it's for houses, commercial buildings, or public facilities. **오류! 책갈피가 정의되어 있지 않습니다.**

11) Cool Brick

There is a new material being experimented on in Pakistan, propelled by the Muscatese Evaporative cooling window, which joins a fired vessel loaded up with water and a wood

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[96] *Ahsan, Muhammad Mubashir, Muhammad Zulqernain, Hassaan Ahmad, Basit Ali Wajid, Saqib Shahzad, and Muzamil Hussain. "Reducing the operational energy consumption in buildings by passive cooling techniques using building information modelling tools." International Journal of Renewable Energy Research (IJRER) 9, no. 1 (2019): 343-353.*

screen. A 3D-printed porous clay block is set in mortar, every block retains water like a wipe and enables air to go through the divider. As air passes through the 3D printed block the water that is present in the tiny scale pores of the clay dissipates, bringing cool air into an inside domain and reducing the temperature using the guideline of evaporative cooling. In Pakistan, the cool brick will provide thermal comfort within the structure without using any mechanical cooling device resulting in less HVAC energy consumption..[97] The assessment of 3D-printed green walls shows that they lower the AC load by **11.20%** in summer and **9.12%** yearly.[98]

12) Low VOC Paint

In Pakistan, paint serves the dual purpose of protecting walls and adding decorative appeal to buildings. The paints used in Pakistan release **harmful chemicals** called VOCs into the indoor air, leading to air pollution indoors. According to **Green Building Code Provisions**, the use of paints and coatings having a high content of VOCs, such as formaldehyde, should be prohibited to ensure healthy indoor air. [99]

To address this issue, paint manufacturers in Pakistan, are now producing low-VOC paints. Notably, in Pakistan, water-based paints are a preferable choice since they contain **three times fewer VOCs** compared to oil-based paints[100]. Moreover, lighter-colored paints and

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97 3D-printed 'cool brick' may provide a cooling solution for arid locations https://www.bdcnetwork.com/3dprinted-cool-brick-may-provide-cooling-solutionarid-locations Retrieved on 13th June (2019)

98 He, Y. et al. (2020) 'Energy-saving potential of 3D printed concrete building with Integrated Living Wall', Energy and Buildings, 222, p. 110110. doi:10.1016/j.enbuild.2020.110110.

99 GBG. 2021. Green Building Guidelines for Prime Minister's Five Million Naya Pakistan Housing Programme. Ministry of Climate Change, Pakistan. http://www.switch-asia.eu/site/assets/files/3035/green_ building_guideline.pdf

100 Brettner, T., R. Kuropka. & H. Petri. Recipe developments of low VOC interior paints. FATIPEC Congress, 24, A-259 – A-267 those with a flat finish tend to have lower VOC levels, making them a better option for indoor spaces, and contributing to better indoor air quality and health.[101]

13) Low Emissivity Windows

The **Energy Conservation Building Code 2023** of Pakistan emphasizes using windows that are properly shaded and insulated and have R values under advisable limits. Regular, uncoated glass in Pakistan has a high emissivity value of **0.91**[102], which means it allows a lot of heat to escape from buildings, making it less energy-efficient.

To address this issue, low-emissivity (Low-E) glass can be utilized. This glass has a nearly invisible coating on one side that reflects heat away in summer and back into the room in winter, it helps in maintaining indoor temperature making buildings more comfortable and energy-efficient in hot weather.

Windows manufactured with Low-E coatings typically cost about 10% to 15% more than regular windows, but they reduce energy loss by as much as **30% to 50%**.[103]

- **Single vs Double-Glazed Window**

Replacement of single-glazed windows with brown-tinted double-glazed ones, while maintaining all other factors unchanged can result in a 4.17% reduction in annual thermal loads.

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101 Buday, M., F. Cater, S. Foulkes, N.S.O. Prakash. & D. Wilson, Sherwin Williams: Splashing into the low VOC paint market. GlobaLens, a division of the William Davidson Institute at the University of Michigan. Case 1-428-993. 1 – 16

102 ASHRAE: American Society of Heating, Refrigerating and Air-Conditioning Engineers https://searchdatacenter.techtarget.com/definition/ ASHRAE Retrieved on 14th July 2019.

103 Window types and technologies (no date) Energy.gov. Available at: https://www.energy.gov/energysaver/window-types-and-technologies

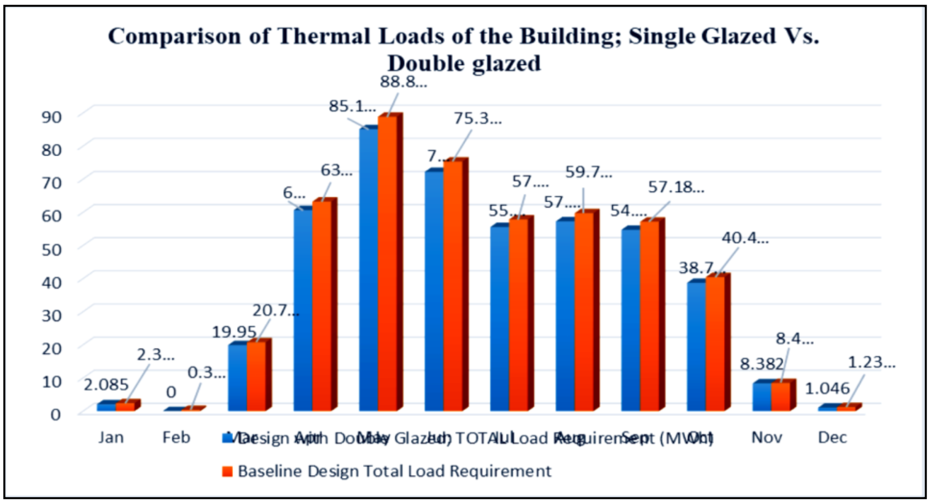
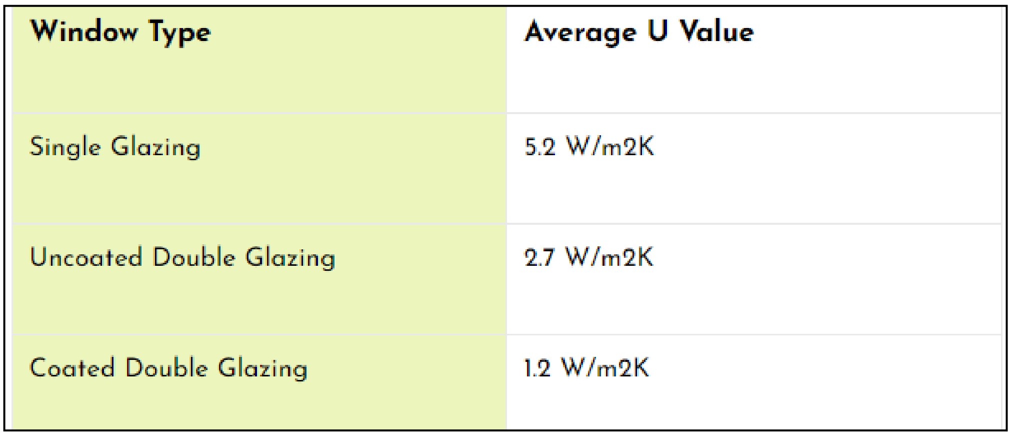


Figure 51: Comparison of Thermal Loads for Single Glazed and Double Glazed Window[104]

- ➢ Annual Load with Single Glazed Windows = 476.024 MWh
- ➢ Annual Load with Brown Tinted Double Glazed Windows = 456.150 MWh
- ➢ Load Saving = **4.1683%**

Table 37: Comparison of U values between Different Categories of Glazing Glass[105]



Window Type	Average U Value
Single Glazing	5.2 W/m2K
Uncoated Double Glazing	2.7 W/m2K
Coated Double Glazing	1.2 W/m2K

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[104] Ahsan, Muhammad Mubashir, Muhammad Zulqernain, Hassaan Ahmad, Basit Ali Wajid, Saqib Shahzad, and Muzamil Hussain. "Reducing the operational energy consumption in buildings by passive cooling techniques using building information modelling tools." International Journal of Renewable Energy Research (IJRER) 9, no. 1 (2019): 343-353.

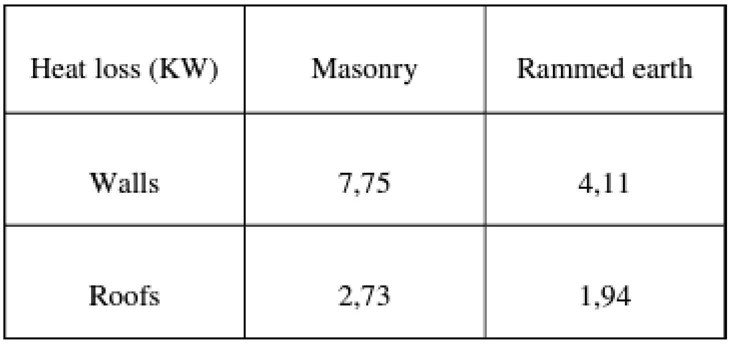
[105] https://www.cuin.glass/blog/u-value-single-vs-double-vs-triple-glazing-vs-c-u-in/

The lower the U value, the better the thermal performance of the glass. Hence, the lower U value of double-glazing glass as shown in the above table validates better thermal performance that increases energy saving potential.[106]

14) Rammed Earth

It is a sustainable building material that is made by compressing layers of earth, gravel, and other locally available materials. Rammed-earth buildings are highly durable and can withstand **earthquakes**, **fires,** and other natural disasters. They have excellent **insulation properties**, which can help reduce the need for heating and cooling systems. The maximum average energy saving in a study indicates a saving **of 2192.27 kWh/annual** from houses built on Rammed Earth.[107]

Table 38: Heat Losses Comparision of Masonry and Rammed Earth**[107]**



Heat loss (KW)	Masonry	Rammed earth
Walls	7,75	4,11
Roofs	2,73	1,94

The added benefit is that this will reduce the carbon output by around **1 tonne per year**, primarily from heating and cooling.[108]

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[106] https://www.cuin.glass/blog/u-value-single-vs-double-vs-triple-glazing-vs-c-u-in/

[107] Li, S.; Wang, M.; Shen, P.; Cui, X.; Bu, L.; Wei, R.; Zhang, L.; Wu, C. Energy Saving and Thermal Comfort Performance of Passive Retrofitting Measures for Traditional Rammed Earth House in Lingnan, China. Buildings 2022, 12, 1716. https://doi.org/10.3390/buildings12101716

[108] https://www.earthhouseaustralia.com.au/energy-savings-of-our-rammed-earth-homes/

Figure 52: Rammed Earth Structure in Pakistan[109]

15) Bamboo

Building Code Of Pakistan (2021) has provided the framework for wood usage concerning preservative treatment, fire safety, ASTM standards, and other compliance regulations, but in practice, wood is being used without proper adherence to these regulations, However, it lacks the direction of wood usage considering resource depletion and that should be an integral part of the codes in future to conserve the natural wood sources.

The **Green Building Code Provisions** developed by MoCC and Switch Asia suggest that 5 % of the building materials used, based on cost, shall be biobased products (**IGCC 2018**). [110] Moreover, it should be composed of solid wood, engineered wood, bamboo, wool, cotton, cork, agricultural fibers, or other biobased materials with at least 50 % biobased content.

The use of Bamboo in Pakistan as an alternative to woodwork is gaining popularity because hardwood and bamboo are the only renewable flooring options available. Bamboo has the benefit of being rapidly renewable and minimizing CO_2 emissions and generates up to **35% more oxygen** than

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109 https://sirewall.com/new-tallest-rammed-earth-structure-on-earth-we-broke-our-old-record/

110 GBG. 2021. Green Building Guidelines for Prime Minister's Five Million Naya Pakistan Housing Programme. Ministry of Climate Change, Pakistan. http://www.switch-asia.eu/site/assets/files/3035/green_ building_guideline.pdf equivalent stands of trees.[111] A study conducted for energy efficiency concluded that the use of bamboo instead of the conventional reinforced concrete structure would reduce energy consumption by **3% to 5%** and reduce **CO_2 emissions by 7% to 20%.** The analysis of results demonstrates that bamboo residential buildings are more carbon-efficient in cold climates.[112]

Figure 53: Utilization of Bamboo in Navy Housing Scheme Zamzama Karachi[113]

16) Galvanised Sheet

Galvanized steel sheets also come with a corrugated pattern. **For heat resistance**, these sheets are dipped and coated with zinc. As compared to **stainless steel**, a galvanized steel sheet is low in price, requires **less maintenance work**, and can be used for a longer period. All these qualities make it one of the best types of heat-resistant roofing sheets in Pakistan.

They can also be used as additional coatings with heat and waterproofing chemicals, exhibit amazing quality of **damage control,** and are widely known for their robustness. This makes the galvanized steel one of the best roofing materials in Pakistan.[114]

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111 https://dassopakistan.com/why-dasso/

112 Bolun Zhao, Yang Yu, Yitong Xu & Haibo Guo (2023) Bamboo as a sustainable construction material for residential buildings in the cold and severe cold regions of China, Architectural Engineering and Design Management

113 https://dassopakistan.com/portfolio-item/mariyum-asad-ali/

114 https://www.zameen.com/blog/heat-resistant-roofing-pakistan-types-cost.html

Hence along with traditional materials used in buildings, these options are viable considering the market demand, awareness, and other factors that influence their role in the building construction.

11. COST EVALUATION OF CONVENTIONAL AND SUSTAINABLE CONSTRUCTION MATERIALS

This analysis is focused on comparing the cost if the traditional construction material is replaced with sustainable material. For this purpose, the commercial office building is chosen such that a G+3 rectangular building is considered for a conventional building and a G+4 "L" shaped building is considered for a green building model. Moreover, AutoCAD 2021 and SketchUp were used for rendering the design of the building models, and STACK (take-off and cost estimation) was used for quantity and cost estimation[115]. The models for both buildings are given below:

Figure 54: Conventional Building[116]

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[115] https://ijcrt.org/papers/IJCRT22A6552.pdf

[116] https://ijcrt.org/papers/IJCRT22A6552.pdf

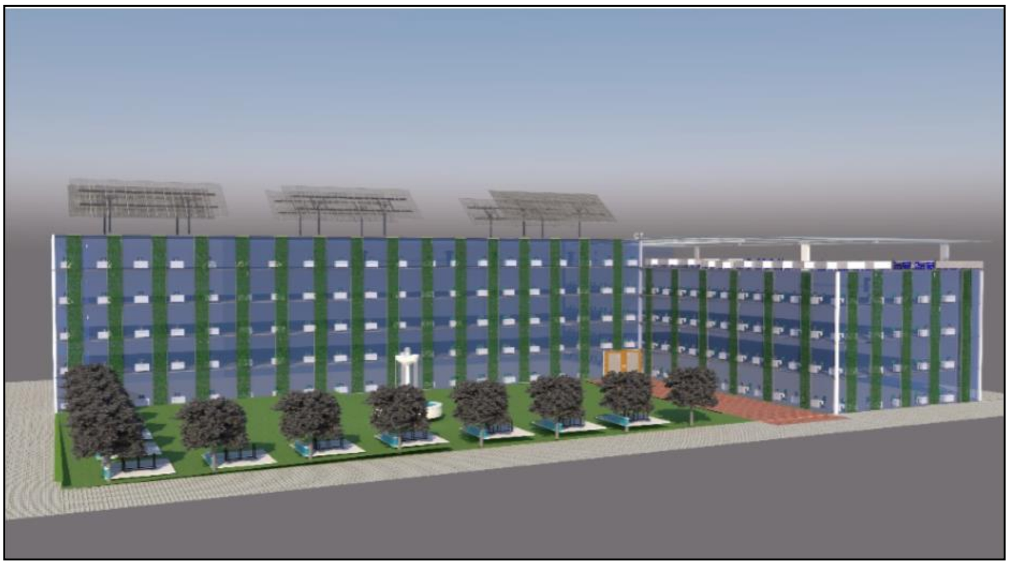
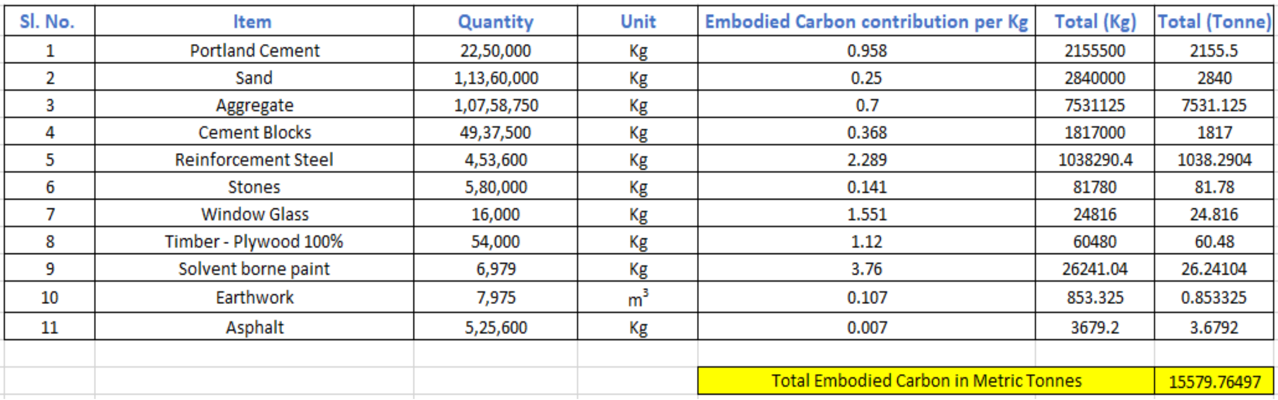


Figure 55: Green Building[117]

CONSTRUCTION MATERIAL

The material used for the construction of both buildings is given below:

Table 39: Construction Material Used in Conventional Building[118]



Sl. No.	Item	Quantity	Unit	Embodied Carbon contribution per Kg	Total (Kg)	Total (Tonne)
1	Portland Cement	22,50,000	Kg	0.958	2155500	2155.5
2	Sand	1,13,60,000	Kg	0.25	2840000	2840
3	Aggregate	1,07,58,750	Kg	0.7	7531125	7531.125
4	Cement Blocks	49,37,500	Kg	0.368	1817000	1817
5	Reinforcement Steel	4,53,600	Kg	2.289	1038290.4	1038.2904
6	Stones	5,80,000	Kg	0.141	81780	81.78
7	Window Glass	16,000	Kg	1.551	24816	24.816
8	Timber - Plywood 100%	54,000	Kg	1.12	60480	60.48
9	Solvent borne paint	6,979	Kg	3.76	26241.04	26.24104
10	Earthwork	7,975	m^3	0.107	853.325	0.853325
11	Asphalt	5,25,600	Kg	0.007	3679.2	3.6792
				Total Embodied Carbon in Metric Tonnes		15579.76497

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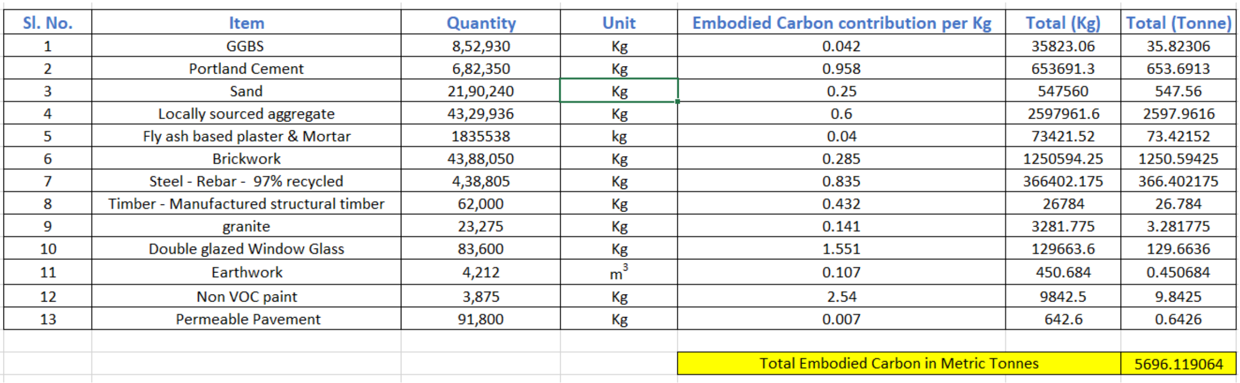
[117] *https://ijcrt.org/papers/IJCRT22A6552.pdf*

[118] *https://ijcrt.org/papers/IJCRT22A6552.pdf*

Table 40: Construction Material Used in Green Building[119]



Sl. No.	Item	Quantity	Unit	Embodied Carbon contribution per Kg	Total (Kg)	Total (Tonne)
1	GGBS	8,52,930	Kg	0.042	35823.06	35.82306
2	Portland Cement	6,82,350	Kg	0.958	653691.3	653.6913
3	Sand	21,90,240	Kg	0.25	547560	547.56
4	Locally sourced aggregate	43,29,936	Kg	0.6	2597961.6	2597.9616
5	Fly ash based plaster & Mortar	1835538	kg	0.04	73421.52	73.42152
6	Brickwork	43,88,050	Kg	0.285	1250594.25	1250.59425
7	Steel - Rebar - 97% recycled	4,38,805	Kg	0.835	366402.175	366.402175
8	Timber - Manufactured structural timber	62,000	Kg	0.432	26784	26.784
9	granite	23,275	Kg	0.141	3281.775	3.281775
10	Double glazed Window Glass	83,600	Kg	1.551	129663.6	129.6636
11	Earthwork	4,212	m^3	0.107	450.684	0.450684
12	Non VOC paint	3,875	Kg	2.54	9842.5	9.8425
13	Permeable Pavement	91,800	Kg	0.007	642.6	0.6426
				Total Embodied Carbon in Metric Tonnes		5696.119064

- Total Embodied Carbon for Conventional Building 15,580 MTCO$_2$e
- Total Embodied Carbon for Green Building 5,696 MTCO$_2$e
- Reduction in Embodied Carbon = **9,884 MTCO$_2$e**

For the above calculations, only using green/sustainable material, 9,884 MTCO$_2$e can be reduced in the provided case before the implementation of any other green building controls, technologies, or building equipment.

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[119] *https://ijcrt.org/papers/IJCRT22A6552.pdf*

COSTS OF BUILDING CONSTRUCTION MATERIALS

The estimated cost for construction materials for conventional and sustainable buildings is given below:

3) Conventional Building

Table 41: Conventional Building Construction Material Cost[120]

Item	Quantity	Unit	Estimated Price ($)
Portland Cement	2,250,000	Kg	195,430
Sand	11,360,000	Kg	91,623
Aggregate	10,758,750	Kg	80,098
Cement Blocks	4,937,500	Kg	127,433
Reinforcement Steel	453,600	Kg	225,136
Stones	580,000	Kg	44,980
Glass	16,000	Kg	14,766
Timber	54,000	Kg	457
Paint	6,979	Kg	8,327
Earthwork Excavation	7,975	m'	138,538
Asphalt	525,600	Kg	163,045
Grand Total			**1,089,833**

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[120] *https://ijcrt.org/papers/IJCRT22A6552.pdf*

The costs given above are only focused on the construction material in a fully functional green building other costs can be for:

- Electrical Wiring
- Water Supply & Sanitation
- Labour Charges
- Scaffolding, Shuttering, etc.
- Consultation and miscellaneous work
- Contingencies

4) Sustainable Building

Table 42: Green Building Construction Material Cost[121]

Item	Quantity	Unit	Estimated Price ($)
GGBS	852,930	Kg	10,583.385
Portland Cement	682,350	Kg	59,280.504
Sand	2,190,240	Kg	17,665.032
Locally sourced aggregate	4,329,936	Kg	37,605.120
Fly ash-based plaster and mortar	849	m’	22,123.943
Brickwork	4,388,050	Kg	52,691.713
Recycled Steel	438,805	Kg	435,584.829

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[121] *https://ijcrt.org/papers/IJCRT22A6552.pdf*

Reclaimed hardwood	62,000	Kg	456.202
Linoleum	23,275	Kg	19,917.753
Window Glass	83,600	Kg	390,860.465
Earthwork Excavation	4,212	m′	73,169.079
Non-VOC Paint	3,875	Kg	6,840.679
Permeable Pavement	91,800	Kg	178,679.070
Grand Total			**1305,457.773**

The costs given above are only focused on the construction material in a fully functional green building other costs can be for:

- Solar Power System
- Rainwater Harvesting System
- Electrical Wiring
- Water Supply & Sanitation
- Labour Charges
- Scaffolding, Shuttering, etc.
- Consultation and miscellaneous work
- Contingencies

Note: The cost of building materials is adjusted considering the year when costs were recorded (2022) and the present scenario (2023).

ELECTRICITY CONSUMPTION

Electricity consumption and saving comparison of a conventional and green building are given below:

Table 43: Electricity Consumption

Building Type	Duration	kWh	$
Conventional Type	1 Year	1,672,200	255,847
Green Type	1 Year	929,000	142,137

- 1 kWh= Assumed $ 0.15 for commercial electricity unit
- Saving/ year = 255,847-142,137
- Saving/ year **= $ 113,710 / year**

Note: In green buildings, electricity can be generated using renewable energy technologies. However, this analysis is only focused on construction material thus it has not been considered.

PAYBACK PERIOD

The payback period for converting conventional buildings into green buildings is calculated and provided below.

- Cost Difference = Grand Total for Sustainable Building - Grand Total for Conventional Building
- Cost Difference = 1,305,458 - 1,089,833
- Cost Difference= $ 215,625
- Payback Period= 1.89 Years
- Payback Period**= Approximately 2 Years**

Note: The payback period is only focused on building construction materials, it does not include any design advancements, technology installation, rainwater harvesting system, or any other costs.

12. MARKET DEMAND FOR GREEN CONSTRUCTION MATERIALS

The construction industry in Pakistan has traditionally been a significant contributor to the country's GDP and employment. However, the rapid urbanization and industrialization taking place in Pakistan have raised concerns about environmental sustainability. This has led to an increasing demand for green construction materials, which are characterized by their environmentally friendly attributes.

One of the primary drivers of the demand for green construction materials in Pakistan is the rising awareness of environmental issues. As the country faces the adverse effects of climate change, there is a growing recognition of the need to reduce carbon emissions, minimize resource depletion, and curb pollution. Green construction materials are seen as a practical solution to address these concerns.

Another factor fueling the demand for green construction materials is the need for sustainable infrastructure development. Major government initiatives like the **Naya Pakistan Housing Scheme** and the **Ravi Riverfront Urban Development Project** have the potential to reshape Pakistan's urban landscape. To ensure the long-term sustainability of these projects, there is a requirement for materials that are not only durable but also environmentally responsible.[122] [123]

REFLECTIONS ON SUSTAINABLE MATERIAL ADOPTION CHALLENGES

Despite the increasing demand, the availability of green construction materials in Pakistan remains limited. The construction industry in the country largely relies on conventional

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[122] https://www.ctc-n.org/technical-assistance/projects/adoption-green-buildings-pakistan-achieve-pakistan-s-nationally

[123] https://www.linkedin.com/pulse/rising-demand-green-buildings-major-driver-building-market-pujari/

materials that may not meet modern sustainability standards. Several key observations can be made regarding the current state of green construction materials in Pakistan. [124] [125]

Limited Product Variety

Green construction materials such as bricks manufactured from zig-zag technology, green cement, and other eco-friendly products are relatively scarce in Pakistan. The market lacks diversity in terms of sustainable construction materials, hindering the construction industry's ability to adopt green practices.

Lack Of Awareness and Education

A significant challenge lies in the lack of awareness and education regarding the benefits of green construction materials. Builders, developers, and consumers often have limited knowledge about these materials and their advantages, which can slow down their adoption.

Cost Considerations

Green construction materials, while environmentally friendly, may be perceived as more expensive than traditional options. This cost differential can discourage builders and developers from choosing sustainable materials, particularly in price-sensitive markets.

Regulatory Framework

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124 https://www.ctc-n.org/technical-assistance/projects/adoption-green-buildings-pakistan-achieve-pakistan-s-nationally

125 https://www.linkedin.com/pulse/rising-demand-green-buildings-major-driver-building-market-pujari/

The absence of comprehensive regulations and standards for green construction materials poses a barrier to their widespread use. Clear guidelines and certifications could encourage the adoption of these materials by ensuring their quality and performance.

RECOMMENDED MEASURES

To overcome the challenges in promoting green construction in Pakistan following measures are recommended.

- **Active collaboration of government with renowned green building certification bodies** like EDGE, LEED, NESPAK, NEECA-Pakistan, etc. These organizations can provide expertise and guidance in implementing green building practices in construction projects. Furthermore, builders and developers should be encouraged to seek green certifications for their projects, which can serve as a benchmark for sustainability.
- Offer **tax incentives** for builders and developers who embrace green construction practices. These incentives can include reduced income taxes, property tax reductions, or deductions for investments in green technologies. **Fee concessions** should be provided for green building map approvals and permits to incentivize eco-conscious construction.
- **Encourage the banking industry** in Pakistan to establish green banking divisions or departments that specifically cater to the financing needs of green construction projects. Low-interest rates and financial incentives should be available for builders and developers engaged in green and affordable housing projects.
- Launch **public awareness campaigns** to educate builders, developers, and the general public about the benefits of green construction materials and practices. **Training and workshops** should be offered on green building techniques to professionals in the construction industry.
- Develop and implement **clear and comprehensive regulations** and standards for green construction in Pakistan. These standards should cover building materials, energy efficiency, waste management, and water conservation.

- Encourage **public-private partnerships** in the construction sector to promote the use of green materials and technologies. These partnerships can lead to innovative solutions and shared resources.
- Invest in **research and development efforts** to develop locally sourced green construction materials and technologies that are cost-effective and eco-friendly.
- Promote **innovation and entrepreneurship** in the green construction sector.
- Establish a system for **monitoring and evaluating** the environmental performance of green construction projects to ensure compliance with sustainability standards. Regular reports should be published on the environmental impact and benefits of green construction initiatives
- To assess the environmental impact of construction materials thoroughly, **a life cycle assessment (LCA)** should be adopted. This assessment evaluates materials from extraction to disposal, helping make informed choices. Finally, **certification and labeling systems** like LEED (Leadership in Energy and Environmental Design) or Green Building Councils can assure material sustainability.

13. MATERIAL SUPPLY CHAIN ANALYSIS

Based on materials availability and its perception in the market, the supply chain of materials in a country influences its adaptation in a sector greatly. In this section green building material supply chain existence in Pakistan, the challenges it faces, and recommendations for the future are discussed comprehensively.

ANALYSIS OF EXISTING MATERIAL SUPPLY

The concept of a green construction material is a transformative idea in Pakistan's construction industry. The supply chain of green construction materials encompasses various key components, starting with the responsible sourcing of eco-friendly raw materials or recycled materials. Manufacturing processes prioritize environmental sustainability, aiming to reduce energy consumption and emissions. Efficient distribution and logistics networks are crucial to ensure a steady supply of green construction materials across Pakistan, while appropriate storage facilities maintain material quality. Effective waste management and recycling strategies are vital to reusing the material and minimizing environmental impact.

Currently, Pakistan lacks a dedicated supply chain for green construction materials. The existing supply chain primarily caters to conventional construction materials, which are readily available and widely used. Green construction materials, on the other hand, are relatively scarce and often require specialized sourcing. An infographic that shows different stakeholders present at various stages of the value chain existing in the green buildings in Pakistan is shown below:

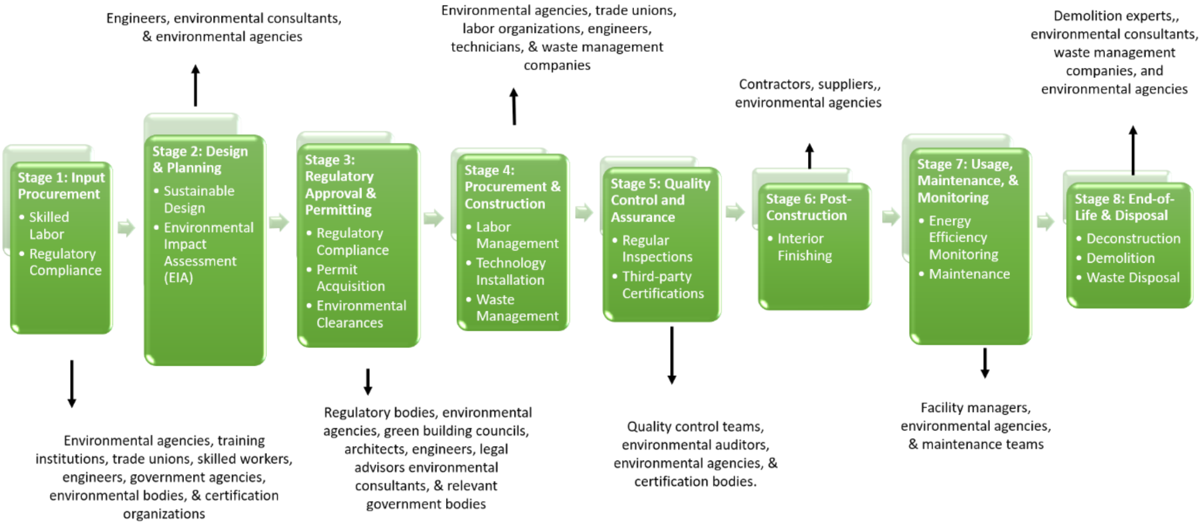

Figure 56: Value Chain Analysis of Green Buildings in Pakistan

SUPPLY CHAIN CHALLENGES AND RECOMMENDATIONS

The establishment of a sustainable supply chain for green construction materials in Pakistan faces a set of challenges that need careful consideration and strategic solutions. The major supply chain challenges and their recommendations are briefly discussed in the infographic below:

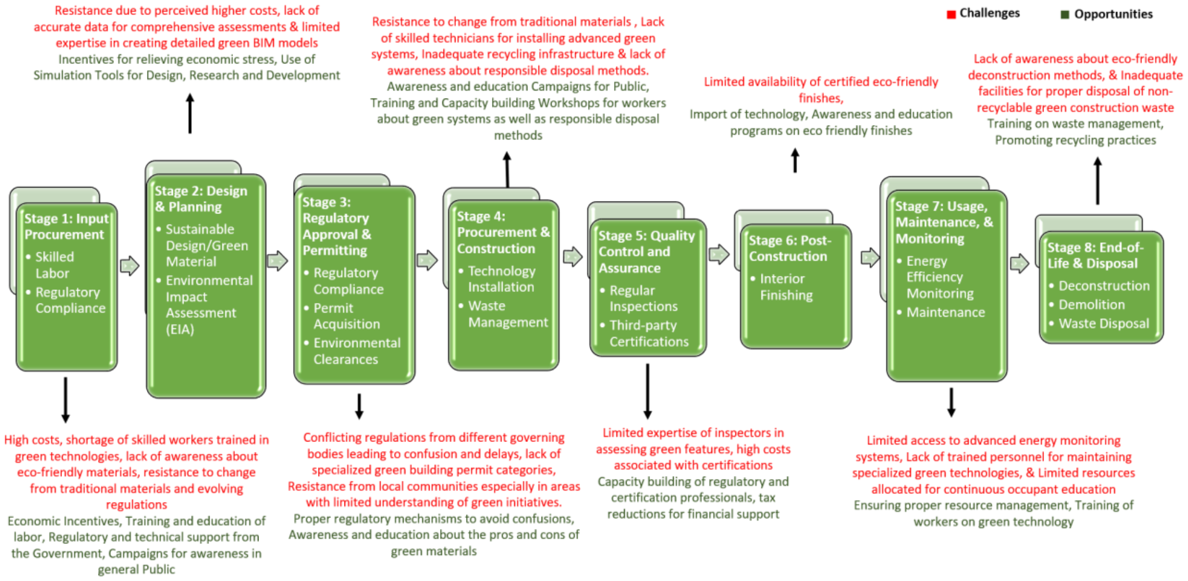

Figure 57: Challenges and Opportunities in the Value Chain of Green Buildings in Pakistan

One of the most pressing challenges is **generating consumer demand** due to a **lack of awareness** among contractors, owners, and other key stakeholders about the advantages of green construction materials. This challenge is surged by **regulatory and policy gaps** related to green construction materials and practices. There is absence of clear standards and regulations that are creating uncertainty in the industry. According to some websites **PEC has published the Green Building Code of Pakistan-2023** but these are not available on the official website. It is utterly important to publish these codes officially and make them mandatory to create the demand for green construction in Pakistan. In addition, relative stakeholders should be made aware of these codes or any other relevant policy and in case of non-compliance actions should be taken against them.[126]

Another critical challenge is the **insufficient recycling** of waste materials generated during construction activities. In Pakistan, mainly plastic and glass are segregated from waste, not

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[126] https://www.iccsafe.org/about/periodicals-and-newsroom/pakistan-engineering-council-releases-green-building-code-based-on-the-international-codes

construction materials. As well as Pakistan currently lacks recycling infrastructure for construction waste and materials, leading to increased environmental impact and missed opportunities for resource reuse. Therefore, it is highly recommended to develop efficient recycling mechanisms for construction materials and use such recycled materials for making green construction materials following the second-tier supply chain concept.

Moreover, some green construction materials already exist in Pakistan but there is **no dedicated supply chain** for them which limits the utilization of these materials. Establishing an effective supply chain for green construction materials should consider a carefully structured approach. The initial step can be **conducting an inventory assessment** of available materials while **identifying local sources** like bamboo forests and straw bales. Parallelly **education and training programs** should be implemented for local stakeholders, including suppliers and builders, to raise awareness about sustainable construction practices. In addition, **supplier network development** should be prioritized which can involve collaborating with existing suppliers in respective areas or supporting community-based cooperatives to ensure a consistent supply. However, **quality control measures** must be in place to maintain material standards. Local communities should be involved in material sourcing and promoting sustainable practices and regulations for environmental, labor, and safety standards should be adhered to. Once the supply chain is created it is recommended to **continuously monitor and evaluate the supply chain's performance**.

Figure 58. Recommendation for Generating Supply Chain in Pakistan

Furthermore, the **limited availability of new and innovative sustainable construction materials** in Pakistan poses a significant hurdle to the widespread adoption of green construction practices. To address this scarcity, **investments and public-private partnerships** can play essential to diversifying the range of sustainable materials, making them more accessible and appealing to builders and contractors.

Lack of skills and training represent another challenge, as construction professionals need specialized knowledge and expertise to effectively work with green construction materials. Educational programs and training are suggested to equip the workforce with the capabilities required to implement green practices successfully.

Indeed, high costs remain a concern, as green construction materials often come with **higher initial** costs **compared to conventional materials**. This cost differential can deter stakeholders from embracing sustainable materials and practices. To overcome this obstacle, policymakers should consider implementing incentives such as **tax benefits and subsidies** to help offset initial costs and encourage the use of green materials.

14. CONCLUSION

The report highlights the drawbacks of conventional materials used in Pakistan, such as clay bricks, cement, concrete, steel, wood, and non-insulated glass windows, and suggests specific sustainable alternatives to mitigate these drawbacks. The construction industry in Pakistan is at a critical phase, with significant opportunities to transition toward more sustainable and green building practices. By addressing the barriers to the adoption of sustainable materials, updating building codes, and promoting awareness, Pakistan can reduce its environmental footprint, improve energy efficiency, and create healthier living and working environments for its citizens. This transition is not only essential for addressing the environmental challenges but also for ensuring the long-term sustainability of the construction sector in the country.

The adoption of sustainable alternative building materials in Pakistan offers the potential to reduce energy consumption, improve indoor air quality, and contribute to environmental sustainability. While there may be higher initial costs, the long-term benefits and savings make these materials a valuable choice for the construction industry. Encouraging green building practices and compliance with building energy frameworks, such as the Energy Conservation Building Code 2023, are critical steps toward a more sustainable future in Pakistan's construction sector.

Appendix 7. Analysis for economic revitalization and training

1. INTRODUCTION

The amount of built-up area in Pakistan varies widely by region and is influenced by factors such as population density, economic development, and land use policies. The Building Sector is responsible for a significant amount of greenhouse gas (GHG) emissions. According to the International Energy Agency (IEA), it is responsible for approximately 28% of global and energy-related GHG emissions and almost 25% of the total emissions in Pakistan.[127,128] Reducing the GHG emissions of buildings is an important part of the efforts of the United Nations (UN) to mitigate climate change and achieve global emissions reduction targets. This can be attained through a combination of energy efficiency measures, the use of renewable energy sources, and the adoption of low-carbon building materials and design methods.

The building sector is responsible for most of the energy consumption in Pakistan, with the residential sector currently being the largest in energy consumption consuming about 49.2%, and the commercial sector consuming about 7% of the total electricity produced in the country. Thus, it can be a major energy and cost savings opportunity if a building is developed with the use of sustainable construction materials, design features, and energy-efficient appliances.[129] Green building through the use of sustainable structure, design, and energy-efficient appliances offers a major saving potential of up to 30% but an economic analysis is important to understand the complexities involved in using these materials, design features, and appliances.[130]

Furthermore, green buildings typically have a higher upfront cost compared to conventional buildings but they offer benefits that built-to-code projects lack. These benefits include cost savings from reduced energy and water use, less waste production, diminished environmental and emissions costs, lower operations and maintenance costs, and enhanced occupant productivity and health. These

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[127] https://iea.blob.core.windows.net/assets/026bff1b-821d-48bc-8a0e-7c10280c62bc/Perspectives_for_the_Clean_Energy_Transition_2019.pdf

[128] https://www.climate-transparency.org/wp-content/uploads/2021/11/Pakistan-CP-2020.pdf

[129] https://unfccc.int/documents/470405 (BUR1)

[130] Baig, A. (2018). Green Buildings as a Solution for Sustainable Housing: Role of Private Housing Schemes, Lahore, Pakistan. Research Gate. https://www.researchgate.net/publication/327267222_Green_Buildings_as_solution_for_Sustainable_Housing_Role_of_Private_Housing_Schemes_Lahore_Pakistan

values range from being predictable (energy and water savings can be recorded over time) to relatively uncertain (productivity/health benefits are somewhat subjective.

This report encompasses a comprehensive cost-benefit analysis and human resource analysis of green buildings in Pakistan, concurrently addressing identified gaps to provide mitigation measures and training modules for economic revitalization.

2. COST-BENEFIT ANALYSIS

The adoption of green materials, design features, and energy-efficient appliances is uncommon in construction practices in Pakistan. This situation is due to a lack of awareness among professionals and the general public, limited access to requisite technology and materials, and higher associated costs. The following section presents a cost-benefit analysis for evaluating the suitability of green buildings. This assessment will help determine whether green buildings represent an advantageous and practical choice for adoption in Pakistan's construction industry.

COST-BENEFIT ANALYSIS OF GREEN BUILDING MATERIALS, DESIGN, AND ENERGY-EFFICIENT APPLIANCES

Cost-benefit analysis of green buildings in Pakistan is carried out for domestic, commercial and industrial buildings. In addition, savings for building materials, design features, and energy-efficient appliances are calculated for these buildings separately.

DOMESTIC SECTOR

In Pakistan, the per capita annual consumption of electricity is 399 kWh in domestic sector.[131] Keeping an average household of 7 persons, give the aggregate consumption as 2793 kWh/Annum. So, the monthly consumption of a house having 7 persons is 233 kWh. Keeping given NEECA electricity rates following calculations have been done.

Table 44 - Electricity Cost in Absence of Green Building Practices

S. No	Units consumed (kWh)	Unit Price	With a 17% tax	Unit consumed by household	Household Monthly Bill (RS)	Yearly bill (Rs)
1	201-300	22.14	25.9038	232.75	6,029.109	72,349.31

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[131] https://www.pbs.gov.pk/sites/default/files/industry_mining_and_energy/publications/cee/report.pdf

2	301-400	25.33	29.6361	360	10,668.996	128,028
3	401-500	27.74	32.4558	420	13,631.436	163,577.2
4	501-600	29.16	34.1172	580	19,787.976	237,455.7
5	601-700	30.3	35.451	650	23,043.15	276,517.8
6	Above 700 units	35.22	41.2074	750	30,905.55	370,866.6

Economic analysis was conducted comparing electricity consumption between conventional and green building approaches using Table 1 as baseline data for residential buildings. For this purpose, a residential building of the area of construction; 25` X 50` (5.5 Marlas) was used. The cost-benefit analysis was conducted in terms of the use of:

iv. Building Materials
v. Building Design features
vi. Energy-efficient appliances

COST-BENEFIT ANALYSIS OF GREEN BUILDING MATERIALS

Green building materials such as fly ash bricks, low VOC (Volatile Organic Compound) paint, low-e windows, rammed earth, and bamboo was analyzed in the structural review document which showed that sustainable building materials such as the use of Fly Ash Bricks instead of conventional bricks can **save up to 40%,** bamboo can offer **savings up to 3-5%**, and cellulose insulation can **save up to 28%** of the energy cost of the building. Also, it showed an increase in the overall cost by 18% but reduced CO_2 emissions by 63%. Additionally, it led to energy-cost savings of $113,710 which **equals 30% of the total energy-cost savings.** The payback period for building using green construction materials was calculated to be almost 2 years.[132]

Below (Table 2) is the analysis of the example residential building in terms of the use of green building materials. The costs are taken based on the local market price in Pakistan, and calculations are done where direct cost for green materials is not available. [133,134] Their average electricity units consumed are taken based on the Table 1 calculations.

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132 https://ijcrt.org/papers/IJCRT22A6552.pdf

133 https://www.zameen.com/blog/construction-cost-5-marla-house.html

134 https://jbms.pk/fly-ash-brick-price/

Table 45 - Use of Energy-Efficient Building Material

	Use of Fly Ash Bricks	Use of Cellulose Insulation in Roof	Combined Use of both Materials (Fly Ash Bricks, Cellulose Insulation)
Electricity Units Range	**201-300**		
No. of Electricity Units Consumed/Month	**232.75**		
Yearly Bill	**72,349.31**		
Percentage Savings (Avg.)	40	28	68
Yearly Benefit of Building Material	28,939.6	20,257.80	49,197.4
Cost of Installation/Retrofitting	3,50,000	36,354	386,354
BCR (Ratio)	4.13	13.9	2.54
ROI (%)	8.2	55	12.73
Payback Period (years)	12.09	1.79	7.8
Life Span	50 years	25 years	20 years

The benefit-cost ratio (BCR) is 4.13, 13.9, and 2.54 for using fly-ash bricks, cellulose insulation, and using the two together, respectively, showing a highly beneficial investment. Moreover, the return on investment and payback period are showing satisfactory results. As a rule of thumb, if the ROI value is greater than 7%, it's considered a good investment. It is thus concluded that the use of energy-efficient materials is a good option in monetary as well as energy-saving terms. The payback period is 12.09, 1.79, and 7.8 years for the use of fly ash bricks, cellulose insulation, and a combination of the two.

COST-BENEFIT ANALYSIS OF BUILDING DESIGN FEATURES

The cost of green building design features such as WWR, building orientation, green roofing systems, and renewable energy systems, was analyzed in the architectural review document and it showed that

WWR can offer up to **12-39% savings** in different climates, Building Orientation can save up to **15-30% of energy cost**, and the case study of several building design parameters such as WWR, Glazing, Insulation, Biophilic design, and building orientation in building design offered a cost saving of up to $113,999 which equals to almost **30% of the building energy consumption**. It showed a payback period of 3 years and 2 months.[135]

Below (Table 3) is the analysis of the example residential building (25' x 50') in terms of the use of green building design features. The cost of installation is calculated by using the local market price of Windows, glazing, and insulation in Pakistan, and calculations are done where direct costs are not given.[136] Their average electricity units consumed are taken based on the Table 1 calculations. The details of the analysis are given in the table 3 below:

Table 46 - Use of Energy-Efficient Building Design Features

	Building with Optimum WWR	**Overall saving through Green Design (WWR, Glazing, Orientation, Insulation)**
Electricity Units Range	**201-300**	
No. of Electricity Units Consumed	**232.75**	
Yearly Bill	72,349.31	
Percentage Savings (Avg) %	25	45
Yearly Benefit of Building Design Features	18,087.32	32,556
Cost of Installation/Retrofitting	1,80,000	2,20,000
BCR (Ratio)	1.51	2.96
ROI (%)	10	15
Payback Period (years)	9.9	6.7

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[135] *https://ijcrt.org/papers/IJCRT22A6552.pdf*

[136] *https://wallrealestate.pk/guide/5-marla-house-construction-cost-pakistan-complete-guide/*

Life Span	15 years	20 years

The benefit-cost ratio (BCR) is 1.51, and 2.96 for using installing optimum WWR and integrating other factors alongside also, respectively, which shows a beneficial investment. Moreover, the Return on investment and Payback periods are showing satisfactory results. As a rule of thumb, if the ROI value is greater than 7%, it's considered a good investment. It is thus concluded that the use of energy-efficient design features is a good option in monetary and energy-saving terms. The payback period for the use of WWR is 9.9 years, and for multiple energy-efficient building design features is approximately 6.7 years, which has differed from the architectural review document due to the difference in size of the buildings.

COST-BENEFIT ANALYSIS OF ENERGY-EFFICIENT APPLIANCES

The energy expert analysis on green buildings shows the use of insulated walls, roofs, and energy-efficient appliances i.e., LED bulbs, inverter AC, energy-saving fans, etc., save 29% of the energy consumption of a building. Also, the solar PV system delivers annual savings of approximately US$ **16,096.50 or PKR 4,819,950** by reducing the consumption of grid electricity. The payback period for **Solar PV systems is about 3 years**, and for **energy-efficient appliances, it is about 1-2 years**.

Below (Table 4) is the analysis of the example residential building (25’ x 50’) in terms of the use of energy-efficient appliances. The cost of installation is calculated by using the local market price of LEDs, and fluorescent bulbs in Pakistan, and calculations are done where direct costs are not given.[137,138] The details of the analysis are given below in the Table 4.

Table 47 - Use of Energy-Efficient Appliances

	Savings by LEDs	**Savings by Fluorescent**
Electricity Units Range	**201-300**	
No. of Electricity Units Consumed/Month	**232.75**	
Yearly Bill	72,349.3	

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[137] *https://www.mdpi.com/2673-4591/23/1/10*

[138] *https://www.shineretrofits.com/knowledge-base/lighting-learning-center/pros-and-cons-of-fluorescent-lighting.html*

Percentage Savings (%)	50	75
Yearly benefit of appliances	36,174	54,261
Cost of Installation/ Retrofitting	185,000	196,655
BCR (Ratio)	1.11	0.8
ROI (%)	19.5	27
Pay Back Period (years)	5.11	3.62
Life Span of bulbs/tubes	5.7 years (50,000 hours)	2.5 Years (24,000 - 36,000 hours)

The benefit-cost ratio (BCR) of LEDs is 1.1, which is higher than the 0.8 value for fluorescent tubes, showing that despite the higher savings of fluorescent tubes they are a slightly costly investment when compared to LEDs. However, the return on investment and payback period are showing satisfactory results. As a rule of thumb, if the ROI value is greater than 7%, it's considered a good investment. It is thus concluded that the use of the energy-efficient appliance is a good option in monetary as well as energy-saving terms. The payback period for the use of LEDs is 5.11 years, and for fluorescent tubes is 3.62 years.

The cost-benefit analysis of building materials, design features, and energy-efficient appliances shows that green buildings have more benefits outweigh the associated costs. All these aspects can lead to an overall 30% decrease in the energy consumption of the building, which can help in utilizing the 30% energy-saving potential that the building sector of Pakistan has to offer.[139]

▪ COMMERCIAL SECTOR

In Pakistan, residential buildings electricity unit is usually charged on the basis on units consumed by a household, while on the other hand for the commercial sector NEPRA has defined a load range based on which price of a unit will be charged.

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139 Baig, A. (2018). Green Buildings as a Solution for Sustainable Housing: Role of Private Housing Schemes, Lahore, Pakistan. Research Gate. https://www.researchgate.net/publication/327267222_Green_Buildings_as_solution_for_Sustainable_Housing_Role_of_Private_Housing_Schemes_Lahore_Pakistan

Table 48 - Electricity Cost for Commercial Units in Pakistan 2023[140]

S. No	Load Type	Rate per Unit (kWh)	With 17% tax
1	Less than 5kW load	Rs. 38.80	45.39
2	More than 5kW load	Rs. 40.26	46.84

The cost-benefit analysis was conducted in terms of the use of:

iv. Building Materials
v. Building Design features
vi. Energy-efficient appliances

COST-BENEFIT ANALYSIS OF GREEN BUILDING MATERIALS

The structural review document analyzed the use of green building materials, finding that they could result in significant energy savings, with fly ash bricks saving up to 40% and bamboo offering savings of 3-5%. However, this green approach increased the overall construction cost by 18% while reducing CO2 emissions by 63%.

Below (Table 6) is the analysis of the example commercial building in terms of the use of green building materials. The costs are taken based on the local market price in Pakistan, and calculations are done where direct cost for green materials is not available. [141,142] Their average electricity units consumed are assumed because of the fact that commercial sector has high variance in number of units consumed by a tall building vs a small commercial shop and similarly for other buildings residing in a commercial sector. For the price of a unit charge building under consideration Is assumed to have load greater than 5 kw.

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140 https://ehsaas8171.com/electricity-price-per-unit-in-pakistan/

141 https://www.zameen.com/blog/construction-cost-5-marla-house.html

142 https://jbms.pk/fly-ash-brick-price/

Table 49 - Use of Energy-Efficient Building Material

	Use of Fly Ash Bricks	**Use of Cellulose Insulation in Roof**	**Combined Use of both Materials (Fly Ash Bricks, Cellulose Insulation)**
Load Type	**Less than 5 kW**		
No. of Electricity Units Consumed/Month	**400**		
Yearly Bill	**224,832**		
Percentage Savings (Avg.)	40	28	68
Yearly Benefit of Building Material	89,932	62,952.96	152,884
Cost of Installation/Retrofitting	3,50,000	36,354	386,354
BCR (Ratio)	12.84	43.29	7.91
ROI (%)	25.69	17.36	39.5
Payback Period (years)	3.89	0.57	2.52
Life Span	50 years	25 years	20 years

The benefit-cost ratio (BCR) is 12.84, 43.29, and 7.91 for using fly-ash bricks, cellulose insulation, and using the two together, respectively, showing a highly beneficial investment. Moreover, the return on investment and payback period are showing satisfactory results. As a rule of thumb, if the ROI value is greater than 7%, it's considered a good investment. It is thus concluded that the use of energy-efficient materials is a good option in monetary as well as energy-saving terms. The payback period is 3.89, 0.57, and 2.52 years for the use of fly ash bricks, cellulose insulation, and a combination of the two.

COST-BENEFIT ANALYSIS OF BUILDING DESIGN FEATURES

The analysis in the architectural review document found that incorporating green building design features like WWR and building orientation can result in significant energy savings of up to 12-39%

and 15-30%, respectively. The study also demonstrated that these features, along with others, could lead to cost savings of approximately $113,999, equivalent to nearly 30% of the building's energy consumption, with a payback period of 3 years and 2 months.

Below (Table 7) is the analysis of the example commercial building in terms of the use of energy efficient design. The costs are taken based on the local market price in Pakistan, and calculations are done where direct cost for green materials is not available. [143], [144] Their average electricity units consumed are assumed because of the fact that commercial sector has high variance in number of units consumed by a tall building vs a small commercial shop and similarly for other buildings residing in a commercial sector. For the price of a unit charge building under consideration Is assumed to have load greater than 5 kw.

Table 50 - Use of Energy-Efficient Building Design Features

	Building with Optimum WWR	**Overall saving through Green Design (WWR, Glazing, Orientation, Insulation)**
Load Type	**> 5kw**	
No. of Electricity Units Consumed/Month	**400**	
Yearly Bill	**224,832**	
Percentage Savings (Avg) %	25	45
Yearly Benefit of Building Design Features	56,208	101,174
Cost of Installation/Retrofitting	1,80,000	2,20,000
BCR (Ratio)	4.684	11.49
ROI (%)	31.22	45.98
Payback Period (years)	3.2	2.17

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143 https://www.zameen.com/blog/construction-cost-5-marla-house.html

144 https://jbms.pk/fly-ash-brick-price/

Life Span	15 years	20 years

BCR for installing optimal WWR is 4.684, and when combined with other factors, it reaches 11.49, indicating a highly advantageous investment. Additionally, the ROI and Payback periods are delivering favorable results, with an ROI exceeding 7%, signifying a sound investment choice. In conclusion, incorporating energy-efficient design features proves to be a prudent decision both in terms of financial and energy savings. The payback period for optimal WWR utilization is 3.2 years, while the use of multiple energy-efficient building design features results in an approximate payback period of 2.17 years, with variations due to differences in building sizes.

COST-BENEFIT ANALYSIS OF ENERGY-EFFICIENT APPLIANCES

The energy expert's analysis of green buildings highlights that the incorporation of insulated walls, roofs, and energy-efficient appliances such as LED bulbs, inverter ACs, and energy-saving fans can lead to a 29% reduction in a building's energy consumption. Additionally, the installation of a solar PV system can yield annual savings of approximately US$ 16,096.50 or PKR 4,819,950 by decreasing reliance on grid electricity, with a payback period of around 3 years for the solar PV system and 1-2 years for energy-efficient appliances. Table 8 provides a detailed analysis of an example commercial building (load >5kw) in terms of the use of energy-efficient appliances, considering local market prices in Pakistan.

Table 51 - Use of Energy-Efficient Appliances

	Savings by LEDs	Savings by Fluorescent
Load Type	**> 5 kw**	
No. of Electricity Units Consumed/Month	**400**	
Yearly Bill	**224,832**	
Percentage Savings (%)	50	75
Yearly benefit of appliances	112,416	168,624
Cost of Installation/ Retrofitting	185,000	196,655
BCR (Ratio)	3.46	2.14

ROI (%)	60.7	85.74
Pay Back Period (years)	1.64	1.16
Life Span of bulbs/tubes	5.7 years (50,000 hours)	2.5 Years (24,000 - 36,000 hours)

BCR of LEDs stands at 3.46, surpassing the 2.14 BCR value for fluorescent tubes, indicating that while fluorescent tubes provide higher savings, they represent a slightly more expensive investment compared to LEDs. Nevertheless, both the return on investment and payback period show positive results with an ROI value exceeding 7% which is generally considered a good investment. Therefore, using energy-efficient appliances is a favorable choice in terms of both financial and energy savings. The payback period for LEDs is 1.64 years, and for fluorescent tubes, it is 1.16 years.

The cost-benefit analysis of building materials, design features, and energy-efficient appliances underscores that green buildings offer more advantages than their associated costs. The combination of these factors can result in an overall 30% reduction in a building's energy consumption, contributing to the realization of the 30% energy-saving potential within the building sector of Pakistan.[145]

INDUSTRIAL SECTOR

Like commercial sector, unit price of electricity and tariff for industrial area is determined based on load they consume.

Table 52 - Electricity Cost For Industrial Units in Pakistan 2023[146]

S NO.	Load Type	Per Unit Price (Peak time)	Per Unit Price(Off Peak)
1	**Up To 25 kW (at 400/230 Volts)**	-	34.33
2	**Exceeding 25-500 kW (at 400 Volts)**	-	33.83

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[145] *Baig, A. (2018). Green Buildings as a Solution for Sustainable Housing: Role of Private Housing Schemes, Lahore, Pakistan. Research Gate. https://www.researchgate.net/publication/327267222_Green_Buildings_as_solution_for_Sustainable_Housing_Role_of_Private_Housing_Schemes_Lahore_Pakistan*

[146] *https://iesco.com.pk/index.php/customer-services/tariff-guide*

3	**Up to 25 kW**	37.89	32.33
4	**Exceeding 25-500 kW (at 400 Volts)**	37.83	32.12
5	**For All Loads up to 5000 kW (at 11,33 kV)**	37.83	32.03
5	**For All Loads (at 66,132 kV & above)**	37.83	31.93

The cost-benefit analysis was conducted in terms of the use of:

iv. Building Materials
v. Building Design features
vi. Energy-efficient appliances

COST-BENEFIT ANALYSIS OF GREEN BUILDING MATERIALS

The structural review document examined green building materials like fly ash bricks, low VOC paint, low-e windows, rammed earth, and bamboo. The findings revealed significant energy savings potential, with fly ash bricks potentially saving up to 40%, bamboo offering 3-5% savings, and cellulose insulation potentially reducing energy costs by 28%. Despite an 18% increase in overall costs, these materials reduced CO_2 emissions by 63% and led to energy cost savings of $113,710, equivalent to 30% of total energy cost savings.

Below (Table 10) is the analysis of the example Industrial vicinity in terms of the use of green building materials. The costs are taken based on the local market price in Pakistan, and calculations are done where direct cost for green materials is not available. [147,148] Their average electricity units consumed are assumed because of the fact that industrial sector has high variance in number of units consumed based on the apparatus, technology and machinery used by a particular industrial unit. For the price of a unit charge building under consideration Is assumed as a small factory having load between 25-500 kw.

Table 53 - Use of Energy-Efficient Building Material

	Use of Fly Ash Bricks	Use of Cellulose Insulation in Roof	Combined Use of both Materials (Fly Ash

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[147] https://www.zameen.com/blog/construction-cost-5-marla-house.html

[148] https://jbms.pk/fly-ash-brick-price/

			Bricks, Cellulose Insulation)
Load Type	**25-500 kw**		
No. of Electricity Units Consumed/Month	**15000**		
Yearly Bill	**63,00000**		
Percentage Savings (Avg.)	40	28	68
Yearly Benefit of Building Material	2520,000	1764,000	4284000
Cost of Installation/Retrofitting	3,50,00000	3635400	386,35400.00
BCR (Ratio)	3.6	12.13	2.21
ROI (%)	72	48.5	11.08
Payback Period (years)	13.8	2.06	9.01
Life Span	50 years	25 years	20 years

The benefit-cost ratio (BCR) is 3.6 for fly-ash bricks, 12.13 for cellulose insulation, and 2.21 when using both materials together, signifying a highly advantageous investment. Additionally, the return on investment (ROI) and payback periods yield favorable results, with an ROI exceeding 7%, indicating a sound investment choice. In conclusion, the use of energy-efficient materials proves to be a prudent decision both in terms of financial and energy savings, with payback periods of 13.8 years for fly ash bricks, 2.06 years for cellulose insulation, and 9.01 years for their combined use.

COST-BENEFIT ANALYSIS OF BUILDING DESIGN FEATURES

The architectural review document analyzed green building design features, finding that WWR can save 12-39% in different climates, building orientation can cut energy costs by 15-30%, and a combination of design parameters could result in $113,999 savings, equivalent to 30% of energy consumption.

Below (Table 11) is the analysis of the industrial vicinity (25-500 kw) in terms of the use of green building design features. The cost of installation is calculated by using the local market price of

Windows, glazing, and insulation in Pakistan, and calculations are done where direct costs are not given.[149] Their average electricity units consumed are assumed because of the fact that industrial sector has high variance in number of units consumed based on the apparatus, technology and machinery used by a particular industrial unit. For the price of a unit charge building under consideration Is assumed as a small factory having load between 25-500kw

Table 54 - Use of Energy-Efficient Building Design Features

	Building with Optimum WWR	**Overall saving through Green Design (WWR, Glazing, Orientation, Insulation)**
Load Type	**25-500 kw**	
No. of Electricity Units Consumed/Month	**15000**	
Yearly Bill	**63,00000**	
Percentage Savings (Avg) %	25	45
Yearly Benefit of Building Design Features	157,5000	2835,000
Cost of Installation/Retrofitting	1,80,0000	2,20,0000
BCR (Ratio)	13.1	25.7
ROI (%)	8.75	12.8
Payback Period (years)	1.14	0.77
Life Span	15 years	20 years

BCR is 13.1 for optimal WWR and 25.7 when combined with other factors, indicating a beneficial investment. The Return on Investment (ROI) is satisfactory with an ROI above 7%, making energy-

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149 https://wallrealestate.pk/guide/5-marla-house-construction-cost-pakistan-complete-guide/

efficient design features a financially and energy-saving option. Payback periods are 1.14 years for WWR and approximately 0.77 years for multiple energy-efficient design features.

COST-BENEFIT ANALYSIS OF ENERGY-EFFICIENT APPLIANCES

The energy expert's analysis indicates that utilizing insulated walls, roofs, and energy-efficient appliances can save 29% of a building's energy consumption. Furthermore, a solar PV system can provide annual savings of around US$ 16,096.50 or PKR 4,819,950 by reducing grid electricity consumption.

Below (Table 12) is the analysis of the example of industrial building (25-500 kw) in terms of the use of energy-efficient appliances. The cost of installation is calculated by using the local market price of LEDs, and fluorescent bulbs in Pakistan, and calculations are done where direct costs are not given.[150,151] The details of the analysis are given below in the Table 4.

Table 55 - Use of Energy-Efficient Appliances

	Savings by LEDs	**Savings by Fluorescent**
Load Type	**25-500 kW**	
No. of Electricity Units Consumed/Month	**15000**	
Yearly Bill	**63,00000**	
Percentage Savings (%)	50	75
Yearly benefit of appliances	3150,000	4725,000
Cost of Installation/ Retrofitting	185,0000	196,6550
BCR (Ratio)	9.7	6.006
ROI (%)	11.7	22.4

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[150] *https://www.mdpi.com/2673-4591/23/1/10*

[151] *https://www.shineretrofits.com/knowledge-base/lighting-learning-center/pros-and-cons-of-fluorescent-lighting.html*

Pay Back Period (years)	0.58	0.416
Life Span of bulbs/tubes	5.7 years (50,000 hours)	2.5 Years (24,000 - 36,000 hours)

BCR for LEDs is 9.7, surpassing the 6.006 value for fluorescent tubes, indicating that although fluorescent tubes offer higher savings, they represent a slightly more costly investment compared to LEDs. Nevertheless, the return on investment and payback periods show positive results, with an ROI exceeding 7%, signifying a sound investment choice. In conclusion, the use of energy-efficient appliances proves to be a beneficial choice in both financial and energy-saving terms, with a payback period of 0.58 years for LEDs and 0.416 years for fluorescent tubes. The cost-benefit analysis of building materials, design features, and energy-efficient appliances highlights that green buildings provide more benefits than their associated costs, potentially leading to an overall 30% reduction in a building's energy consumption, contributing to the utilization of Pakistan's 30% energy-saving potential in the building sector.

FACTORS INFLUENCING BUILDING STRUCTURE, DESIGN, AND ENERGY COSTS

Several factors exert influence on building structure, design, and energy costs. These factors are critical in shaping the sustainability and efficiency of structures within the construction industry. The following factors are critical in determining the factors that can introduce a change in the overall energy performance, construction, and energy cost of a building.

ECONOMIC FACTORS

The economic sustainability of construction ensures high economic growth and employment in the construction industry but it is also intrinsically linked to improved project delivery. While there is a perception of high initial costs it is important to consider the concept of whole life value. Whole life value takes into consideration the initial cost; design and procurement cost, cost in use; maintenance operation and dismantling cost, and residual value of the construction material. In the long run, the whole life value of the sustainable construction material should resort to profitability without compromising their positive environmental impact.

The **construction industry in Pakistan** is influenced by a lack of funding availability, high material costs, and high housing demand. Moreover, the shortages in foreign investment, volatile material prices, and increased housing demand in urban areas affect the construction industry. Although government policies encourage energy-efficient practices and safety standards, their implementation remains a concern. Despite these challenges, the industry has grown due to government initiatives and rising real estate demand, contributing significantly to the country's economy. [152]

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[152] *https://zarea.pk/economys-impact-on-pakistans-construction-industry/*

ENVIRONMENTAL FACTORS

The environmental factors are geared towards preventing harmful effects on the environment. These are realized by minimizing the production of waste, appropriate usage of natural resources, and protecting the environment. Local and recycled building materials have been touted to reduce CO_2 emissions leading to the production of healthier buildings which concomitantly strengthen the economy. [153] Literature has provided evidence that the promotion of prioritization of the use of local and recycled building materials has been advanced in research and development due to the evolution of the low-carbon building movement. Szydlik (2014) added in a study that sustainable buildings maximize resource efficiency, energy efficiency, water conservation systems, and grey water use, enhance indoor environment and quality, and usage of non-toxic materials. [154] This agrees with Reddy (2016)[155] who asserted that selecting sustainable materials is keen to the reduction or minimization of the economic (pricing) of buildings. Energy efficiency reductions in the construction and operation of buildings lead to reduced financial burdens for owners.

Environmental concerns are increasingly significant in **Pakistan's real estate** market, with demand for energy-efficient and eco-friendly properties.[156] Extreme weather conditions, such as hurricanes and earthquakes, can necessitate costly structural reinforcements. To accurately estimate costs, understanding local climate and conditions is vital. To optimize construction expenses in Pakistan, it's essential to consider factors like accessibility, resource availability, and local regulations, and collaborate with local experts and experienced construction companies.[157]

SOCIAL FACTORS

The social factor addresses the needs (culture, living conditions) of people involved in construction activities. According to Patil and Patil (2017), social factors highlight improvements in the quality of human life and the human living environment encompassing intergenerational equity, culture,

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153 Kibert CJ. 2016. Sustainable construction: green building design and delivery. Hoboken, New Jersey: John Wiley & Sons.

154 Szydlik C. 2014. Identifying and overcoming the barriers to sustainable construction. [Doctoral dissertations] 2330. https://scholarsmine.mst.edu/doctoral_dissertations/2330.

155 Reddy V. S. 2016. Sustainable construction: analysis of its costs and financial benefits. IJIREM. 3(6):522–525.

156 https://www.agency21.com.pk/blog/factors-affecting-pakistans-real-estate-market/

157 https://syed-brothers.com/construction/factors-affecting-commercial-building-construction-cost/

education, and health. According to Jamilus et al. (2013)[158], social factors provide high customer satisfaction. It stated that the social aspect of sustainability undergoes degradation in the same way as the natural environment. The need for a comfortable housing system is to be met by the usage of sustainable construction materials/products. Social sustainability is to improve the quality of life of individuals. Patil and Patil (2017)[159] asserted that sustainable building materials provide the opportunity for living inhabitants to live in healthy, comfortable conditions throughout the building's full life cycle. The emissions from the various construction materials could end up in health risks such as cancer, asthma, and so on. Othman et al. (2018)[160] in a study posited that long-term exposure to specific building materials may be harmful to the overall health of building occupants. Materials can contain hazardous, irritating, toxic, or odorous elements that can adversely impact human overall health either directly or indirectly.

In **Pakistan**, social factors significantly influence construction projects. These factors encompass accidents, shopping, tourism, and traffic, impacting project schedules, costs, and quality. Transportation efficiency, health, safety, migration, land value, and several other factors also play vital roles in project performance, making it crucial to address these considerations in the context of Pakistani construction.[161]

SOLUTIONS/STRATEGIES

To address the financial aspects and gaps identified in green buildings in Pakistan, the following strategies and solutions can be considered. Below (Figure 1) is the graphical representation of financial solutions for different stages of the value chain of buildings in Pakistan.

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[158] *Jamilus MH, Ismail AR, Aftab HM. 2013. The way forward in sustainable construction: Issues and challenges. Int J Adv Appl Sci. 2(1):15–24.*

[159] *Patil AK, Patil EM. 2017. Sustainable construction materials & technology in context with sustainable development. Int J Eng Res Technol. 10(1): 112–117.*

[160] *Othman M, Mohamed AF, Othman M. 2015. Review of carbon emission and LCA application towards sustainable building. Malays Constr Res J. 16(1): 77–96.*

[161] *Khahro SH, Memon AH, Memon NA, Memon ZA, Naresh R. Influence of Social and Economic Factors on Construction Project Performance in Pakistan. Sustainability. 2023; 15(3):2469. https://doi.org/10.3390/su15032469*

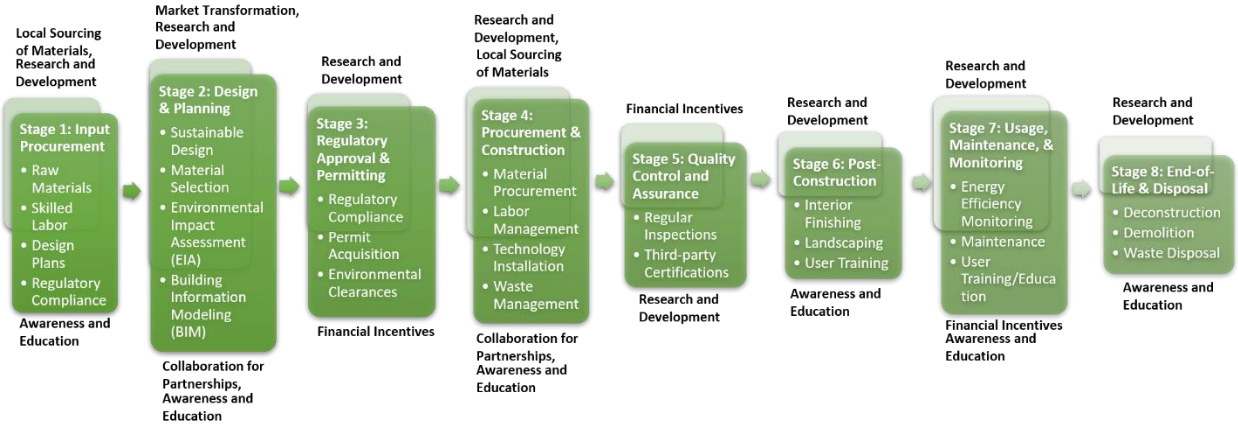

Figure 59 - Financial Solutions of the Design and Construction Phases of Green Buildings in Pakistan

FINANCIAL INCENTIVES AND SUBSIDIES

The government of Pakistan can offer **subsidies or tax incentives** to encourage the use of green building materials and practices. This can help offset the initial higher costs. Also, financial institutions can provide specific **green financing** options, such as lower interest rates or longer repayment terms, for individuals and companies investing in green buildings. Further, the Government can establish a system of **grants or rebates** for green building projects that meet certain sustainability criteria. These incentives can help reduce the upfront costs.

AWARENESS AND EDUCATION OF GOVERNMENT, PROFESSIONALS, AND PUBLIC

Awareness of the Government can ensure investments in sustainable buildings and technology. **Training programs and workshops** for architects, engineers, and builders can be offered to educate them about the benefits and techniques of green construction, which can lead to increased adoption and reduced costs as skilled labor becomes more readily available. Also, doing **public awareness campaigns** to educate homeowners and businesses about the long-term cost savings associated with green buildings can drive demand for such changes in the building sector of Pakistan.

LOCAL SOURCING AND RECYCLING OF MATERIALS

Encouraging the use of **locally sourced building materials**, **design technology,** and **energy-efficient appliances** can reduce transportation costs and support the local economy. Also, promoting the **recycling** of construction waste and the use of recycled materials can reduce costs and minimize environmental impact.

FUNDING FOR RESEARCH AND DEVELOPMENT

The Government should allocate **funding for research and development** in the green building sector to develop innovative and cost-effective green materials and technologies and also, establish a

platform for sharing research findings and best practices within the industry to facilitate knowledge transfer and cost reduction.

COLLABORATION AND PARTNERSHIPS

Foster **partnerships** between **government agencies, private sector entities,** and **NGOs** to jointly promote and invest in green building initiatives and encourage **collaboration among different sectors** of the construction industry to share resources and knowledge, leading to cost reduction.

MARKET TRANSFORMATION BY PROFESSIONALS

Encourage architects, real estate developers, and homeowners to **create a market demand** for green buildings, which can drive competition and lower prices. This can be achieved if infrastructure professionals promote the use of green materials, design technology, and efficient appliances.

By implementing these strategies and solutions, Pakistan can address the financial aspects and gaps in green buildings, making them more accessible and affordable while reaping long-term economic and environmental benefits.

3. HUMAN RESOURCE ANALYSIS

The construction industry in Pakistan is a significant contributor to the country's economy, and there is a wide range of skills and expertise available among the labor force in the construction sector. Pakistan boasts a substantial labor force of 68.75 million individuals.[162] However, it is difficult to gauge the percentage of labor, who have green building construction knowledge. This concept is relatively new in Pakistan but there is a growing interest in sustainable building practices. In the pursuit of economic revitalization in Pakistan's construction industry through the adoption of green building practices, a careful evaluation of required human resources is essential. This report includes the assessment of skills and expertise available and required in the value chain of the green building structure, design, and energy-efficient appliances in Pakistan.

ASSESSMENT OF THE VALUE CHAIN OF GREEN BUILDINGS IN PAKISTAN

The value chain of green materials involves several individuals including engineers, architects, project managers, electricians, laborers, and several other experts. Analysis of all the relevant individuals is important to identify the gaps in the value chain of green building, design, and energy-efficient appliances.

ASSESSMENT OF MATERIALS AND TECHNOLOGY

The assessment of materials and technology in the building value chain is shown below (Figure 2) and carried out as follows:

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[162] *https://www.pbs.gov.pk/sites/default/files/labour_force/publications/lfs2020_21/LFS_2020-21_Report.pdf*

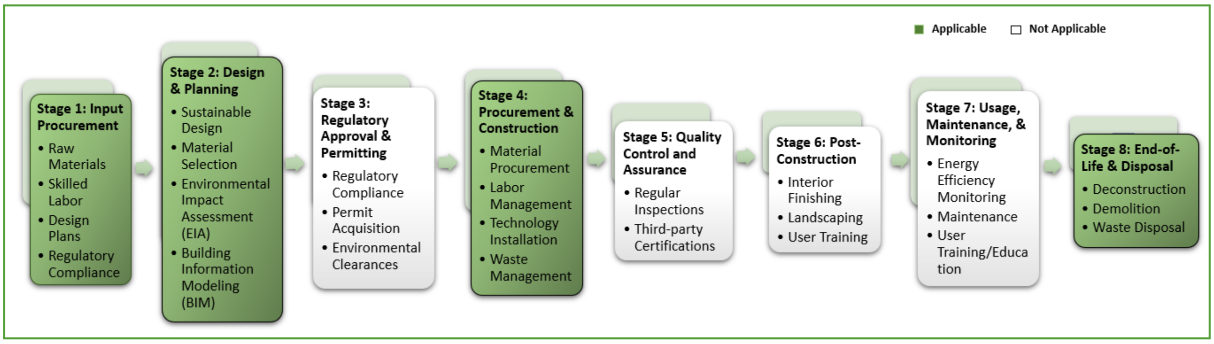

Figure 60 - Materials and Technology in Construction Value Chain

1. Sustainable Materials and Construction Techniques

Several sustainable and green building materials are produced locally in Pakistan but they are not produced in very high quantities due to the low market demand. Most of the sustainable materials to be used in green buildings are given below:

- **Fly Ash Bricks:** Fly ash bricks, made from waste materials, and produced by coal-fired power plants, are strong, durable, and environmentally friendly, as they help reduce waste and save energy. They are cheaper than traditional bricks, making them an affordable option for construction in Pakistan. **Tameerkaro Construction Company and Sitara Chemical Industries** are two of the very few suppliers of fly ash bricks in Pakistan.

- **Cellulose insulation:** Cellulose insulation is used in roofs due to the low thermal conductivity of Cellulose foam making it an excellent choice for insulation purposes. **Duracon Engineering and Lakhwa Chemical Services** are the suppliers of cellulose roof insulation in Pakistan.

- **Insulated Glass (Glazed Glass):** Insulated glass unit (IGU), more commonly known as double glazing, consists of two or three glass window panes separated by a vacuum or gas-filled space to reduce heat transfer across a part of the building envelope. **Al-Haq Glass & Aluminum, Pakistan Sunshine, and the graph** are a few firms that provide single- and double-glazed glass for windows.

- **Cool Bricks:** In Pakistan, a new material called the "cool block" that has been made using a special window called the Muscatese Evaporative cooling window is being tested. This cool block is created by putting water in a ceramic container and placing it next to a wooden screen. It is still in the experimental phase, hence there is **no supply** yet.
- **Bamboo:** Bamboo is a highly sustainable material that grows quickly and can be harvested without damaging the environment. It is strong and durable, making it an ideal construction material. Bamboo is used in building construction in Pakistan primarily for structural support in various

construction applications, including scaffolding, roofing, and as a building material itself. Bamboo is grown in Pakistan on **private farms**, particularly in the Punjab region, and is also supplemented by **imports from other countries** such as China and Bangladesh to meet the demand for construction purposes. **NYJ industries** are the biggest suppliers of bamboo in Pakistan.

- **Straw Bale:** Straw bale construction is gaining popularity in Pakistan due to its affordability and sustainability. Straw bales are made from the leftover stalks of wheat, rice, and other crops, which are often burned or discarded. They are highly insulating, making them an ideal material for construction in hot climates Straw bale buildings are also earthquake-resistant, which is crucial in Pakistan, where earthquakes are common. **Zeta Traders, Shoaib Enterprises, and Syed Usman Corporation** are a few suppliers of straw bales in Pakistan.

- **Low VOC Paints:** In Pakistan, paint serves the dual purpose of protecting walls and adding decorative appeal to homes and buildings. However, some paints can release **harmful chemicals** called VOCs into the indoor air, leading to air pollution indoors, which is where the need for low-VOC paints comes in. Paint manufacturers in Pakistan such as **Brighto, Berger, and Master Paints** are now supplying low-VOC paints.

- **Rammed Earth:** Rammed Earth is made by compressing layers of earth, gravel, and other locally available materials. Rammed-earth buildings are highly durable and can withstand earthquakes, fires, and other natural disasters, while also having excellent insulation properties, which can help reduce the need for heating and cooling systems. The use of rammed earth is **very common in rural areas** of Pakistan, but not very much in urban areas.

- **Stone, Marble & Chips:** Natural stones such as granite, marble, and limestone are used in Pakistan for building purposes. They are commonly used for cladding and flooring. These materials are mostly **available in the local market**. However, imported marbles are also available in the market. Solar Chips or green chips are used, and manufactured locally, and their cost is 20% higher than regular chips. They are used on rooftops to control direct heat from the sun.

- **Energy Efficient Lights** are manufactured in Pakistan. The system of smart and energy-efficient lights, swatches, doorbells, locks, swatches, surveillance cameras, and AI-integrated technologies are **available in the market**. However, the cost is 40-50% more than the locally manufactured products.

- **Water efficient Fixtures** are manufactured in Pakistan and there are several local manufacturers available, meeting the market demand as **Faisal Sanitary, Sonex Sanitary, Master Sanitary, and Super Asia Sanitary.** Most of them are water efficient. However, some of the imported water-efficient, sensor-embedded fixtures such as sensor taps, and sensor toilet flush are available in the market, providing smart solutions to homes.

Most of the building materials are produced locally in Pakistan such as bamboo, rammed earth, and natural stones. However, some building materials such as smart glass/glazed glass, fly ash bricks, insulation, and advanced electrical equipment, are imported from other countries mainly due to the presence of only a few local suppliers. Also, there is a limited number of firms in Pakistan offering expertise in **sustainable materials and construction techniques**. These firms prioritize the use of environmentally friendly materials and practices that align with principles of sustainability and conservation. Firms such as **Banu Mukhtar-Lahore** are at the forefront of this movement, emphasizing the use of eco-friendly materials and methods that align with environmental conservation principles.

2. Sustainable Design & Renewable Energy Technology

Sustainable design, also known as green or eco-friendly design, focuses on minimizing the negative impact of buildings on the environment and maximizing their energy efficiency. It involves incorporating sustainable design features such as WWR, Building Orientation, green roofs, and renewable energy sources. In the Pakistani context, sustainable design is gaining importance due to increasing environmental concerns. There are a few firms such as **Landscape-Karachi, Amir Adnan Associates-Lahore, and Consulting and Design Consortium Pvt. Ltd**., providing sustainable building design services to this industry.

Renewable energy technology focuses on the utilization of natural resources to generate clean and sustainable energy. Few firms are working in this area, that design energy-efficient buildings that incorporate renewable energy technologies, leading to sustainable and environmentally friendly construction projects in Pakistan such as the **Pakistan Council of Renewable Energy & Technology**.

ASSESSMENT OF SKILLS

The assessment of skills in building a value chain is shown below (Figure 3), and carried out as follows:

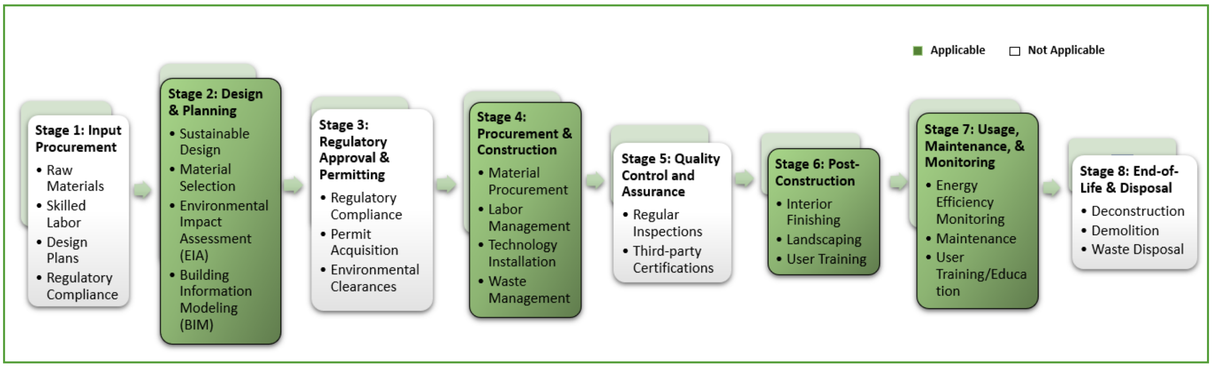

Figure 61 - Skills in Construction Value Chain

1. Architecture & Engineering

In the context of green building structures, architecture and engineering are of utmost importance. Architects and engineers are responsible for making buildings that not only look good but also have a minimal impact on the environment. They ensure that the construction uses sustainable materials and energy-efficient systems. Moreover, they strike a balance between making the building environmentally friendly while still being visually appealing and fitting into the local culture. In simple terms, architects and engineers are crucial for turning regular buildings into eco-friendly and energy-efficient green structures.

Within Pakistan's construction landscape, a multitude of architectural firms and engineers thrive, proficiently versed in various architectural styles and building engineering disciplines. Their expertise extends to the aesthetics, functionality, and cultural context of structures. However, a significant gap persists in the availability of expertise in sustainable and eco-friendly design practices. This shortage of firms dedicated to green design limits the widespread integration of sustainable principles into construction projects.

2. Construction Management

Construction management plays a crucial role in ensuring the successful execution of construction projects. Construction management is of vital importance Professionals in this field are responsible for overseeing all aspects of a project, including scheduling, budgeting, and quality control ensuring that projects are completed on time and within budget while maintaining high standards of quality. Construction management is essential for the efficient allocation of resources, preventing delays, and managing costs effectively. This expertise is vital for the construction industry's growth and success.

Pakistan exhibits self-sufficiency in construction management skills. Substantial growth in construction management services has been observed in recent years. This growth has solidified the nation's self-sufficiency in construction management skills, ensuring the timely, budgeted, and high-quality completion of construction projects.

3. Masonry, Concrete Work, Electrical, HVAC, Plumbing, and Carpentry Skills

Trades skills in masonry, concrete work, electrical, HVAC, plumbing, and carpentry are the backbone of the construction industry in Pakistan, these skills are essential for creating strong and durable structures. Masons and concrete workers lay the foundation and build the structural framework, ensuring stability. Electricians and HVAC technicians install crucial systems for power and climate control. Plumbers set up water supply and drainage systems, while carpenters add the finishing touches. These trade skills are really important to utilize green construction materials to the fullest. If expertise is not available in this domain then the availability of green materials is of no use.

A considerable labor force in Pakistan possesses a high level of proficiency in critical construction trades. These skills encompass masonry, concrete work, electrical work, HVAC installation, plumbing, and carpentry, collectively forming the foundation of construction endeavors. These skilled individuals form the backbone of construction projects, contributing significantly to the creation of sturdy foundations and structures.

ASSESSMENT OF CERTIFICATION AND REGULATORY BODIES

The assessment of certification and regulatory bodies in building the value chain is shown below (Figure 4), and carried out as follows:

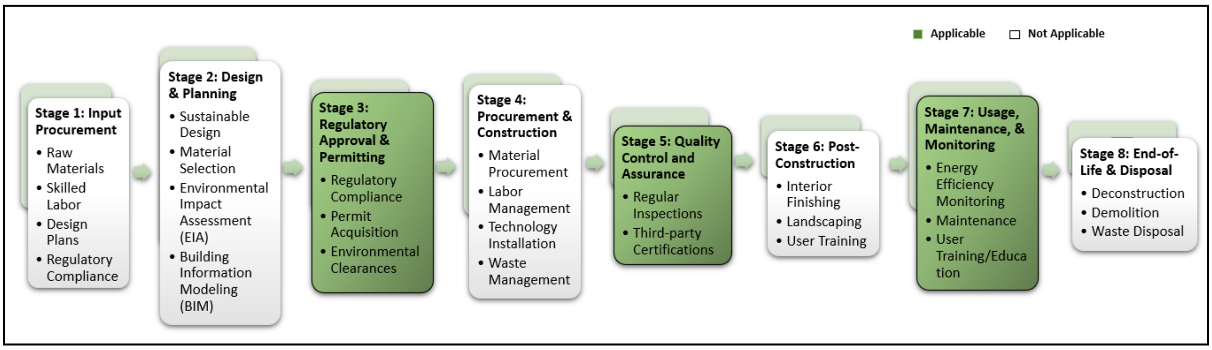

Figure 62 - Regulatory and Certification Bodies in Construction Value Chain

1. Green Building Certification System

Green building certification systems hold particular significance in Pakistan's construction industry, primarily concerning building materials. These systems play a crucial role in advancing sustainability by ensuring that construction projects utilize eco-friendly materials, thus reducing the environmental impact. Green building certification can play a crucial role in advancing sustainable development and reducing the environmental impact of the built environment in Pakistan. It is primarily driven by **LEED certification** and supplemented by local initiatives, such as the **Green Building Certification System (GBCS)** launched by the **Pakistan Green Building Council (PGBC)** and **National Green Building Standards by The Pakistan Engineering Council (PEC).** It promotes sustainable construction practices and recognizes buildings that meet specific environmental criteria. One of the few firms that provides this service to the country is **EDGE green building certification**. EDGE provides a simple and easy-to-use interface that can calculate and evaluate the environmental impact of the building design as well as energy efficiency and water conservation of the building by taking some inputs from the user.

2. Regulatory Bodies for HVAC, Safety, and Water Conservation

The importance of regulatory bodies and standards for HVAC (Heating, Ventilation, and Air Conditioning), safety, and water conservation in the construction industry, particularly in green building projects, cannot be overstated.

HVAC (Heating, Ventilation, and Air Conditioning), building safety, and water conservation standards in Pakistan are established and regulated by various authorities to ensure the well-being of occupants, prevent structural failures, and mitigate potential hazards. Here are the key organizations involved in setting building safety standards in Pakistan:

- **Pakistan Engineering Council (PEC):** The Pakistan Engineering Council is the regulatory body responsible for overseeing the engineering profession in Pakistan. PEC sets and enforces standards related to building design, construction, and safety. It develops the Pakistan Building Code (PBC), which provides guidelines for structural design, fire safety, electrical systems, water conservation, HVAC, and other aspects of building safety.
- **National Engineering Services Pakistan (NESPAK):** NESPAK is a leading engineering consultancy firm in Pakistan that provides expertise in various engineering disciplines,

including building safety. NESPAK works closely with government organizations and local authorities to develop and update building codes and standards. They provide consulting services and ensure compliance with building safety regulations, water conservation, and HVAC.

- **Local Development Authorities**: Local development authorities, such as the Lahore Development Authority (LDA), Karachi Development Authority (KDA), and Capital Development Authority (CDA), oversee building and construction activities within their respective jurisdictions. These authorities enforce building codes, bylaws, and regulations to ensure compliance with given standards.
- **National Disaster Management Authority (NDMA):** The National Disaster Management Authority is responsible for disaster risk reduction and management in Pakistan. NDMA plays a role in establishing guidelines and regulations related to building safety in areas prone to natural disasters, such as earthquakes, floods, and cyclones. They provide recommendations for designing structures to withstand such hazards.
- **Punjab Emergency Service (Rescue 1122):** Rescue 1122 is an emergency service provider in Punjab province. While not primarily responsible for setting safety standards, it plays a crucial role in responding to emergencies and enforcing safety protocols during rescue operations. They provide guidelines for fire safety and emergency evacuation in buildings.

- **International Standards:** Pakistan often adopts international building safety standards and guidelines. These include standards from organizations such as the International Code Council (ICC), the International Organization for Standardization (ISO), and the American Society of Civil Engineers (ASCE). International standards provide references and best practices for various aspects of building safety.

Value chain analysis shows the presence and absence of materials, technology, design features, and energy appliances regarding green buildings. There is a lack of firms supplying green materials, features, and expertise in this area, which is discussed in the identified gaps section as follows.

IDENTIFIED GAPS

While the construction industry in Pakistan exhibits a range of skills, significant gaps and challenges remain:

- **Limited Expertise in Sustainable Practices:** Across multiple segments, there is an overall lack of expertise in sustainable and eco-friendly practices. This gap includes the knowledge and skills needed to implement sustainable design, construction, and operational practices. Addressing this gap is essential for promoting environmentally responsible economic revitalization.
- **Inadequate Specialization in Green Building Certification:** The expertise required for green building certification is not readily available in most segments. Professionals who can navigate certification systems like LEED and ensure compliance with environmental criteria are in short supply. Bridging this gap is crucial to achieving sustainable and energy-efficient construction.

- **Regulatory Compliance Expertise:** The segments generally lack sufficient human resources with expertise in regulatory compliance, particularly related to safety, HVAC standards, and water conservation. Regulatory bodies and standards play a crucial role in ensuring building safety and environmental performance. Addressing this gap is essential for maintaining compliance with building codes and environmental regulations.
- **Limited Human Resources for Sustainable Materials and Techniques:** There is a gap in the availability of human resources knowledgeable in sustainable materials and construction techniques. These professionals are needed to promote the use of eco-friendly materials and construction methods that align with sustainability and conservation principles.
- **Insufficient Skilled Workforce in Specialized Trades:** While there is a skilled labor force in trades like masonry, concrete work, electrical work, HVAC installation, plumbing, and carpentry, there may be gaps in specialized skills required for sustainable and energy-efficient construction practices. Building a skilled workforce in these specialized trades is essential for high-quality and sustainable construction.

RECOMMENDATIONS/SOLUTIONS/STRATEGIES

To address these identified gaps and facilitate economic revitalization through green building construction, a series of strategic recommendations and solutions are proposed:

HUMAN RESOURCE CAPACITY BUILDING

Building the capacity for adopting green buildings involves a comprehensive approach that encompasses both skilled and unskilled manpower. Given some strategies and training activities to consider these can be grouped based on the audience and target sector

Green Building Workshops, Seminars, and Training Initiatives Organize **workshops and seminars** to introduce the concepts of green buildings, green building materials, their benefits, and the environmental impacts of conventional construction. Also, **develop online/onsite courses** or **webinars** that provide an overview of green building principles, practices, and technologies adopted**.** Further, **collaborate** with green building organizations, industry experts, and NGOs to develop and deliver training programs.

Public Awareness

Launch public awareness **campaigns** to educate homeowners, developers, and the general public about the importance of building codes, energy efficiency, and sustainable construction practices. Further, provide easily accessible online resources, guidelines, and toolkits to help stakeholders understand and comply with building codes.

Training for Professionals

Offer **training programs** and workshops for architects, engineers, builders, and local government officials to enhance their understanding of the latest building codes and green building practices and design training programs focused on specific **green building technologies**, such as energy-efficient

HVAC systems, renewable energy integration, rainwater harvesting, etc. Further, introduce **certification programs** for construction and building inspection professionals to ensure they have the necessary expertise to enforce and monitor codes effectively and conduct **workshops on sustainable design** principles, energy-efficient architecture, passive design strategies, and using sustainable materials. Also, teach the design and installation of **rainwater harvesting systems** to reduce water consumption. Also, provide knowledge about reusing grey water for non-potable purposes.

Training for Labor

Educate workers on **waste segregation**, recycling practices, and proper disposal methods on construction sites and provide **practical training sessions** where individuals can work with green building technologies under supervision. Further, train construction workers in techniques for reducing construction waste, efficient resource use, and proper installation of green technologies.

The strategies and training activities proposed for human resource capacity building are essential to promote green building practices in Pakistan. By raising awareness and providing training in green building concepts, public awareness campaigns, and professional development, these initiatives can significantly contribute to the adoption of eco-friendly construction methods. The introduction of certification programs and workshops for professionals ensures the necessary expertise for enforcing green building codes effectively. Ultimately, these actions lay the foundation for a more sustainable and environmentally responsible construction industry in Pakistan.

STRENGTHENING COMPLIANCE AND ENFORCEMENT

Local Capacity

Establish **specialized teams** at the local level tasked with monitoring and enforcing building codes. These teams should consist of trained inspectors, engineers, and other relevant professionals. While also **fostering collaboration** between local authorities, professional associations, and construction industry stakeholders to enhance enforcement efforts.

Technology and Data Management

Develop **digital platforms** for submitting building plans, permit applications, and inspection requests. Implement electronic record-keeping to improve transparency and accessibility of enforcement data. Further, utilize **remote monitoring** technologies, such as drones and satellite imagery, to conduct inspections and verify compliance with building codes.

Review and Continuous Improvement

Establish a **schedule for periodic reviews and updates** of human resource capacity building to ensure they remain aligned with technological advancements, best practices, and changing environmental concerns and **solicit feedback** from industry stakeholders, professionals, and the public to identify challenges, gaps, and areas for improvement in the enforcement process. Also, develop key performance indicators (KPIs) to measure the effectiveness of building code enforcement efforts, including compliance rates, energy savings, and environmental impact.

By developing a robust policy framework, building local capacity, leveraging technology, and fostering collaboration, Pakistan can create a more effective and efficient system for enforcing building codes. Continuous review, stakeholder engagement, and data-driven decision-making will be essential for ensuring the long-term success of these efforts and promoting sustainable and resilient construction practices across the country.

PROCESS FOR IMPLEMENTATION OF GREEN BUILDING CODES AND CERTIFICATION IN PAKISTAN

The implementation and actualization of the Green Building Code can be achieved by following the steps below:

- Establish a **Green Office coordinator** and a team to plan a practical environmental program.
- The detailed plan should have a different stage **assessment strategy**. For example, dividing the building construction into three stages the base structure assessment, the grey structure assessment, and the final building assessment.
- For all chosen indicators for assessment, numeric **objectives**, benchmarks, and monitors are set to fulfill the assessment process.
- The final building assessment, specifically checks the environmental aspects of the building, including energy efficiency, ventilation, waste reduction, recycling, and water conservation aspects.
- Special attention be paid to green issues in **procurements** and the purchase of green smart building materials. Incentives be given to industries manufacturing smart building materials solar chips, ash bricks, PVC, etc.
- **Annual reports** be compiled and set to the regulatory offices for audit purposes and certification purposes.
- **Training and certification** of the Project development offices, and district offices development could be done. Thus, only certified people are allowed to perform different tasks/ jobs in the construction industry.
- Incentives for the construction of green buildings, as **tax relaxations**/ **subsidies** could be given to real estate contractors
- Quick and efficient **e-approval** process be implemented. File approvals or approvals from CDA could be done by adding a separate swift digital platform by the name of Green Dream/ Green Building/ Green Society etc
- For industrialists, who are producing green technology or materials, incentives be given in terms of relaxing the caps and allowing trade by increasing the production units
- Designated **certified firms** or individuals be allowed in the construction industry
- Acquiring licenses for the engineers or contractors could be made compulsory. For certified/licensed engineers and contractors, who have proven themselves by constructing green smart projects, awards and relaxation in license renewals be given

- **Clean development mechanism** (CDM) projects be initiated with the coordination of local industry and foreign partners for long-term sustainability and SDG achievement.

Figure 63 - Process for Implementation of Green Building Codes and Certification in Pakistan

RECOMMENDATIONS FOR TECHNOLOGICAL IMPLEMENTATION OR ADOPTION

The **implementation of technology**, especially in government and policy institutions, is a key focus. Some suggestions to help with this include conducting a thorough assessment of Pakistan's ecological region to determine the availability of raw materials for making **smart building materials**, as Pakistan has abundant natural resources. Additionally, it is important for **academia and research** institutions to better understand the challenges faced by industries. Instead of seeking random ideas, they should conduct research based on **industry needs**. For instance, **research grants** can focus on finding low-cost, smart bricks for construction. Providing incentives and tax exemptions to industries involved in making smart building solutions is another recommended step. Furthermore, **reducing the import** of smart building equipment can support local industry growth and generate employment opportunities.

Educating people, training professionals and workers, enforcing green building rules, and supporting local industries in making materials are key recommendations for green materials in Pakistan. The report also suggests using available resources for smart building materials, promoting research that aligns with industry needs, providing incentives to local industries, and reducing imports of building equipment. These steps can help Pakistan transition to greener and more sustainable construction practices.

4. CONCLUSION AND WAY FORWARD

This report highlighted the significance of adopting green building practices in Pakistan to reduce greenhouse gas emissions, lower energy consumption, and ultimately, enhance the country's economic and environmental sustainability. Green building materials, design features, and energy-efficient appliances offer substantial cost savings, good BCR (Benefit-to-Cost Ratio), and good returns on investment with feasible payback periods. Alongside, there are long-term benefits, with a potential energy reduction of up to 30% in all aspects such as materials, design, and energy-efficient appliances. Also, various factors influence construction costs, including economic, environmental, and social aspects, making green building practices a favorable choice. To facilitate this shift, the report suggests strategies such as financial incentives, awareness and education initiatives, local sourcing, research funding, collaboration, and market transformation by professionals. By implementing these strategies, Pakistan can bridge the financial gaps in green buildings and promote sustainable construction practices, benefiting both the economy and the environment.

Furthermore, Pakistan's construction industry holds significant potential for green building practices. While it possesses a large labor force and some local sources of sustainable materials, there are notable gaps in expertise, green certification, and regulatory compliance. Addressing these gaps through capacity building, awareness programs, and enforcement measures is essential for fostering sustainable construction and economic revitalization. The adoption of technology and support for local industries can further drive progress. Transitioning towards green building practices will not only benefit the environment but also contribute to Pakistan's long-term economic growth and improved quality of life.

Moving forward, Pakistan should take action on the recommendations provided in this report. This includes creating and enforcing green building rules, offering financial incentives, and educating people about green construction. Promoting local materials, supporting research, working together, and making sure everyone follows the rules are equally important. Using technology and cooperation between the government and private sector will be crucial and periodic evaluation and adjustment of strategies will ensure the country remains on a sustainable path. By doing this, Pakistan can benefit from green building practices, leading to better economic growth, a healthier environment, and a better lifestyle for its citizens.

Appendix 8. Review Analysis of the Pakistan Green Building Regime

VI. Introduction

109. Pakistan does not possess a formal, unified statutory regime addressing the concept and phenomenon of green buildings. Green buildings are distinguishable from energy efficient buildings in that Green buildings represent the practice of developing structures and employing processes that prioritize environmental responsibility and resource efficiency, which goes beyond the singular dimension of energy efficiency.[163] Compared to the narrower focus of the energy efficiency approach, this approach spans the entire life cycle of a building, from initial site selection to design, construction, operation, maintenance, renovation, and eventual demolition. It expands upon and complements the traditional building design considerations of cost-effectiveness, utility, durability, and occupant comfort.
110. In this regard, green buildings circumscribe not just energy efficiency (the first step to green building), but also other important elements including the promotion of water conservation, indoor environmental quality, the use of sustainable construction materials and the reduction of environmental impact and the preservation of natural surroundings.
111. While green buildings are a relatively new policy imperative in Pakistan, there have been attempts dating back to the late 1980s (with varying degrees of success) to both make building codes more energy-efficient and the construction industry as a whole more environmentally friendly. Below, we survey these efforts from a legislative and regulatory perspective and use the locus of green buildings to assess what the potential path forward may be to make green building practices more mainstream in the Pakistani building / construction industry.
112. To do this, we primarily discuss four areas of legislation and regulation: (1) building control (with a corollary discussion of environment protection standards); (2) the energy efficiency regime; (3) the national standards regime; (4) finance and tax.

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[163] US Environmental Protection Agency, "Green Buildings" (US EPA 2016), https://archive.epa.gov/greenbuilding/web/html/about.html.

VII. The Statutory and Regulatory Framework[164]

E. Regulation of Construction & Building Control in Pakistan

Building Control as a Provincial Subject: Development Authorities, DHAs, Cantonments and Private Housing Societies as Regulators

113. The survey of any regulatory landscape necessarily needs to start with in an inquiry of where the power to legislate and administer lies. Pakistan is constitutionally a federal republic in which powers to regulate affairs are divided between the Federal and provincial governments respectively. Especially since the 18th Constitutional Amendment to the 1973 Constitution in 2010, the provinces reserve substantial autonomy to legislate, administer and enforce a number of matters in their respective territories. This includes the environmental protection, building control and the regulation of construction, since the federation retains powers to only legislate in respect of these matters to the extent of the Islamabad Capital Territory, or insofar as they bear relation to a federally controlled project, such as the Naya Pakistan Housing and Development schemes.[165]

114. There are two notable exceptions to this – building control in Cantonment areas across the country, which are governed by the federal Cantonments Act, 1924,[166] and the various Defence Housing Authorities ("**DHA**") across the country which are each governed by a federal law establishing them in each major city in the country.[167] Furthermore, the Federal Government (through the Ministry of Housing and Works) continues to play a role in developing national policies for housing and development (though these policies are again not binding upon the provinces and merely set

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[164] *A table collating the various laws, rules, regulations, By-laws and policies discussed in this section have been reproduced at the end of this report in Table 1.*

[165] *See, Naya Pakistan Housing Development Authority Act, 2020. <https://naphda.gov.pk/naphda.gov.pk/docs/NAPHDA%20ACT%202020.pdf>*

[166] *Cantonments Act 1924 (as amended by the Cantonments (Amendment) Act 2023). https://pakistancode.gov.pk/english/UY2FqaJw1-apaUY2Fqa-ap2Z-sg-jjjjjjjjjjjj*

[167] *Defence Housing Authority Lahore Order, 2002 establishes DHA Lahore; Authority Rawalpindi Act, 2013 establishes DHA Rawalpindi/Islamabad; The Pakistan Defence Housing Officer Order 1980 established the DHA Karachi.*

priorities for the Federal Government to advance),[168] as well as promoting interprovincial coordination.

115. At the provincial level, the provincial legislatures have generally conferred quasi-legislative (regulation and bylaw making) powers and enforcement powers on both development authorities through the legislations that create them, and local governments (such as under those established under provincial statutes like the Punjab Local Government Act, 2022,[169] the Sindh Local Government Act, 2013,[170] the KPK Local Government Act, 2013,[171] and the Balochistan Local Government Act, 2010[172]). Due to primarily political challenges in making local governments functional, a discussion of which is beyond the purview of this Report, building control is primarily enforced and administered by development authorities within the areas of their jurisdiction. Each development authority usually has jurisdiction over an area roughly equal to the size of a district. As stated above, cantonments and DHAs within these areas fall outside the jurisdiction of the development authority and come within the purview of either the Cantonment Board established under the federal Cantonment Act, 1924 to administer that particular cantonment, or the DHA, established under the parent DHA statute. In some circumstances, building control is only indirectly administered through developers of private housing schemes, or not at all and left to private bodies, such as in the case of cooperative housing society like the Model Town Cooperative Housing Society ("**MCS**") in Lahore.

116. There are also some federal housing projects administered by the Federal Government which are as a result subject to regulation by federal authorities. The most notable of these is the Naya Pakistan Housing Scheme, a low cost housing project announced by the Federal Government in 2020.[173] This scheme is administered by the Naya Pakistan Housing and Development Authority under the Naya Pakistan Housing and Development Authority Act, 2020.[174] Though interest (and momentum) in this scheme has diminished since the ouster of the PTI

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168 See, for example, the National Housing Policy, 2001. < https://mohw.gov.pk/SiteImage/Misc/files/National%20housing%20policy%202001.pdf>

169 https://punjablaws.gov.pk/laws/2857.html

170 http://www.pas.gov.pk/uploads/acts/Sindh%20Act%20No.XLII%20of%202013.pdf

171 https://www.lgkp.gov.pk/wp-content/uploads/2021/07/THE_KHYBER_PAKHTUNKHWA_LOCAL_GOVERNMENT_ACT_2013.pdf

172 https://pabalochistan.gov.pk/pab/pab/tables/alldocuments/actdocx/2019-11-15_15:29:42_5a2af.pdf

173 https://naphda.gov.pk/

174 https://naphda.gov.pk/naphda.gov.pk/docs/NAPHDA%20ACT%202020.pdf government that introduced it, the Naya Pakistan Housing Scheme is a example of a development agency developing and attempting to implement green building standards, and is therefore of interest for the purposes of this report. A brief discussion of these green building standards follows further below in the "Regulation of Energy Efficiency Related Standards" section.

117. The location of a residential or commercial building project determines which authority is the concerned building control authority whose rules, regulations and bylaws must be adhered to in order to gain the necessary building permits, site-map approvals, inspection clearances, and completion certificates to successfully navigate its construction.

118. The table below summarizes some notable agencies and authorities in major cities that exercise building control powers, and the building control measures they presently enforce:

Name	**Governing Legislation**	**Power to administer & legislate**	**Building Regulation**
CDA	The Capital Development Authority Ordinance, 1960[175]	Federal	Islamabad Residential Sectors Zoning (Building Control) Regulations, 2020[176]
LDA	The Lahore Development Authority Act, 1975[177]	Provincial (Punjab)	Lahore Development Authority Building and Zoning Regulations 2019 (amended up till 2020)[178]
Cantonment Board Clifton, Karachi	The Cantonments Act, 1924[179]	Federal	The Cantonment Board Clifton Building By-Laws, 2007[180]

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[175] https://www.cda.gov.pk/documents/docs/cda-ordinance-1960.pdf

[176] https://www.cda.gov.pk/documents/docs/buildingRegulations2020.pdf

[177] https://punjablaws.gov.pk/laws/308.html

[178] https://lda.gop.pk/website/images/Amended_Building_Regulations_2019_with_amendment_approved_till_28_01_2020.pdf

[179] https://lcb.gov.pk/assets/media/cantonments-act-1924.pdf

[180] https://cbc.gov.pk/assets/media/cbc-building-By-laws-2007-final.pdf

SBCA	Sindh Building Control Ordinance, 1979[181]	Provincial (Sindh)	The Karachi Building & Town Planning Regulations, 2002
DHA Islamabad / Rawalpindi	Defence Housing Authority Rawalpindi Act, 2013[182]	Federal	DHA Islamabad/ Rawalpindi By-Laws and Regulations Revised 2022[183]
DHA Lahore	Defence Housing Authority Lahore Order, 2002[184]	Federal	DHA Construction & Development Regulations 2014[185]
Naya Pakistan Housing and Development Authority	Naya Pakistan Housing and Development Authority, 2020[186]	Federal	Standardization of Building Codes Standards and Specifications for Low-Cost (Affordable) Units - 2021[187]

119. The building control regulations surveyed (listed above) show no consistent patterns. While each building control agency administers its regulations through a system of pre-construction approvals, permissions, no objection requirements, building plan approvals and other related measures, the requirements that building plans need to comport to vary. While some reference the Building Code of Pakistan (discussed further below) as the metric along which seismic, structural, and material requirements need to be measured against (in the case of the LDA Building Regulations also requiring compliance with the Building Code's energy related provisions), there is no consistent practice. Some even stipulate compliance with foreign standards, such that structure analysis, design, detailing and loading should

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[181] http://www.sindhlaws.gov.pk/setup/publications/PUB-22-000006.pdf

[182] https://pakistancode.gov.pk/english/UY2FqaJw1-apaUY2Fqa-apaUY2FqbJc%3D-sg-jjjjjjjjjjjjj

[183] https://serv4.dhai-r.com.pk/storage/app/media/DHAI%26R%20By%20Laws%20-%202022.pdf

[184] https://nasirlawsite.com/laws/dhalo.htm

[185] https://dhalahore.org/wp-content/uploads/2021/06/DHA-Construction-Regulaiton-2014-Updated.pdf

[186] https://pakistancode.gov.pk/english/UY2FqaJw1-apaUY2Fqa-apaUY2NpZ5s%3D-sg-jjjjjjjjjjjjj

[187] https://naphda.gov.pk/naphda.gov.pk/docs/Standardization%20of%20Building%20Codes,%20Standards%20and%20Specifications%20for%20Low-Cost%20(Affordable)%20Units%20-%2020May%2021.pdf

be "*in accordance with the requirements of current Uniform Building Code and American Code or British relevant Code or any other Code*."[188]

120. This can probably be accounted for by a lack of any central coordination mechanism between these various authorities in respect of building control requirements, the absence of any central guidance on the provincial or national goals of building control, or even what best current practices may be.
121. Building codes and regulations administered by various building control authorities also provide for standards for the testing of materials. For example, the Cantonment Board Clifton, Karachi requires that "*Regular testing will be carried out of materials such as aggregates, cement, concrete, reinforcing steel and all architectural materials, the quality control and quality assurance criteria laid down in standards of FIDIC, American Standard Testing method (ASTM), OR ACI or UBC and project specifications, quality assurance programme of architect or engineer may also be followed.*"[189] However, the building control authorities in question have scant, if any, mechanism available to either enforce or verify compliance in respect of such requirements and provisions. Some of them, as this example demonstrates, can also be so vague as to essentially become irrelevant or immaterial.

The Building Code and the Engineering Profession

122. The Building Code of Pakistan is a consolidated construction code created and periodically by the Pakistan Engineering Council (the "**PEC**"), the apex statutory body charged with licensure and regulation of the engineering profession. The PEC was created by the Pakistan Engineering Council Act, 1975 which is a Federal law, and is enforced federally (with policy input from the federating units through the Council of Common Interest).
123. The Building Code of Pakistan is by itself a non-binding code detailing the minimum standards engineers ought to follow for the "*construction, alteration, relocation, enlargement, replacement, repair, equipment, use and occupancy, location, maintenance, removal and demolition of every building or structure or any appurtenances connected or attached to such buildings or structures*."[190] The Building Code of Pakistan 2021 ("**BCP 2021**") is the most recent iteration, having succeeded the Building Code of Pakistan 1986, and is based substantially on the 2021 International Building Code, the 2021 International Performance Code for Buildings and Facilities and the 2021

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[188] Cantonment Board Clifton, Karachi Building By-laws, 2007, By-law 70. < https://sindhzameen.gos.pk/pdf/Building%20By-Laws%202007.pdf>

[189] See, for example. Cantonment Board Clifton, Karachi Building By-laws, 2007, By-law 78. < https://sindhzameen.gos.pk/pdf/Building%20By-Laws%202007.pdf>

[190] Building Code of Pakistan, 2021, Section 101.2

International Zoning Code.[191] Once construction is complete, a distinct legal framework for post-completion building maintenance is lacking in Pakistan. Building owners have the freedom to decide on maintenance and improvements at their discretion.[192]

Architects as Gatekeepers of Building Design: Untapped Opportunities

124. Besides structural or consultant engineers, who are almost universally required to certify the structural aspects of a building within the jurisdiction of each building authority discussed above, there is an equal, if not more significant role ascribed to architects, who bear the primary responsibility of certifying and submitting a building plan and drawings to the building control authority for approval. Each set of building regulations for each building authority codifies this role,[193] and may even require parties engaging in construction to acquire certification only from architects registered with that particular building authority.[194]

125. The profession of architecture is more broadly regulated under the Pakistan Council of Architects and Town Planners Ordinance 1983[195] (also a federal statute – the "**PCATPO**")), by the Pakistan Council of Architects & Town Planners ("**PCTAP**"), whose members are appointed by the Federal Government.[196] There are by-laws prepared under the PCATPO which govern the professional ethics and standards of licensed architects and town-planners. Needless to say, green building practices and energy efficiency related standards have scant, if any, mention these by-laws – the only obligation placed on architects is to "*advise on the efficient use of energy in new and existing buildings*."[197]

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[191] Ibid, Source Documents, , p.vii.

[192] "Data Collection Survey on Energy Efficiency and Conservation in the Building Sector in Pakistan, Japan International Cooperation Agency (JICA) Study (2016), p.2-24. Web <https://openjicareport.jica.go.jp/670/670/670_117_12249256.html>

[193] See, for example, DHA Lahore Building Regulations 2014, Reg. 14, 15(t), 43 and 64.

[194] Ibid, Reg. 64.

[195] https://pakistancode.gov.pk/english/UY2FqaJw1-apaUY2Fqa-bpmY-sg-jjjjjjjjjjjj

[196] Ibid, section 3 and 4.

[197] Code of Professional Conduct, Architects Appointment, Part 2 – Other Services, 2.10. < https://pcatp.org.pk/document/PCATP%20Hand%20Book.pdf>

Environmental Approvals and Building Control

126. In addition (and in supplement) to the broader building control regulatory framework, each province's environment protection statute (such as the Punjab Environmental Protection Act 1997), also provides for the necessity of an environmental impact assessment (EIA) or initial environmental examination (IEE) for the construction of certain projects anywhere in the province from the province's environmental protection agency.[198]

127. Building by-laws and regulations for most building control authorities recognize the need for EIAs and IEEs and make it a prerequisite for obtaining these prior to being granted approval for drawing and site maps to commence construction. It is worth noting however, that EIAs and IEEs are not required for every kind of construction or development, but it does cover a number of important residential and commercial constructions, such as housing schemes, apartment buildings, restaurants, urban development projects, and hotels.[199]

F. <u>Regulation of Energy Efficiency Related Standards</u>

The 1990 Energy Code

128. The discourse on implementation of energy-related provisions in the construction of residential and commercial buildings in Pakistan has its roots in the Building Energy Code of Pakistan, 1990.[200]

129. The Building Energy Code of Pakistan 1990 (the "**1990 Energy Code**") was a set of recommendations prepared by the National Energy Conservation Centre (ENERCON), a department of the Planning & Development Division of the Federal Government for the benefit of the Ministry of Housing & Works.[201] It appeared to be fundamentally motivated by the Government's realization that buildings accounted for 40% of the total electricity consumed in Pakistan, and there was a 14% annual

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198 See, for example, the Punjab Environmental Protection Act 1997, Section 12. < https://punjablaws.gov.pk/laws/2192a.html> . The environment is also a legislative and administrative subject that has been devolved to the provinces. Prior to the 18th Amendment, there was a central Pakistan Environment Protection Act 1997, which now only applies to the Islamabad Capital Territory.

199 See, the Punjab Environmental Protection (Review of Initial Environmental Examination and Environmental Impact Assessment) Regulations 2022, Regs. 3, 4 and 5 read with Schedules I and II.

200 Building Energy Code of Pakistan, prepared by the National Energy Conservation Centre (ENERCON), Planning & Development Division, Government of Pakistan (1990) < https://www.humanitarianlibrary.org/sites/default/files/2013/05/buildingecp.pdf>

201 Ibid.

increase in demand by buildings, which warranted a new set of standards aimed at reducing the energy consumption of buildings.[202] While ENERCON indicated that the 1990 Energy Code would form a part of the Building Code of Pakistan 1986 (which was the latest iteration of the national building code at the time – the "**1986 Building Code**"), it was not immediately mandatory to comply with,[203] and ENERCON viewed it as a guidance document, supplemented by a Compliance Handbook,[204] and workshops / seminars with building professionals that would help familiarize the industry with the concept. Once this familiarity was developed, ENERCON suggested that the 1990 Energy Code be made mandatory to comply with.[205]

130. Thematically, the 1990 Code was mostly based on the American Society for Heating, Refrigerating and Air-Conditioning ("**ASHRAE**") standards, setting minimum performance standards for building windows and openings, heating, ventilating and air- conditioning (HVAC) equipment and lighting, ENERCON also made attempts to account for Pakistan's unique weather and climatic conditions by adopting separate standards for each of the five (05) climatic zones identified in the 1986 Building Code.[206]

131. From 2003 to 2012, the Ministry of Housing & Works together with ENERCON ran an Awareness Campaign of Energy Conservation and Environment with the apparent aim of increasing awareness about the 1990 Energy Code.[207] During this time, there were efforts to also update the 1990 Energy Code, but a 2012 effort to commission the National Energy Services Pakistan (NESPAK),[208] was not able to take

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[202] *Ibid, Preface.*

[203] *Ibid.*

[204] *Ibid.*

[205] *Ibid.*

[206] *Ibid, Clause 1.4 – Applicability.*

[207] *"Data Collection Survey on Energy Efficiency and Conservation in the Building Sector in Pakistan, Japan International Cooperation Agency (JICA) Study (2016), p.2-35. Web <https://openjicareport.jica.go.jp/670/670/670_117_12249256.html>*

[208] *The National Engineering Services Pakistan (NESPAK) is a Pakistan-based multinational state-owned enterprise and an energy contractor which provides consulting, construction, engineering, and management services domestically and internationally. Web< https://www.nespak.com.pk/>*

off,[209] and ENERCON ultimately engaged with the PEC to both update the 1990 Energy Code as well as formally incorporate it into the 1986 Building Code.[210] On 28 March 2013, the Building Code of Pakistan – Energy Provisions 2011 (the "**2011 Energy Provisions**") became both the successor of the 1990 Energy Code and a formal (binding) regulation under the PEC (Conduct & Consulting) By-Laws 1986, which prescribe professional standards for engineers, and which make non-compliance / non-observance of the 2011 Energy Provisions **mandatory** at the risk of misconduct proceedings on grounds of violation of professional engineering work.[211]

132. The 2011 Energy Provisions aim to establish energy efficiency standards for buildings. They are substantially an adaption of the ASHRAE standards 90.1-2004, with the exception of Section 4, which has been tailored to accommodate the energy codes of regional countries and local environmental considerations. [212]

133. The 2011 Energy Provisions delineate the scope, considering building size, construction type, applicable systems, exemption criteria, and priority in case of conflicting provisions. The Provisions encompass the regulation of building components and facilities such as building envelopes, mechanical systems and equipment (including HVAC), service water heating, lighting, and electrical power and motors.[213]

134. The 2011 Energy Provisions only apply to buildings of a certain scale and scope, encompassing buildings and building clusters with a total connected load of 100kW or more, a contract demand of 125 kVA or more, a conditioned area of 900 m^2 or

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209 Data Collection Survey, JICA, p.2-35.

210 Ibid.

211 See, PEC (Conduct and Consulting) Bylaws 1986, Bylaw 11 (Application of Building Code of Pakistan (1) (Energy Provisions-2011). The Energy Provisions apply to apply for engineering design of buildings and building clusters that have a total connected load of 100 Kilo Watts or greater, or a contract demand of 125 KVA or greater, or a conditioned area of 900 m2 or greater, or un-conditioned buildings of covered area of 1,200 m2 or more. S.R.O. 249(I)/2013, notified by the Ministry of Science and Technology, amends the Pakistan Engineering Council (Conduct and Practices of Consulting Engineers) Bylaws 1986 to formally incorporate the Building Code of Pakistan Energy Provisions 2011. Web<https://www.pec.org.pk/wp-content/uploads/2021/05/S.-R.-O.-249-I-for-Building-Code-of-Pakistan-Energy-Provisions-2011.pdf>

211 Data Collection Survey, JICA, p.2-36.

212 Data Collection Survey, JICA, p.2-36.

213 2011 Energy Provisions, Section 2.2.

more, or unconditioned buildings with covered areas of 1,200m^2 or more.[214] Furthermore, the Provisions only apply to new buildings and their systems, new portions of existing buildings and their systems (if they exceed the specified area or load limits), new systems and equipment in existing buildings, and an increase in electricity load beyond the aforementioned limits.[215] They do not cover buildings that exclusively use sources other than electricity or fossil fuel, government-notified historically significant and heritage buildings, as well as equipment and building system parts utilized solely for manufacturing processes.[216] They also do not take precedence over relevant safety, health, or environmental codes; they must yield to these provisions.[217]

135. Although the PEC formally has the power to police and enforce the compliance of the 2011 Energy Provisions, as a practical matter it is nearly impossible for it to do so because it has no formal role in the building control process and is not in charge of vetting and providing approval for building plans. At present, the most the PEC can do is initiate misconduct proceedings upon a report that a consultant engineer has failed to comply with the 2011 Energy Provisions.

136. The only institutions that are administratively capable of enforcing the 2011 Provisions or other similar building code related regulations are the concerned building control authorities discussed above. However, the various building control authorities have been slow to formally incorporate the 2011 Energy Provisions, [218] and for that matter even the Building Code of Pakistan, into their building regulations. The table below summarizes references to, and mandates for compliance with, the 2011 Energy Provisions in the regulations of some building control authorities:

Name	**Building Regulation / Bylaws**	**Incorporation of 2011 Energy Provisions?**
Capital Development Authority	Islamabad Residential Sectors Zoning (Building Control) Regulations 2020	No
Lahore Development Authority	Lahore Development Authority Building and Zoning Regulations 2019 (amended up till 2020)	Yes

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[214] 2011 Energy Provisions, Section 2.1.

[215] Ibid.

[216] Ibid, Section 2.3.

[217] Ibid, Section 2.4.

[218] Ibid.

Sindh Building Control Authority	The Karachi Building & Town Planning Regulations, 2002	Not expressly, but references the BCP more broadly
DHA Islamabad / Rawalpindi	Building By-Laws DHA Islamabad/ Rawalpindi Revised 2022	No
DHA Lahore	DHA Construction & Development Regulations 2014	No

The National Energy Efficiency & Conservation Act 2016

137. By 2014, local and international development agencies began calling for the establishment of a stand-alone energy efficiency and conservation framework at the national/federal level to address the growing energy crisis. In its 2016 report, the Japanese International Cooperation Agency ("**JICA**") documented the growing calls for such a regime and reiterated its need by drawing parallels to the implementation and relative success of such an infrastructure in Japan.

138. One of the many challenges associated with creating such a regime was that, as discussed earlier, several areas which have a direct nexus with the potential mandate or area of concern for an energy efficiency and conservation authority, such as building control, are within the legislative and administrative domain of the provinces <u>exclusively</u>. While this handicap could have been overcome through a mechanism in the Constitution whereby provinces can pass a resolution to "delegate" the power to legislate to the federation in the interest of creating a national legislative framework for an area of importance,[219] (which has been successfully managed in several areas, such as the regulation of pharmaceuticals by the Drug Regulatory Authority of Pakistan[220]), there was no such consideration to do that in this case. Instead, since the regulation of electricity, oil and gas fall within the purview of the Federation,[221] as does interprovincial matters and coordination,[222] the Federal Government relied on the power to regulate these domains to propose a new National Energy Efficiency and Conservation authority, which would coordinate

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[219] Constitution of Pakistan 1973, Article 144. Power of Majlis-e-Shoora (Parliament) to legislate for one or more provinces by consent.

[220] The Drug Regulatory Authority of Pakistan Act, 2012 < https://www.dra.gov.pk/wp-content/uploads/2022/10/DRAP-2012-_As-Amended-till-Feb-2022.pdf>

[221] See, Schedule IV, Part II, Items 2 and 4.

[222] Ibid, Schedule IV, Part II, Item 13.

with the provinces and their designated energy conservation authorities to implement energy efficiency related measures.

139. After two years of circulation and consideration as a bill, on 29th June 2016, the National Energy Efficiency and Conservation Act 2016 ("**NEECA Act**") formally came into force in Pakistan.[223] The NEECA Act does several important things.

140. The NEECA Act empowered the Federal Government to create the Pakistan Energy Efficiency and Conservation Board ("**NEECB**"), an inter-governmental and inter-sectoral forum composed of a minister,[224] secretaries,[225] regulators[226] and industry representatives,[227] whose province of responsibilities include, among other things, policy formulation, collaboration with the National Standards Board to enforce energy efficiency standards, labelling, incentives and fines,[228] and the establishment of organizations to promote its objectives.[229]

141. More importantly, NEECB is charged with the supervision of a new body, also created by the NEECA Act, called the Pakistan Energy Efficiency and Conservation Authority ("**NEECA**").[230] NEECA steps into the shoes of ENERCON as the focal

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[223] *The National Energy Efficiency and Conservation Act, 2016 ("NEECA Act"). <https://www.pakistancode.gov.pk/english/UY2FqaJw1-apaUY2Fqa-apaUY2JwZpo%3D-sg-jjjjjjjjjjjj>*

[224] *In particular, the Minister for the Division to which the subject matter of the NEECA Act is allocated (presently the Ministry of Energy).*

[225] *In Pakistan's bureaucratic setup, a Secretary is usually the head of the bureaucratic head of a ministry or department of the concerned government (on the federal and provincial levels). The NEECA Act places the following secretaries on the PEECB: (1) Federal Secretary for the Division to which the subject matter of NEECA Act is allocated – presently the Energy Division; (2) Federal Secretary, Ministry of Finance; (3) Federal Secretary, Ministry of Planning and Development; (4) Federal Secretaries of the Divisions to which Petroleum and Natural Resources, Industries, Housing and Works, and Climate stand allocated; and (5) Secretaries of departments designated by each of the provinces to implement the NEECA Act. See NEECA Act, Section 3(b)(c)(d)(e)(f)(g)(h)(i)(j)(k)(l) and (m).*

[226] *In particular, the Chairmans of the Oil & Gas Regulatory Authority (OGRA) and the National Electric Power Regulatory Authority (NEPRA). See, See NEECA Act, Section 3(n) and 3(o).*

[227] *In particular, one nominee from the Chambers of Commerce and Industry, one person from the agricultural sector, and five persons from the private sector. NEECA Act, Section 3(p)(q) and (s)*

[228] *NEECA Act, Section 4.*

[229] *Ibid, Section 5.*

[230] *NEECA Act, Section 6.*

federal agency for "*initiating, catalyzing, carrying out and coordinating the implementation of all energy conservation programs in all sectors of economy.*"[231]

142. NEECA, having a broad mandate, has a number of powers and functions, including the development and implementation of policies, programs, and projects related to energy efficiency and conservation. The Authority is also responsible for conducting research and development activities, as well as providing technical assistance and training to stakeholders.[232] It is charged with preparing and updating the national energy conservation policy, recommending national energy efficiency standards, establishing accredited laboratories for conducting tests and analysis, undertaking inquiries and investigations into energy conservation issues, carrying out energy audits, directing energy use assessment, and potentially prohibiting manufacture, sale or import of non-energy efficient equipment and appliances.[233] One independent means of achieving this, as provided through the NEECA Act is through NEECA's power to certify and appoint energy auditors, who have the power to make an examination of energy consumption in a project and to prescribe means for its conservation.[234]
143. Most recently, under its prescriptive powers, NEECA has prepared a National Energy Efficiency and Conversation Policy, 2023,[235] which remains on the agenda of the Council of Common Interests (a constitutional body composed of representation from both the federation and the provinces that has oversight of matters with an interprovincial nexus, specifically those listed in Part II of the Federal Legislative List of the Constitution of Pakistan) but has yet to be accorded approval.
144. In addition to the NEECB and NEECA, the Federal and Provincial Governments also have important roles to play under the NEECA Act. The Federal Government has the power to, among other things, set standards and issue directions in writing to any person, officer, authority, or designated consumer for the efficient use of energy and its conservation.[236] These directions may include regulating the norms for process and energy consumption standards in any industry or building, as well as regulating the energy consumption standards for equipment and appliances. It

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[231] *Ibid, Section 7(a)*

[232] *Ibid, Section 7.*

[233] *Ibid.*

[234] *Ibid, Section7(s)*

[235] *The National Energy Efficiency Policy (2023), prepared by NEECA. <https://neeca.gov.pk/SiteImage/Policy/NEEC%20Policy%202023-1%20(1).pdf>*

[236] *NEECA Act, Section 10.*

specifically has the power to prescribe and amend energy conservation building codes, and direct designated consumers to comply with the provisions of energy conservation building codes, to prescribe standards for energy auditors, and to prescribe penalties for energy inefficient apparatus, appliances, equipment, plant and machinery.[237]

145. The Federal Government also has the power to issue energy saving certificates to consumers, and stipulate the standards and regulations in accordance with which they will be granted.[238] The NEECA Act itself envisions one benefit for these certificates – that they can be sold to people whose energy consumption is in excess of the prescribed standards – essentially looking to emulate the concept of markets for carbon credits by proposing a kind of energy efficiency credits market.[239]

146. Provincial governments have powers similar to the Federal Government to require compliance with the energy building codes and are expected to appoint designated departments or agencies to coordinate with NEECA in implementing the terms of the NEECA Act. At present, the Sindh Energy Efficiency and Conservation Agency (SEECA),[240] the Pakhtunkhwa Energy Development Organization (PEDO),[241] the Punjab Energy Efficiency and Conservation Agency (PEECA),[242] and the Baluchistan Energy Department, Government of Baluchistan appear to be in line to fulfil this role, though the ability and willingness to make these agencies functional in this regard can be substantially improved. These designated agencies are intended to have inquiry, investigative and energy audit related powers.[243]

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[237] *Ibid, Section 10(k)(l)(p)(q) and (r).*

[238] *Ibid, Section 11(1).*

[239] *Ibid, Section 11(2).*

[240] *https://www.sindhenergy.gov.pk/*

[241] *https://pedokp.gov.pk/*

[242] *https://peeca.punjab.gov.pk/. It appears that while the Punjab Energy Efficiency and Conservation Agency (PEECA) is functional, it hasn't formally been notified as a Designated Agency under the NEECA Act yet, a matter that PEECA has been drawing the Punjab Governments attention to as late as October 2023.See "NEECA asks Punjab and KP to establish their EEC Agencies" Business Recorder. 28 October 2023. Web. https://www.brecorder.com/news/40270463/neeca-asks-punjab-kp-to-establish-their-eec-agencies*

[243] *NEECA Act, Section 18.*

147. The NEECA Act also provides for the possibility of energy conservation tribunals to be notified, but to date, no such tribunals appear to have been notified by the Federal Government.[244]

148. NEECA has already published a national Energy Conservation Building Code in 2023,[245] and the Punjab Energy Efficiency Agency has a nearly identical version of it available on its website as a draft Energy Efficiency & Conservation Building Code of Punjab, 2017.[246] However, a fundamental problem that remains is that ultimately the time for consideration of these codes is during the process of gaining approvals for the construction of a commercial or residential building, which process is still entirely regulated and administered by the various building control authorities, none of whom have yet introduced procedures, requirements or guardrails to ensure that engineers and architects are signing certificates and furnishing building plans after duly considering the requirements of these new codes.

149. Not only that, but it appears that even though the PEC has been involved with (and has indeed been pivotal to) the creation of the national Energy Efficiency Building Code, it has <u>not</u> yet been notified either as a component of the Building Code of Pakistan, or as an update to the 2011 Energy Provisions, with the absence of the latter measure meaning that consulting engineers are not actually required to use it. However, sources in the PEC and NEECA suggest that, as of the date of writing of this report, there are ongoing consultations to formally notify the 2023 Energy Efficiency Code as a successor to the 2011 Energy Provisions.

Other Energy Efficiency and Green Building-related Interventions

150. There have been some initiatives by the Federal Government to encourage the adoption of green building codes and standards, at least to the extent of federally administered projects. The Ministry of Climate Change and Environmental Coordination ("**MoCC**") has taken an important role in this regard. While the MoCC has no direct role in the regulation or enforcement of green building standards, as the Ministry that acts as the focal point of the Federal Government as regards to climate change and environmental degradation and its impacts, it has undertaken a number of steps to encourage the adoption of practices that result in a better national environment and forestall the risks and anticipated consequences of climate

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[244] Ibid, Section 19.

[245]https://neeca.gov.pk/NewsDetail/ZDY0NTY2MzAtNDBjNi00ODlyLWFkMzgtN2MzMTBmNGNhYTc3

[246] Draft Punjab Energy Conservation Building Codes - 2017 <https://peeca.punjab.gov.pk/system/files/ECBC%20Draft%20Document.pdf>

change.[247] The Ministry is also actively engaged as part of Pakistan's international carbon emissions reduction obligations. These obligations are directly linked with the construction industry in Pakistan which as discussed earlier, plays a significant role in the carbon production of the country. Most relevantly for the purposes of this report, the MoCC is currently engaged in the Climate Resilient Urban Human Settlements Unit project which seeks to develop and strengthen the capacity of city administrations to assess the emission targets and adopt low-carbon energy-efficient comprehensive action plans to convert their urban-heat islands into "Climate Resilient Cities", towards fulfilling international commitments of the Federal Government. The project involves coordination and collaboration with the Pakistan Urban Planning & Policy Centre at the Ministry of PD&R (Planning, Development& Reforms); along with the UN-Habitat (Pakistan); all provincial urban units; and the Line Departments of P&D; Local Governments; Housing & Urban Development of the Governments of Gilgit & Baltistan and the AJK.[248]

151. According to industry insiders, specifically in the context of green building codes and standards, the MoCC has been coordinating and collaborating other federal entities, such as the PEC and NEECA in order to draft and promulgate green building codes which are applicable throughout Pakistan. While no drafts have been made available for public review, we understand that the Energy Efficient Building Code is being used as the underlying document for purposes of establishing a unified regulatory and enforcement regime.
152. Prior to this, the Federal Government received funding to prepare a green building code for implementation as part of its Five Million Housing Programme, and a group steered by SWITCH-Asia prepared the *Model Green Building Code Provisions for Five Million Housing Programme in Pakistan*.[249] As the name suggests though, these are model building code provisions, and do not have the force of law.

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247 Recent projects undertaken by the MoCC include the "Ten Billion Trees Tsunami Program" and the "Climate Resilient and the Urban Human Settlements Unit".

248https://mocc.gov.pk/ProjectDetail/NGRhYjMxMzAtZGJmMS00NjA2LWFjYWEtZWIwNjI5MjExM2Vi.

249 https://www.switch-asia.eu/resource/model-green-building-code-provisions-for-the-five-million-housing-programme-in-pakistan/#:~:text=EU%20SWITCH%2DAsia%20in%20collaboration,Code%20Provisions%2C%20based%20on%202018

G. The National Standards Regime and Certification Systems

153. Pakistan does not yet have any official accreditations or standards recognized by the government for green buildings. There have been some efforts to introduce product certifications for energy-efficient appliances, most recently under the new energy efficiency and conservation regime introduced by the NEECA Act, such as NEECA's efforts to implement energy efficient certifications for fans,[250] but progress on that front has faced delays and can be improved.

The development of certifications and standards by government agencies

154. There is a federal regime in place for national standards, with a reasonable degree of private sector participation for the purposes of performing assessments on the basis of officially notified standards. For standards and quality control, the Pakistan Standards and Quality Control Authority, established by the Pakistan Standards and Quality Control Authority Act 1996 ("**PSQCA Act 1996**"), has been the main body in charge of, among other things, providing grading and setting quality labelling standards for ingredients, performance, specification, usage, methods and other relevant quality control matters as well as grading the products when requested by manufacturers, or whenever necessary for the purpose of quality improvement.[251] The PSQCA also has the power to prohibit, manufacture, keeping in stock and sale of certain articles that do not conform to Pakistan Standards, as well as to prohibit their export, registration or even use of a name.[252]

155. There is some overlap here since 2016, since NEECA possesses similar powers,[253] but there has been some degree of consensus that since PSQCA has superior resources, pre-existing infrastructure and an established track record in devising and implementing quality standards, it is probably better suited to leading the effort on the creation and adoption of Pakistan Standards for energy efficiency and green labelling with supplementary assistance from NEECA.

156. In fact, the PSQCA has already been collaborating with NEECA to produce Pakistan Standards for energy efficiency of certain products. There is already a Pakistan Standard for "Comfort Fans and Regulators for Household and Similar Purposes."[254]

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[250] *See, NEECA Energy Efficiency Standards And Labelling Scheme. <https://neeca.gov.pk/Detail/OGQ5MDVmMjQtZjA5Yy00ZWZmLWJiNGUtOTYxN2Y3YmEwNWM>*

[251] *PSQCA Act 1996, S.8.*

[252] *Ibid, Ss. 11, 12, 13 and 14.*

[253] *NEECA Act, 2016, Section 7.*

[254] *https://www.psqca.com.pk/Electrotechinal/PS%201%202021%20Rev%203%202021%20Final.pdf*

Similarly, we see a clearer division of roles between NEECA and PSQCA's roles through the introduction of the draft National Energy Efficiency Authority (Pakistan Energy Labels) Regulations,[255] through which NEECA proposes to itself take on the authority of registering and implementing Pakistan Energy Labels, but only on the basis of Energy Star Rating prescribed by the PSQCA, and on the basis of Minimum Energy Performance Standards (MEPS) also adopted by the PSQCA and approved by NEECA.[256]

157. Under these Energy Label Regulations, there is also finally an attempt to introduce mandatory requirements for certain household products, such as room air conditioners, motors, fans, house hold refrigerating appliances and LED Lights to be energy efficient, and a prohibitions on manufacturers, assemblers and importers from procuring and selling inefficient appliances,[257] as well as a registration and certification mechanism,[258] so there is more legal infrastructure in place to push for more energy efficient certification and labelling.

158. Consultations around introducing these regulations continue,[259] but there is no news on their notification.

The development of certifications and standards in the private sector

159. Global recognition according to the LEED certifications granted by the U.S. Green Building Council has also spurred interest internationally in the creation and adoption of private green building codes and certifications. In Pakistan, the Pakistan Green Building Council ("**PGBC**"), which is a not-for-profit organization, is posturing itself as the "*only organization in the country advocating, promoting, developing Pakistan specific green guidelines and certifying sustainable building practices and product*."[260] The PGBC is a prospective candidate for membership with the World Green Building Council.

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[255] https://neeca.gov.pk/SiteImage/Misc/files/Pakistan%20energy%20label%20regulations.pdf

[256] Ibid, 2022 Draft Regulations, Reg.2 (Definitions).

[257] Ibid, Reg. 3.

[258] Ibid, Reg. 4.

[259] "Energy efficient technologies crucial to cope energy crises: Khwaja Asif" AP Pakistan. Web. Accessed 21 November 2023. https://www.app.com.pk/national/energy-efficient-technologies-crucial-to-cope-energy-crises-khuawaja-asif/

[260] The Pakistan Green Building Council, About. <https://pakistangbc.org/ourteam.php>

160. It appears that PGBC has not yet framed independent guidelines for Pakistan, but it continues to promote or facilitate the acquisition of the LEED and SEED standards administered by the World and U.S. Green Building Council.[261] While there is limited public reporting on the activities of the PGBC, they enjoy the patronage and support of notable industry participants (such as Bani Mukhtar, which is a leading builder and a founding member of the PGBC),[262] and also find mention in the Securities and Exchange Commission of Pakistan ("**SECP**")'s latest Green Bond guidelines, as a body whose standards would be recognized for the purposes of identifying and validating the issuance of bonds for green building projects.[263]

H. Financial and Tax Incentives

161. Currently, there are very limited, if any, tax and fiscal benefits available for energy efficient construction or green buildings.

162. At the federal level, the Federal Board of Revenue ("**FBR**") administers several federal taxes and levies, most notably income tax under the Income Tax Ordinance 2001, sales tax on goods under the Sales Tax Act 1990, federal excise duty under the Federal Excise Act 2006 and customs duties under the Customs Act 1969.[264] The Federal Government has afforded waivers and reductions to custom duties and sales tax on solar panels, but there are no concessions currently available to green building materials. Fiscal and tax-based incentives are a good policy to spur the adoption of new policies or to encourage new sectors. For instance, the Income Tax Ordinance 2001 already contains mechanisms for the grant of tax credits based on the securing of various certifications (e.g. not for profit certification from the Pakistan Centre for Philanthropy, or certifications for I.T service providers by the Pakistan Software Export Board).

163. At the provincial level, each province also administers a series of taxes, the most significant of which are the sales tax on services (collected under each province's own sales tax on services statute by the provincial Revenue Authority) and property tax, collected by the provincial excise and taxation department, or in the case of Islamabad, by the CDA. Property tax is based on the annual value of properties in areas designated as Rating Areas by the provincial government, with higher rates for rented properties compared to self-occupied ones. No special concessions or

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[261] Data Collection Survey, JICA, 2-89.

[262] https://banumukhtar.com/pakistan-green-building-council-gbc/

[263] https://www.secp.gov.pk/document/green-bonds-guidelines/

[264] Customs Act, 1969. <https://download1.fbr.gov.pk/Docs/20117161572837289customsAct.pdf>

exemptions presently exist for green buildings or energy efficient buildings, though reduction / concessionary incentives are granted for other purposes, such as early payment.[265]

164. As the chief regulator of the banking sector, the State Bank of Pakistan can play a massive role in the availability of finance through banks for the purposes of developing green buildings and energy efficiency projects. However, there is a general malaise of low credit availability in Pakistan driven by a number of factors, including but not limited to a risk averse banking sector, high interest rates, onerous security requirements, inefficient mechanisms for recovery in cases of default and other similar factors. While the State Bank of Pakistan has tried as recently as 2021 to improve access to credit to the construction industry generally for the purposes of housing development,[266] these efforts have not yielded much success in terms of improving access to housing finance. No measures of this nature have expressly incorporated energy efficiency or green buildings as a priority.
165. Policy interventions such as the Green Banking Guidelines issued by the State Bank of Pakistan to banks have attempted to increase the accessibility and adoption of green finance and green banking, but these have also had a limited impact.[267] Through the Green Banking Guidelines, the State Bank has sought to do a number of things, including encouraging banks to incorporate environmental and social risk factors into their lending decisions, promoting the adoption of best practices in risk management to mitigate potential negative environmental and social impacts associated with financing activities, promoting financing for environmentally sustainable projects, such as renewable energy, energy efficiency, and other green initiatives and providing incentives for banks to offer favorable terms for loans and financing related to environmentally friendly projects, and encouraging banks to build internal capacities to assess and manage environmental risks. However, these guidelines appear to have a very limited impact in the adoption of green banking and green finance nationally.

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265 Data Collection Survey, JICA, 2-93

266 See, for example, the SBP's Guidelines for financing of housing units in under-construction Projects <https://www.sbp.org.pk/smefd/circulars/2021/C10.htm>;

267 https://www.sbp.org.pk/smefd/circulars/2017/C8-Annex.pdf

166. The SECP has also just recently introduced guidelines for the issuance of green bonds/sukuks by public and private,[268] which expressly recognizes green buildings[269] as a legitimate subject of the use of proceeds from raising green bonds. As the guidelines are brand new as of this Report, no green bonds /sukuks have so far been issued.

VIII. Analysis of Gaps and Failures

167. Needless to say, the legal infrastructure undergirding the push for energy efficient and green buildings is not optimally geared to achieve that purpose.

168. Pakistan's chief problem in this regard is fundamental in nature: the degree to which building control is successfully administered varies widely, and the mechanics for it do not, at present, present a strong likelihood that tying in additional requirements either for green building materials and methods will prompt a visible transformation.

169. There is at least one study that documents the relative weakness of building Bylaws enforcement by various building control authorities in Pakistan.[270] It suggests that between public building control authorities (such as the LDA and local government) and private building control authorities (housing societies such as the Model Town Cooperative Housing Society ("**MCS**") in Lahore), the private authorities generally have stronger enforcement practices than the public ones, with better results in the public sphere by authorities such as the Cantonment Boards. It was found that 100% of house plans were approved by the MCS, while Lahore Cantonment Board also had significant control in its area and more than 85% plans were approved from the authority, while LDA had a mixed trend of approved and not-approved status due to weak enforcement. The local government administration had the weakest enforcement results, with 70% of house plans not being approved by the building control authority.

170. A number of reasons have been proffered to explain this. Fundamentally, it appears to be a resources problem, with the lack of monitoring machinery, and shortage of

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268 https://www.secp.gov.pk/document/green-bonds guidelines/?wpdmdl=42537&refresh=655b3e19318821700478489

269 SECP Guidelines - Issuance of Green Bonds/Sukuks, Section 5(x) – Criteria for use of proceeds "Green Buildings - which meet regional, national or internationally recognized standards or certifications such as LEED-USA, BREEAM-UK, Pakistan Green Building Council."

270 Dr. Muhammad Asim, Dr. Saima Gulzar & Rumana Khan Shirwani, "Study on Impediments and Success of Building Bylaws implementation in Lahore, Pakistan" Journal of Research in Architecture and Planning, Vol.22, No.1 (2017). <https://jrap.neduet.edu.pk/arch-journal/JRAP_2017(FirstIssue)/04.pdf>

technical manpower at the municipal level. Local political influence has also been suggested as a hurdle in controlling building violations.[271] By contrast, it is suggested that private building control authorities have better enforcement practices because of the participation of private parties, whose direct participation in the building control authorities (through electoral processes) gives them a direct stake in administration and enforcement, and enables building owners to put pressure on authorities to take prompt action and enforce its own Bylaws in the interest of the common good.[272]

171. Presently, the only consistent mode of enforcement found in the building Bylaws and regulations of building control agencies is the requirement that an architect and/or the consultant engineer provide a certification of the compliance of the building plan with the stipulated building standards (whether this is the Building Code of Pakistan, or the various other foreign standards building control agencies find acceptable).[273] There is, to be clear, little to no follow up or inspection regime in place regarding the accuracy of this certification, nor any post-completion, or random audit mechanism to gauge compliance. This has partial ties to the problem of capacity at the building control authority level, but also exposes a procedural / regulatory defect in enforcement.

172. The problem of capacity and lack of effective enforcement, especially at the level of the development authorities such as LDA, CDA etc. has been repeatedly highlighted through prior work in this area. Development authorities are routine found to not possess the technical and skilled staff necessary to assess compliance with the requirements of energy efficiency codes and green building codes.

173. JICA, for example, underlined in 2016 that while the 2011 Provisions state that the review and approval of the plans and specification by respective sanctioning from the development authorities or municipalities shall be in accordance with the EP-2011, many of these authorities or municipal corporation lack of technical and skilled staff who can understand the existing policies, proposals and can play their role for the implementation. It found that while development authorities were present in every major city, their role regarding urban planning and development remains unsatisfactory except of a few which managed to achieve targets and planned new strategies to cope with urban planning and housing issues.[274]

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271 Ibid.

272 Ibid.

273 See, for example, the LDA Building Regulations 2019, Reg. 2.2.3(b), 9.3(1), 10.3.1, 10.3.3(e).

274 Building energy efficiency policies and practices in Pakistan: A literature review - 5th International Conference on Energy, Environment & Sustainable Development (EESD) 2018

174. In addition to capacity problems, JICA also highlighted that there was also an awareness problem among building control agencies, architects, engineers and consumers regarding energy related building standards such as the 2011 Energy Provisions.[275] This is to be expected given the complete absence of any effective compliance and enforcement mechanism in respect of energy efficient building codes and protocols such as the 2011 Energy Provisions. [276] Even where compliance can be assured, existing codes are already required to be updated regularly, (3 years standard), but such updates haven't been forthcoming in the past – though there is some renewed energy to do this owing to the establishment of NEECA. Still, despite the development of the national Energy Efficient Building Code in 2023 (12 years after the 2011 Energy Provisions, and 7 years after the NEECA Act was enacted), it should be borne in mind that outside of NEECA's own framework, neither the PEC nor the building control authorities are presently required to enforce it.

175. In an effort to resolve some of these concerns, NEECA is reported engaging with building authorities to improve incorporation and implementation of energy-efficiency related measures. NEECA has estimated that they hope to have engaged with and onboarded all the various building control authorities by the end of 2024.

176. Outside of the domain of building methodologies, green building codes also rely on the prescription of environmentally friendly and code-compliant construction materials. However, the rating system for manufactured goods in Pakistan is underdeveloped, and at present, domestically manufactured equipment and fixtures such as window frames come with no product specifications (such as airtightness or waterproofing).[277] The lack of a market certificated products is also limiting factor when it comes to the adoption of energy efficient and green building practices.[278]

177. In this regard, while there is measurable (and commendable) progress in improving material and product certification, it has been commented that the technical aspects of programs are relatively straightforward, but the political, governance issues, and budgetary constraints can impede government-led initiatives. There has been emphasis placed on the importance of continuity and support from government leadership for national labelling success. Broader stakeholder engagement, including industry involvement, is crucial for adoption. Limited promotional budgets and the voluntary nature of the labelling had led to a loss of consumer awareness, but with

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275 2-104.

276 "A Comparative Analysis of Energy Provisions of Pakistan Building Code with Indian and USA Building Energy Codes" JAABE (2018)

277 Data Collection Survey, JICA, 2-103.

278 Ibid.

NEECA's 2022 Regulations, there may be an opportunity for more momentum on the front of enforcement.

178. Finally, as discussed above, there are limited fiscal and tax incentives to adopt energy efficient and green building standards, which make the added cost of implementing green building practices even less attractive.

179. As discussed earlier, within the domestic legal framework, the NEECA Act provides for the awarding of energy efficiency certificates to buildings for energy conservation, which are envisioned as a tradeable commodity in the vein of the global carbon credits market – the idea being that if there were energy usage caps for types of buildings, then building owners who fail to remain under such caps could purchase energy efficiency certificates from building owners who use less energy. However, this mechanism currently exists only on paper, and NEECA has neither notified any standards for the assessment or award of energy saving certificates, nor purported to set any mandatory or voluntary energy consumption quotas for buildings that would create the need for parties to sell or purchase energy efficiency certificates.

180. On the topic of the carbon credit market that had its genesis in the Kyoto Protocol and the Glasgow COP26, Pakistan lags behind in effectively tapping into this mechanism.[279] Energy efficient and green buildings could potentially serve as an additional avenue to capitalize on the global carbon credit trading market by enabling housing society developers, constructors or building owners to claim carbon credits for reductions in the emissions resulting from the erection of green buildings. A number of challenges stand in the way of this, most notably the absence of public knowledge of carbon credits, as well as the absence of local carbon credit markets or supporting legislative / regulatory infrastructure. Even so, there is a nascent market for certification agencies in Pakistan that can certify emissions reductions for registration and trading, and private businesses such as SGS offer such services.[280]

181. Taxation is a significant but underutilized policy tool in this regard. In other countries such as the United States, there are various tax credits and concessionary tax rates available to persons building owners as well as equipment and material manufacturers who implement green building and energy efficient measures. The Internal Revenue Service (IRS) of the U.S. Federal Government has provided the guidance regarding tax credits to construct new energy-efficient homes available

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279 Dr. Muhammad Khurshid, "Pakistan fails to earn dollars through carbon credits" Express Tribune. Online. 27 March 2023. < https://tribune.com.pk/story/2408383/pakistan-fails-to-earn-dollars-through-carbon-credits>

280 https://www.sgs.com/en-pk/services/product-carbon-footprint under the Energy Policy Act of 2005 through IRS Notice 2008-35, which provides guidance for credit for building energy-efficient homes other than manufactured homes, and IRS Notice 2008-36, which provides guidance for credit for building energy-efficient manufactured homes.[281]

182. Similarly, the Tax Relief and Job Creation Act of 2010 modifies and extends the energy-efficient appliance credit for certain dishwashers, clothes washers and refrigerators manufactured after December 31, 2010.[282] Similarly, the commercial building deduction appears in the new section 179D, which was enacted in the Energy Policy Act of 2005. The provision allows deductions for taxpayers who own, or are lessees of, a commercial building and install property as part of the commercial building's interior lighting systems, heating, cooling, ventilation and hot water systems, or building envelope.[283]

183. In Pakistan, tax incentives both at the Federal and provincial levels could potentially spur a revolution in the adoption of green building standards in constructing buildings if appropriate tax credits, tax breaks

IX. Recommendations for a Path Forward

184. To encourage the integration of smart and green city concepts, as well as energy efficiency provisions in urban planning and design, legal frameworks play a pivotal role in shaping and incentivizing sustainable practices. The Federal and provincial governments both need to implement an integrated strategy that both provides incentives and also mandates the maintenance of clearly defined thresholds / standards at the risk of penalty.

185. As discussed in detail above, Pakistan's federal form of government necessarily requires buy-in from the provinces in order for there to be any effective building control, since property, urban planning, development and ancillary matters remain largely within the legislative and administrative control of the provincial governments and legislatures, and then further down, in the hands of local development authorities created mostly under provincial statutes (except for Cantonments, DHAs and federal housing schemes or programs such as the Naya Pakistan Housing Project).

186. Thus both levels of government can look to enacting legislation that mandates or incentivizes the incorporation of energy-efficient technologies and green building standards in urban development projects. Zoning laws, for example, can be revised

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[281] *Data Collection Survey, JICA, 3-47.*

[282] *Ibid.*

[283] *Ibid.*

to prioritize the allocation of land for eco-friendly initiatives and set specific energy efficiency targets for new constructions.

187. Moreover, financial incentives such as tax breaks, grants, or low-interest loans can be introduced to motivate developers and businesses to invest in smart and green technologies. These incentives can be tied to the attainment of specific sustainability goals, ensuring that the benefits of environmentally friendly practices are both economic and ecological. Additionally, stringent building codes and certification programs can be implemented, requiring adherence to energy efficiency standards for obtaining construction permits. By embedding such requirements in legal frameworks, governments create a regulatory environment that fosters innovation and motivates stakeholders to prioritize sustainability in urban development.

188. Furthermore, collaboration between public and private sectors can be encouraged through legal mechanisms, fostering partnerships that leverage resources and expertise to implement smart city solutions. The law can facilitate the creation of public-private partnerships (PPPs) that focus on the development and maintenance of green infrastructure, including energy-efficient buildings and smart grid systems. By doing so, the legal system becomes a catalyst for the widespread adoption of sustainable practices, promoting a holistic approach to urban development that addresses environmental concerns while also meeting the needs of a growing and technologically advancing population. These approaches are discussed below:

Improving the implementation of Green Building Standards

189. As noted previously, in Pakistan, the power of the state to regulate affairs is divided between the Federal and provincial governments. On a Federal level, the NEECA Act provides mechanisms for the enforcement of the provisions of the Act including compliance with energy consumption standards. The Act provisions for the appointment of inspectors, by the designated provincial agency, for the purposes of enforcement.[284] The inspectors may enter into a premises to undertake inspection of any equipment for compliance with the energy consumption standards or other such matters as may be authorized. According to our information, no such inspectors have been appointed by any of the provincial agencies.

190. Furthermore, under the NEECA Act, there exists a provision which allows for NEECA to carry out energy audits of any building for the purposes of identifying energy conservation issues and making recommendations for corrective measures.[285] Through such audits, NEECA can not only play a facilitatory and educational role as regards to adoption of energy efficient and green building standards and practices but can also develop a formal legal mechanism for ongoing monitoring of certain larger scale projects to ensure compliance on an ongoing basis. Such a mechanism,

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284 See, Section 15 of the NEECA Act.

285 See Section 7 (s) of the NEECA Act.

for instance, could involve an initial inspection / audit at the pre-approval stage based on the submitted plans and drawings and then follow-up audits and inspections as construction proceeds.

191. If NEECA and through it, the provincial designated agencies such as PEECA, seek to improve enforcement on matters related to energy efficient, they must undertake serious efforts and make available adequate financial resources to build out its inspection and audit capacities. This is only possible if there is a collective appreciation on Federal and provincial government levels of the dire need for the adoption of energy efficient and green building provisions in Pakistan and a willingness to direct significant financial resources towards this issue. Such resources could be granted to NEECA, for instance, through the Energy Conversation Fund, a Fund which is envisioned under the Act, to be established by the Federal Government for the purposes of promoting efficient use of energy and for meeting out the expenses incurred in the implementation of the law.

192. The MoCC also has an important role to play *vis a vis*, devising, streamlining and coordinating implementation plans. As the Federal Government's primary ministry that deals with issues of climate change and environmental coordination, the MoCC can play a beneficial faciliatory role in the development and adoption of green building standards for Pakistan. Where support of the Federal Government is provided, both financial and political, the MoCC is well placed to gather all stakeholders, both at the provincial and federal levels, at one forum in order to devise national mechanisms for the adoption and enforcement of green standards as well as to resolve any ongoing concerns that arise as regards to the jurisdiction of a particular agency, authority, ministry or government to act in a particular area. The currently active coordination mechanism instigated by MoCC for NDC implementation, monitoring and reporting is a testament to how such an engagement is possible between the provincial and federal entities. Being the focal and decision-making entity on decarbonizing the economy and environmental sustainability, a green building certification system administered by MoCC and supported by NEECA is suggested. At federal level, the enforcement of the certification system can be handled by PEC. This certification system can be implemented by both public and private entities possessing research capacities and testing labs. Academic institutions can play a pivotal role in conducting green building materials testing.

193. On a provincial level, the focal agencies that must pay their role are the provincial designated agencies. As discussed previously, the majority of local building development authorities have not yet adopted even the 2011 Energy Provisions, let alone any of the energy efficient codes or guidelines. The Provincial Designated Agencies must, therefore, as an initial and first step, undertake efforts to ensure that standards as regards efficiency efficient are formally adopted as part of the respective building regulations / standards in force in their provinces so that these may be formally enforced.

194. Notwithstanding, it should be remembered that the capacity, competency and commitment of local development authorities, such as the LDA, itself is under question and in such circumstances, it is unlikely that such bodies will consider the enforcement of energy efficient and green building provisions as a priority. In this respect, delegating this responsibility further, to the private housing schemes, which have demonstrated a greater capacity and willingness to enforce building code provisions and punish violations may be a solution worth exploring. Where such schemes do not exist, greater private participation in matters related to enforcement of energy efficient and green building standards could provide a solution. Such participation could be in a number of forms, such as through a direct outsourcing of the enforcement of energy efficient and green building standards or through more tailored measures such as increasing the involvement and responsibility of architects working on a particular project, through amendments in bylaws providing for the professional ethics and standards of licensed architects and town-planners which add specific obligations upon architects and town planners to ensure that any building they design and construct conforms with the relevant energy efficiency and green building requirements applicable. While currently, there is only an obligation to "*advise on the efficient use of energy in new and existing buildings*."[286], this could be expanded to include more specific obligations regarding design, choice of material etc.

195. As this report has attempted to make clear, given the nature of Pakistan's governance structure without provincial and federal coordination, serious progress in the area of development and enforcement of energy efficient and green building standards will likely remain lacking.

196. A consultative inter-agency committee on building codes could potentially solve this problem – it could be a consultative caucus for provincial, federal and local stakeholders to interact and coordinate their respective efforts with regards to impletion of a uniform building code, based on green building principles, which contains the appropriate enforcement mechanisms as regards energy efficiency. The committee could have representation from NEECA, each provincial designated agency, all the building control authorities discussed earlier (LDA, CDA, the Cantonment Boards, the Naya Pakistan Housing Development Authority) and from the local government. Such a platform could be beneficial not only for purpose of coordination of efforts of the individual stakeholders but for the resolution of any issues as regards jurisdiction in a more streamed and timely fashion.

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286 Code of Professional Conduct, Architects Appointment, Part 2 – Other Services, 2.10. < https://pcatp.org.pk/document/PCATP%20Hand%20Book.pdf>

Regular Updates of the Relevant Building Codes

197. In addition to developing a stringent enforcement mechanism as regards energy efficient and green building standards, at international best practices inform us, it is equally important to regularly, at defined intervals, update the building standards and codes to account for changes in technology, building practices, availability of materials etc. While the Energy Conservation and Building Code, 2023 states that "*The code would be revised every 3 years, with the possibility of earlier updates if necessary to ensure its continued relevance and effectiveness*",[287] in the past, it has been seen that regular revisions in the codes rarely occurs according to this timeline.

198. For instance, while both the Building Energy Code for Pakistan, 1990 and the Punjab Energy Conversation Building Code 2017 both provided for defined periods after which the codes would be reviewed and updated as required, neither code has seen any substantial amendment following its initial publication.[288] Given the rapid pace of technological change, it is therefore imperative that the obligations as regards to regularly reviewing the building codes and updating them as required is adhered to and the relevant stakeholders chalk out an implementation mechanisms through which such reviews and updates may be made, in accordance with the provided timelines and best practices.

Material and Energy Efficiency Standards & Certifications

199. For green buildings to be viable, the material that is used to construct them must be convenient to identify and source. There is already a wide enabling framework available for the government to implement material standards certifications.

200. While the NEECB has the power to establish organizations for the purposes of carrying out its functions under the NEECA Act,[289] given its already pre-existing expertise in the area, the PSQCA is probably best placed to take on the mantle of establishing quality control and certification standards for equipment and materials, with participation from the private sector in carrying on inspections through a fee based model in order to bring energy efficiency and green building certifications to market.[290]

201. The NEECA Act also provides for a potential end-user certification system that potentially looks to create secondary market for energy conservation certificates that

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[287] *See Clause 1.4 of the Energy Conservation and Building Code, 2023.*

[288] *A three-year minimum and a five year maximum period is provided under the Punjab Code, 2017 while a three year period is provided under the Building Energy Code, 1990.*

[289] *NEECA Act 2016, Section 5.*

[290] *NEECA Act 2016, Section 7(e).*

can be used to offset a consumer's non-energy-efficient practices[291] (much like the carbon credit system sought to be implemented by the Kyoto Protocol). While this provision is promising, it must be borne in mind that, looking across the field to Pakistan's small, shallow and weak secondary markets for securities (the PSX and the PMEX), the possibility of a robust secondary market in energy efficiency credits and tradable energy certificates is best left as a second step once there is more widespread understanding and acceptance of green buildings and energy efficient buildings, a well-established enforcement mechanism, and a larger market for green building related products.

Fiscal and Tax Incentives.

202. Fiscal incentives can also have a substantial impact on the implementation and realization of an effective green building regime, combining benefits stemming from both the Federal and provincial tax regimes to create a cascade of benefits for all the stakeholders involved in the building process.
203. Financing plays a crucial role in promoting green buildings by incentivizing sustainable practices, encouraging energy efficiency, and addressing environmental concerns. Green building financing can come from various sources, including government initiatives, private investors, and financial institutions. Countries like
204. In some African countries, microfinance institutions provide loans to small-scale developers and homeowners to implement green building techniques. [292] These loans can be specifically targeted at improving energy efficiency and using sustainable materials. Brazil has implemented public-private partnerships to fund sustainable urban development projects, including green buildings.[293] The collaboration between government entities and private investors helps mobilize resources and expertise.
205. Private companies or municipalities can enter into energy performance contracts where the financing is tied to achieving specific energy efficiency goals. The savings generated from improved energy performance can be used to repay the financing.
206. There are numerous other opportunities for the State Bank of Pakistan to intervene to assist in promoting green building financing. It can, for instance, work with financial institutions to enable them to offer financial products that reward green building practices. Lower interest rates or special coverage for green features can incentivize developers to invest in sustainable construction.

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[291] See, NEECA Act 2016, Section 11.

[292] https://sparkassenstiftung-easternafrica.org/media/detail/role-of-microfinance-institutions-in-green-financing-1039

[293] Ibid.

207. Green financing has also made significant headway in the past decade internationally. Sweden have issued green bonds to finance environmentally friendly projects, including green buildings.[294] Investors purchase these bonds, and the funds are allocated to sustainable development projects.

208. The SECP has also just recently introduced guidelines for the issuance of green bonds/sukuks by public and private,[295] which expressly recognizes green buildings[296] as a legitimate subject of the use of proceeds from raising green bonds. These guidelines create the opportunity for businesses looking to improve their ESG metrics to use green building standards as a means to show their commitment to environmental sustainability, and to raise financing more easily specifically for this purpose. The Federal Government, the State Bank and the SECP can implement a range of further policy measures to promote the utilization of this mode of financing to encourage companies to implement green buildings, such as encouraging mutual funds and public funds to invest in these funds more actively.

209. As discussed earlier, the operationalization of Energy Efficiency certificates under the NEECA regime, which closely emulate Emissions Reduction Certificates (ERCs), is also a potentially useful tool in improving the demand for green buildings. ERCs have emerged as a powerful instrument in the realm of sustainable development, offering a tangible way to incentivize and promote green building practices. One of the key advantages of ERCs is their tradability. Building owners or developers can monetize the certificates by selling them in emissions trading markets. Buyers, often companies seeking to offset their own emissions or comply with environmental regulations, purchase these certificates as a way to invest in sustainability while meeting their carbon reduction goals.

210. The existence of a market for ERCs creates a financial incentive for housing society developers, investors and building owners to prioritize sustainable building practices. By attaching a tangible value to emissions reduction, ERCs encourage the adoption of energy-efficient technologies, renewable energy sources, and other green building strategies. This, in turn, fosters a shift towards more sustainable and environmentally friendly construction practices.

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[294] https://unfccc.int/climate-action/momentum-for-change/financing-for-climate-friendly/gothenburg-green-bonds

[295] https://www.secp.gov.pk/document/green-bonds guidelines/?wpdmdl=42537&refresh=655b3e19318821700478489

[296] SECP Guidelines - Issuance of Green Bonds/Sukuks, Section 5(x) – Criteria for use of proceeds "Green Buildings - which meet regional, national or internationally recognized standards or certifications such as LEED-USA, BREEAM-UK, Pakistan Green Building Council."

211. Tax benefits also serve as potent tools for molding market behavior, and the Federal and provincial governments could offer several different kinds of tax concessions to incentivize building developers and owners to opt for green building frameworks.

212. The Federal Government, which has legislative and administrative authority over federal taxes (income, excise, customs and sales tax on goods), could consider amending the Income Tax Ordinance 2001 to introduce a tax credit, or other concessions or benefits, to persons deriving income from property if they possess a recognized green building certification or an energy efficiency certification. Similarly, builders, constructors, engineers, and architects can be given concessionary rates applicable to their income from business if they're able to show that a certain percentage of their projects in a given tax year are certified green or energy efficient.

213. At the end of material sourcing, the Sales Tax Act 1990 and the Customs Act 1969 could be amended to provide concessionary sales tax and customs duty rates for building materials and appliances that are duly certified by the PSQCA and NEECA as "green" or "energy efficient".

214. At the provincial level, the provincial tax on immoveable property acts could be amended to provide concessionary rates or tax holidays to properties that are able to obtain a LEED or SEED certification. The sales tax on services acts could make reduced tax rates to applicable to the services of architects, builders and engineers who achieve a minimum number of LEED, SEED or other building certification standards as a percentage of their total projects in a given tax year.

215. In addition to incentives provided through the taxation regime, private lending institutions could be brought on board by the respective governments in an effort to make financing available for the retrofitting of old buildings with new, energy efficient and green standard materials and technology. The markup rates for finance availed under such schemes could be subsided by the governments directly or the governments could agree to act the surety for the loans granted under such schemes, in return for the financial institution charging a lower or sustained rate of interest.

216. Both models have been used in the past by both the provincial and Federal governments to increase access to finance for targeted segments of society. Such schemes would be helpful in not only providing property developers and builders with the needed additional capital to undertake energy efficient measures at their buildings but will also open up an avenue where through retrofitting, the long-term costs associated with operating an older building are reduced, providing a direct financial incentive to the building owner who has undertaken the changes. The adoption of solar technology in Pakistan is a testament to the success of such a model

where once the long-term financial value for the consumer becomes apparent, the adoption rates see a significant uptick as a *snowball effect* begins to occur.[297]

Table I

Name	**Governing Legislation**	**Power to administer & legislate**	**Notable Rules, Regulation, Bylaws or Codes Administered**
Building Control			
CDA	The Capital Development Authority Ordinance, 1960[298]	Federal	Islamabad Residential Sectors Zoning (Building Control) Regulations, 2020[299]
LDA	The Lahore Development Authority Act, 1975[300]	Provincial (Punjab)	Lahore Development Authority Building and Zoning Regulations 2019 (amended up till 2020)[301]
Cantonment Board Clifton, Karachi	The Cantonments Act, 1924[302]	Federal	The Cantonment Board Clifton Building By-Laws, 2007[303]
SBCA	Sindh Building Control Ordinance, 1979[304]	Provincial (Sindh)	The Karachi Building & Town Planning Regulations, 2002

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297 The "snowball effect" in the context of technology adoption refers to a phenomenon where the adoption or use of a particular technology or innovation grows exponentially over time, often building momentum as more people or organizations begin to use it.

298 https://www.cda.gov.pk/documents/docs/cda-ordinance-1960.pdf

299 https://www.cda.gov.pk/documents/docs/buildingRegulations2020.pdf

300 https://punjablaws.gov.pk/laws/308.html

301https://lda.gop.pk/website/images/Amended_Building_Regulations_2019_with_amendment_approved_till_28_01_2020.pdf

302 https://lcb.gov.pk/assets/media/cantonments-act-1924.pdf

303 https://cbc.gov.pk/assets/media/cbc-building-By-laws-2007-final.pdf

304 http://www.sindhlaws.gov.pk/setup/publications/PUB-22-000006.pdf

DHA Islamabad / Rawalpindi	Defence Housing Authority Rawalpindi Act, 2013[305]	Federal	DHA Islamabad/ Rawalpindi By Laws and Regulations Revised 2022[306]
DHA Lahore	Defence Housing Authority Lahore Order, 2002[307]	Federal	DHA Construction & Development Regulations 2014[308]
Naya Pakistan Housing and Development Authority	Naya Pakistan Housing and Development Authority, 2020[309]	Federal	Standardization of Building Codes Standards and Specifications for Low-Cost (Affordable) Units - 2021[310]
Building Codes and Energy Efficiency Codes			
PEC	Pakistan Engineering Council Act 1976[311]	Federal	• Building Code of Pakistan, 2021 • PEC (Conduct & Consulting) By-Laws 1986 • Building Code of Pakistan – Energy Provisions 2011
NEECA / NEECB	National Energy Efficiency and Conservation Act 2016	Federal	• National Energy Efficiency Authority (Pakistan Energy Labels) Regulations, 2022 • National Energy Efficiency and Conversation Policy, 2023 • Energy Conservation Building Code 2023
Sindh Energy Efficiency and Conservation Agency		Sindh	N/A

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[305] https://pakistancode.gov.pk/english/UY2FqaJw1-apaUY2Fqa-apaUY2FqbJc%3D-sg-jjjjjjjjjjjj

[306] https://serv4.dhai-r.com.pk/storage/app/media/DHAI%26R%20By%20Laws%20-%202022.pdf

[307] https://nasirlawsite.com/laws/dhalo.htm

[308] https://dhalahore.org/wp-content/uploads/2021/06/DHA-Construction-Regulaiton-2014-Updated.pdf

[309] https://pakistancode.gov.pk/english/UY2FqaJw1-apaUY2Fqa-apaUY2NpZ5s%3D-sg-jjjjjjjjjjjj

[310] https://naphda.gov.pk/naphda.gov.pk/docs/Standardization%20of%20Building%20Codes,%20Standards%20and%20Specifications%20for%20Low-Cost%20(Affordable)%20Units%20-%2020May%2021.pdf

[311] https://www.pec.org.pk/wp-content/uploads/2021/03/PEC-Act-1976.pdf

Pakhtunkhwa Energy Development Organization		KPK	N/A
Punjab Energy Efficiency and Conservation Agency		Punjab	• Draft Punjab Energy Efficiency Code 2023
Baluchistan Energy Department		Balochistan	N/A
National Certification Regime			
Pakistan Standards and Quality Control Authority	Pakistan Standards and Quality Control Authority Act 1996	Federal	• Various Pakistan Standards, including but not limited to Pakistan Standard for Comfort Fans and Regulators for Household and Similar Purposes – Methods for Measuring Performance
Taxation			
Federal Board of Revenue	• Federal Board of Revenue Act, 2007 • Income Tax Ordinance 2001 • Sales Tax Act, 1990 • Federal Excise Act, 2006 • Customs Act, 1962	Federal	
Punjab Revenue Authority	• Punjab Revenue Authority Act 2012 • Punjab Sales Tax on Services Act 2012	Punjab	
Sindh Revenue Board	• Sindh Revenue Board Act, 2010 • Sindh Sales Tax on Services Act, 2011	Sindh	
KPK Revenue Authority	• KPK Revenue Authority Act, 2022 • KPK Sales Tax on Services Act, 2022	KPK	
Balochistan Revenue Authority	• Balochistan Revenue Authority Act, 2015	Balochistan	

	- Balochistan Sales Tax on Services Act 2015		
Finance			
State Bank of Pakistan	- State Bank of Pakistan Act, 1956	Federal	- Green Banking Guidelines
Securities and Exchange Commission of Pakistan	- Securities and Exchange Commission of Pakistan Act, 1997 - Companies Act, 2017	Federal	- Guidelines on Green Bonds

Appendix 9. Pakistan's green building rating system and item-specific scores

Categories	Evaluation Items	Evaluation	Points (Residential)	Points (Non-residential)	Remarks
A.: Site Planning & Development (Points: 17)	A.1 Ecological value of existing land	Existing land's ecological value, land use, zoning, etc.	2	2	
	A. 2 Minimizing soil cut/fill in earthwork	Sum of the absolute amounts of fill and cut for topographic change over the entire land area	2	2	Pakistan to consider necessity
	A.3 Validity of measures to prevent natural light interference	The maximum elevation angle from the adjacent property's boundary to the building's north-facing elements	3	3	
	A.4 Heat wave response and heat island effect mitigation plan	Installations for heatwave and heat island effect mitigation	3	3	
	A.5 Building connected green space axes	Connections to the internal and external green axes	2	2	
	A.6 Ecological area ratio (mandatory)	Presence and proportion of areas with natural circulation functions in relation to outdoor space	3	3	
	A. 7 Accessibility to public transport and amenities	Access and proximity to public transportation and amenities	2	2	
B. Energy & Environmental Pollution (Points: 30) * Green buildings in response to energy and climate change	B.1 Building envelop & opening (mandatory)	Energy performance assessment: Performance criteria for each part of the building	17	17	
	B.2 Prohibition of specific materials to protect ozone layers	Ozone depleting substance standards to address global warming	3	3	Additional: Proposed for expected effects for green industry development

	B.3 Use of renewable energy sources	Percentage of renewable energy supply	8	6	Moved from C to B
	B.4 Lighting energy saving (non-residential)	Light density and lighting type	0	2	Moved from C to B
C. Resource Efficiency (Points: 21) * Materials and resources + water	C.1 Building material substantiality (mandatory)	Use of Eco-label certified products, Good Recycled Product certified products and equivalent	6	6	Moved from B to C
	C.2 Water efficiency (mandatory)	Application of Eco-label certified water saving products	6	6	
	C.3 Rainwater management (additional)	Presence of stormwater retention facilities for sprinkler water, landscaping water, etc.	3	3	Added: Emphasis on Pakistan's need for water resources (Review Draft Deliverable2. 8p, Vision 2030 ...)
	C.4 Solid & Liquid Wastes Management (mandatory)	Recyclable domestic waste storages and sorting of recyclables	6	6	
D. Indoor Environmental Quality (Points: 24)	D. 1 Use of low indoor air pollutant discharging materials (mandatory)	Use of low VOC materials	9	9	
	D.2 Tobacco smoke control	Smoke-free building or smoke-free policy	1	1	
	D.3 Natural lighting (residential buildings)	Minimum natural light performance measured as average daylight factor (DF) and uniformity factor	6	0	
	D.4 Resting and refreshing area	Designated areas for building users	0	6	Added: for non-

		(customers/employees) to rest and refresh			residential buildings
	D.5 Natural & controlled ventilation	Installation of windows and ventilation systems for residents to control to bring in fresh air	8	8	Moved from B to D
E. Post-Completion Green Building Actions (Points: 8)	E.1 Environmentally-friendly space planning and management	Building's green elements and engagement of green building certified professionals in design	2	2	
	E.2 Construction site environment management	Contractor's establishment and implementation of a construction site environmental management plan	2	2	
	E3. Operation and maintenance	Manuals for managers and users	3	3	
	E4. Monitoring	Continuous monitoring throughout the building lifecycle (energy, water consumption, air quality data)	1	1	
Total			**100**	**100**	-

Appendix 10. Detailed Suggestion PGBC Criteria

<table>
<tr><td rowspan="3"></td><td colspan="5">PAKISTAN GREEN BUILDING CODE</td></tr>
<tr><td>CATEGORY</td><td colspan="4">A. Site Planning & Development</td></tr>
<tr><td>CRITERIA</td><td>A.1. Ecological Value of Existing Land</td><td>POINT</td><td>2</td><td>Evaluation Item</td></tr>
<tr><td colspan="6">PURPOSE AND METHODS</td></tr>
<tr><td>PURPOSE</td><td colspan="5">Protect environmentally valuable land resources by evaluating the environmental and ecological value of existing land.</td></tr>
<tr><td>SDGs</td><td colspan="5">11 SUSTAINABLE CITIES AND COMMUNITIES
13 CLIMATE ACTION
15 LIFE ON LAND</td></tr>
<tr><td>METHOD</td><td colspan="5">Scoring based on existing land’s ecological value, land use, zoning, etc.</td></tr>
<tr><td colspan="6">DETAILS</td></tr>
<tr><td>POINTS</td><td colspan="5">2 (Evaluation Item)</td></tr>
<tr><td>RATING TARGET</td><td colspan="5">Residential Building (Including Community Centers)
Non-residential Building (Excluding Parking Lots, Mechanical Equipment Rooms, Electrical Rooms, etc.)</td></tr>
<tr><td>RATING STANDARD</td><td colspan="5">• Score = (Weight) x (Points Allocated)
<table>
<tr><th>Level</th><th>Ecological value of existing land</th><th>Weight</th></tr>
<tr><td>1</td><td>Land with low ecological value land ≥ 80% of land area</td><td>1.0</td></tr>
<tr><td>2</td><td>Land with low ecological value land ≥ 70% and < 80% of land area</td><td>0.8</td></tr>
<tr><td>3</td><td>Land with low ecological value land ≥ 60% and < 70% of land area</td><td>0.6</td></tr>
<tr><td>4</td><td>Land with low ecological value land ≥ 50% and < 60% of land area</td><td>0.4</td></tr>
</table>
- Land with low ecological value: Meets any of the following conditions
· Previously used land (reused land)
· Full remodeling
· Ecologically damaged land from being used as landfill or suchlike
- Large-scale development sites such as housing development districts, coastal and wetland landfills, etc. are not considered land with low ecological value.</td></tr>
<tr><td colspan="6">REFERENCE MATERIALS & SUBMISSION DOCUMENT</td></tr>
<tr><td>REFERENCE MATERIALS</td><td colspan="5">- USGBC LEED Green Building Rating System.
- The National Land Planning and Utilization Act and its Enforcement Decree related to the subdivision of land use and zoning may be of relevance.</td></tr>
</table>

	- Documents that elucidate the status of urban ecology in Pakistan can be referenced; if not, relevant guidelines should be prepared.
SUBMISSION DOCUMENT	Satellite or aerial photography On-site photos Urban planning verification certificate Land use plan certificate Land use change certificate

Appendix 4

	PAKISTAN GREEN BUILDING CODE				
	CATEGORY	A. Site Planning & Development			
	CRITERIA	A.2. Minimizing Soil Cut/Fill in Earthwork	**POINT**	2	Evaluation Item

PURPOSE AND METHODS

PURPOSE	Minimize the amount of cut and fill in earthwork by encouraging the utilization of existing topography and planning for less disturbance.
SDGs	11 SUSTAINABLE CITIES AND COMMUNITIES 12 RESPONSIBLE CONSUMPTION AND PRODUCTION 15 LIFE ON LAND
METHOD	Sum of the absolute amounts of fill and cut for topographic change over the entire land area

DETAILS

POINTS	2 (Evaluation Item)
RATING TARGET	Residential Building (Including Community Centers) Non-residential Building (Excluding Parking Lots, Mechanical Equipment Rooms, Electrical Rooms, etc.)

RATING STANDARD

- Score = (Weight) x (Points Allocated)

$$\text{Soil cut/fill (\%)} = \frac{\text{Soil cut/fill (m3)}}{\text{Total earthwork volume (m3)}} \times 100$$

Level	Minimizing soil cut/fill in earthwork	Weight
1	The absolute value of the sum of the soil cut and fill volume in the site (soil cut/fill amount) ≤ 100% of the total site area × 1 meter (total earthwork volume)	1.0
2	The absolute value of the sum of the soil cut and fill volume in the site (soil cut/fill amount) ≤ 200% of the total site area × 1 meter (total earthwork volume)	0.8
3	The absolute value of the sum of the soil cut and fill volume in the site (soil cut/fill amount) ≤ 300% of the total site area × 1 meter (total earthwork volume)	0.6
4	The absolute value of the sum of the soil cut and fill volume in the site (soil cut/fill amount) ≤ 400% of the total site area × 1 meter (total earthwork volume)	0.4

- Total earthwork volume (m^3): Total land area (m^2) × 1m

- Soil cut/fill(m^3): Soil cut (m^3) + soil fill (m^3)

- Excavation and backfill for building foundations, basements, etc., is not included in the soil cut/fill volume.

REFERENCE MATERIALS & SUBMISSION DOCUMENT	
REFERENCE MATERIALS	- Standard Specifications for Construction Work, Ministry of Land, Infrastructure, and Transport - Complex Construction Design and Estimation Standards, Korea Land and Housing Corporation, 2009
SUBMISSION DOCUMENT	- Cadastral maps (area, contour lines) - Civil engineering plans (cross sections, longitudinal sections, soil cut and fill plans) - Site photography - Earthwork estimates (including total cut and fill estimation) - Land use plan certificate

<table>
<tr><td colspan="6">PAKISTAN GREEN BUILDING CODE</td></tr>
<tr><td>CATEGORY</td><td colspan="5">A. Site Planning & Development</td></tr>
<tr><td>CRITERIA</td><td>A.3. Validity of Measures to Prevent Natural Light Interference</td><td>POINT</td><td>3</td><td>Evaluation Item</td></tr>
</table>

PURPOSE AND METHODS

PURPOSE	Encourage the structure to avoid blocking sunlight to neighboring properties, taking into account conflicts with existing structures and potential impacts on future development projects.
SDGs	7 AFFORDABLE AND CLEAN ENERGY 11 SUSTAINABLE CITIES AND COMMUNITIES 13 CLIMATE ACTION
METHOD	The maximum elevation angle from the adjacent property's boundary to the building's north-facing elements

DETAILS

POINTS	3 (Evaluation Item)
RATING TARGET	Residential Building (Including Community Centers) Non-residential Building (Excluding Parking Lots, Mechanical Equipment Rooms, Electrical Rooms, etc.)

RATING STANDARD

Score = Weight X Points allocated

Maximum elevation angle = arctan (Height of building / Distance between the building and the neighboring property line to the north)

Level	Maximum elevation angle range	Weight
1	Maximum elevation angle < 40°	1.0
2	Maximum elevation angle ≥ 40° and < 45°	0.8
3	Maximum elevation angle ≥ 45° and < 50°	0.6
4	Maximum elevation angle ≥ 50° and < 55°	0.4

- The maximum elevation angle is the angle of the north-facing elevation of the elements of the building from the adjacent property line.

REFERENCE MATERIALS & SUBMISSION DOCUMENT

REFERENCE MATERIALS	- Building height provisions in Pakistan's building code for daylight, etc. Example) Article 61 of the Building Act of Korea and Article 86 of its Enforcement Decree (height limitation of buildings for sunlight, etc.)

	- Green building design guidelines from Pakistan's government departments related to construction/architecture (Korea: Design Guidelines for Eco-friendly Buildings (Ministry of Construction and Transportation, December 1999))
SUBMISSION DOCUMENT	- Plot - Cross/longitudinal sectional views - Maximum evaluation angle estimation

<table>
<tr><td rowspan="3"></td><td colspan="5">PAKISTAN GREEN BUILDING CODE</td></tr>
<tr><td>CATEGORY</td><td colspan="4">A. Site Planning & Development</td></tr>
<tr><td>CRITERIA</td><td>A.4. Heat Wave Response and Heat Island Effect Mitigation Plan</td><td>POINT</td><td>3</td><td>Evaluation Item</td></tr>
</table>

PURPOSE AND METHODS

PURPOSE	Encourage building plans to incorporate responses to heat waves and heat island effect as they aggravate due to climate change
SDGs	3 GOOD HEALTH AND WELL-BEING 11 SUSTAINABLE CITIES AND COMMUNITIES 13 CLIMATE ACTION 15 LIFE ON LAND
METHOD	Scoring based on heatwave and heat island effect mitigation plans

DETAILS

POINTS	3 (Evaluation Item)
RATING TARGET	Residential Building (Including Community Centers) Non-residential Building (Excluding Parking Lots, Mechanical Equipment Rooms, Electrical Rooms, etc.)

RATING STANDARD

Scoring

Level	Heatwave and heat island effect mitigation measures	Point
1	At least 3 installations for heatwave and heat island effect mitigation	3.0
2	2 installations for heatwave and heat island effect mitigation	2.0
3	1 installation for heatwave and heat island effect mitigation	1.0

Climate change response plan	Location and type	Example
Buildings, facilities, installations to mitigate heatwave and heat island effect	Building facade/roof	Wall greening
		Wall insulation paint
		Cool roof paint
		Rooftop greening
		Roof spraying
		Insulation film
		Building exterior shade
	Space	Heat wave shelters

			Temporary protection
		Other	Portable cool mist (cooling fog)
			Fixed cool mist (cooling fog)
			Coot jet
			Heated and cooled chair
			Air curtain
			Shade
REFERENCE MATERIALS & SUBMISSION DOCUMENT			
REFERENCE MATERIALS	-		
SUBMISSION DOCUMENT	- Plot - Cross/longitudinal sectional views - Maximum evaluation angle estimation		

PAKISTAN GREEN BUILDING CODE

CATEGORY	A. Site Planning & Development			
CRITERIA	A.5. Building Connected Green Space Axes	**POINT**	2	Evaluation Item

PURPOSE AND METHODS

PURPOSE	Create continuous green space within the site and encourage connections to external green space
SDGs	3 GOOD HEALTH AND WELL-BEING 11 SUSTAINABLE CITIES AND COMMUNITIES 13 CLIMATE ACTION 15 LIFE ON LAND
METHOD	- Assessment based on the length ratio of the internal green space axis - If the internal green space axis is connected to an external green space, assessment based on the length ratio and length of the connection

DETAILS

POINTS	2 (Evaluation Item)
RATING TARGET	Residential Building (Including Community Centers) Non-residential Building (Excluding Parking Lots, Mechanical Equipment Rooms, Electrical Rooms, etc.)

RATING STANDARD

• Scoring with Rating Method 1 or Rating Method 2

Level	Length ratio of green axis on site	Point
1	Internal green space axis length ≥ 50% of total site circumference (0.50×A ≤ L)	2.0
2	Internal green space axis length ≥ 40% and < 50% of total site circumference (0.40×A ≤ L < 0.50×A)	1.6
3	Internal green space axis length ≥ 30% and < 40% of total site circumference (0.30×A ≤ L < 0.40×A)	1.2
4	Internal green space axis length ≥ 20% and < 30% of total site circumference (0.20×A ≤ L < 0.30×A)	0.8

[Rating Method 2]

• Score = Based on the length of the internal green space axis and length of the connection to external green space axis

If the internal green space axis is connected to an external green space (including biotop), score = Item 1) + Item 2)

Level	If connected to an external green space (including biotop)	Point
1	Item-specific score 2.0	2.0

2	Item-specific score ≥ 1.6 and < 2.0	1.6
3	Item-specific score ≥ 1.2 and < 1.6	1.2
4	Item-specific score ≥ 1.0 and < 1.2	0.8

1) Degree of connection of the internal green space axis to an external green space (including biotop)

Degree of connection of the internal green space axis to an external green space (including biotop)	Point
Width of connection of the internal green space axis to an external green space (including biotop) ≥ 8m	1.0
Width of connection of the internal green space axis to an external green space (including biotop) ≥ 6m	0.8
Width of connection of the internal green space axis to an external green space (including biotop) ≥ 4m	0.6

2) Internal green space axis length ratio

Internal green space axis length ratio	Point
Internal green space axis length ≥ 25% of total site circumference (0.25×A ≤ L)	1.0
Internal green space axis length ≥ 20% and < 25% of total site circumference (0.20×A ≤ L < 0.25×A)	0.8
Internal green space axis length ≥ 15% and < 20% of total site circumference (0.15×A ≤ L < 0.20×A)	0.6
Internal green space axis length ≥ 10% and < 15% of total site circumference (0.10×A ≤ L < 0.15×A)	0.4

- L : Internal green space axis length, A: Total site circumference

- The green space axis should consist of multi-layered planting and quality soil growth environment (vegetation, soil, water resources, etc.) to enable the habitat and movement of living organisms.

- The green space axis should be at least 4 meters wide with disconnections no greater than 1 meter; up to 3 meters of sectional disconnections allowed.

- A green space axis is recognized if it has a walkway that is less than 1 meter in width, constructed with connections to the planting surface, such as stone paving, etc.

REFERENCE MATERIALS & SUBMISSION DOCUMENT

REFERENCE MATERIALS

-

SUBMISSION DOCUMENT

- Planting plan
- Cross-sectional view of green space axis
- Green space axis length estimation

	- Design description with green space axis - Proof of green space planning - (For implementation) On-site installation photography

PAKISTAN GREEN BUILDING CODE

CATEGORY	A. Site Planning & Development			
CRITERIA	A.6. Ecological Area Ratio	**POINT**	3	Evaluation Item

PURPOSE AND METHODS

PURPOSE

Quantitatively evaluate changes in the ecological functions of the land (soil circulation, rainwater circulation, air and climate regulation, habitat, etc.) due to change sin land cover to prevent urban climate change and other ecological problems and pursue ecological soundness.

SDGs

11 SUSTAINABLE CITIES AND COMMUNITIES
13 CLIMATE ACTION
15 LIFE ON LAND

METHOD

Evaluate the ecological area ratio as a ratio of the total land area to the sum of the ecological areas calculated by categorizing space (cover) types and multiplying each space (cover) type by the corresponding coefficient; evaluate the degree of enhancement in consideration of the statutory building coverage ratio of the site.

DETAILS

POINTS

3 (Evaluation Item)

RATING TARGET

Residential Building (Including Community Centers)

Non-residential Building (Excluding Parking Lots, Mechanical Equipment Rooms, Electrical Rooms, etc.)

RATING STANDARD

Presence and proportion of areas with natural circulation functions in relation to outdoor space

- Score = (Weight) x (Points Allocated)

$$\text{Ecological area ratio enhancement} = \frac{\text{Ecological area ratio (\%)}}{\text{100\% –statutory building coverage ratio (\%)}}$$

$$\text{Ecological area ratio (\%)} = \frac{\text{(Converted area by cover type *+ Converted area by planting type**)}}{\text{Total land area}} \times 100$$

* Converted area by cover type = Area of natural circulation function = Σ(area by cover type × coefficient)

** Converted area by planting type = planting area = Σ(Number of plants × converted area × coefficient)

Cover type		Weight	Space (cover) type description
1	Natural ground green space	1.0	- Natural or created green space on the ground

2	Water space (permeability)	1.0	- Water space with groundwater holding properties - Coefficient = 0.5 for water space with cutoff facilities on the ground
3	Artificial ground green space ≥ 90 ㎝	0.7	- Green space on artificial ground with an effective soil depth ≥ 90 ㎝ - If soil depth < 90cm, coefficient = 0.5 (minimum soil depth 40cm)
4	Rooftop greening ≥ 40 ㎝	0.6	- Space with multi-layer planting with an effective soil depth ≥ 90 ㎝ - If soil depth < 40cm, coefficient = 0.4
5	Permeable pavement (including planting)	0.4	- If net pavement area is 50% or more or if no planting, weight = 0.2 (0 for impermeable pavement)
6	Wall greening	0.3	- Greening of windowless walls or retaining walls, up to 10 meters high (minimum soil depth 20 cm)
7	Interfaces with retention and infiltration facility	0.1	- Interfaces with stormwater infiltration for groundwater enrichment or temporary retention facilities

Planting type			Coefficient	Note for planting type determination
8	Planting height	Converted area	0.1	- Deciduous trees H≥4m, B≥12cm, or R≥15cm - 2 evergreen tall trees H≥4m, W≥2m - Deciduous trees H≥5m, B≥18cm or R≥20cm - 4 evergreen tall trees H≥5m, W≥3m - Deciduous trees H≥5m, B≥25cm or R≥30cm - 8 evergreen tall trees H≥5m, W≥5m * For shrubs with a height of 1.5 meters or higher, 50% of 0.3 (0.15).
	0.3m -1.5m	0.1		
	1.5m-4.0m	0.3		
	Higher than 4.0m	3.0		

REFERENCE MATERIALS & SUBMISSION DOCUMENT

REFERENCE MATERIALS

* Adjustments needed depending on the local climate zone, green space creation technology and market conditions in Pakistan

Following materials or similar sources in Pakistan

- Research on core technology development for ecological cities
- Measures to use ecological metrics for urban planning
- Research on the introduction of ecological area ratio standards

Other relevant resources on open green space

Other reference materials from Korea

- Seoul Ecological Area Ratio Operating Guidelines, Seoul Metropolitan City

	- Report on the Improvement of Ecological Area Ratios, December 2015, Seoul Metropolitan City
SUBMISSION DOCUMENT	- Design drawings (plot, ecological area ratio/green space map, planting plans/pavement plans, pavement/underground structure, etc.) - Ecological area ratio estimation (with space type and estimation formula) - Water permeability test report for permeable pavement - Site photography

PAKISTAN GREEN BUILDING CODE

CATEGORY	A. Site Planning & Development			
CRITERIA	A.7. Accessibility to Public Transport and Amenities	**POINT**	2	Evaluation Item

PURPOSE AND METHODS

PURPOSE	Reduce carbon emissions and conserve energy by curbing traffic with the use of public transportation and local amenities adjacent to the site.
SDGs	3 GOOD HEALTH AND WELL-BEING 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE 11 SUSTAINABLE CITIES AND COMMUNITIES 13 CLIMATE ACTION
METHOD	Evaluation based on the walking distance to public transportation (railroad, bus, port, etc.), the number of public transportation facilities, and the number of living amenities within a certain radius from the site entrance.

DETAILS

POINTS	2 (Evaluation Item)
RATING TARGET	Residential Building (Including Community Centers) Non-residential Building (Excluding Parking Lots, Mechanical Equipment Rooms, Electrical Rooms, etc.)

RATING STANDARD

Score: Public transport score + living amenities score

Level	Walking distance to public transportation	Point
1	2 or more public transports within 300m	1.0
2	Nearest public transport within 200m	0.8
3	Nearest public transport at a distance of 200m – 300m	0.6
4	Nearest public transport at a distance of 300m – 400m	0.4

- A public transportation facility is a facility necessary for the operation of public transportation under the Act on the Support and Promotion of Use of Public Transportation.

- Types of public transportation facilities include railroad, bus, passenger ports, and passenger flights.

- Walking distance is a physical distance via the safest and most convenient route.

- Distance is measured as the walking distance from the pedestrian path entrance to the public transportation facility.

- Village bus stops and airport limousine stops are counted as bus facilities.

Level	Distance from the site entrance to living amenities	Point

1	Living amenities within a 500m radius from the site entrance	1.0
2	Living amenities within a 600m radius from the site entrance	0.8
3	Living amenities within a 700m radius from the site entrance	0.6
4	Living amenities within a 1km radius from the site entrance	0.4

- A living amenity facility is a neighborhood living facility that meets the basic needs in daily living and the following conditions:

. Living amenities should include at least 10 types of living amenities.

. Class 1 and Class 2 neighborhood living facilities under Article 3-5 of the Enforcement Decree of the Building Act and parks

Some Class 2 neighborhood living facilities (bars, massage shops, and singing rooms) are excluded.

- Living amenities are facilities that are central to the lives of urban residents, such as medical, educational, and public facilities.

- Urban living amenities should include at least four of the following: medical, retail, cultural, religious, senior and children, educational, sports, business, and accommodation.

- Distance to a living amenity is measured as a radius distance from the site entrance. The site entrance is the primary or secondary entrance, whichever is more convenient.

- Redundant facilities are counted as one facility.

REFERENCE MATERIALS & SUBMISSION DOCUMENT

REFERENCE MATERIALS	- Act on the Support and Promotion of Use of Public Transportation, Ministry of Land, Infrastructure, and Transport
SUBMISSION DOCUMENT	- Plot - Cross/longitudinal sectional views - Land use plan for the housing development district (traffic impact assessment improvement plans) - Photos of stops for public transportation facilities - Location maps of the primary and secondary entrances and living amenities (with a radius diagram) - Housing development plan, district unit plan - Complex plan - Vicinity map (locations of public transportation facilities and pedestrian entrances, distance from public transportation facilities to the pedestrian entrances) - Data related to public transportation facilities adjacent to the building (urban railroad masterplan, etc.)

	PAKISTAN GREEN BUILDING CODE				
	CATEGORY	B. Energy & Environmental Pollution			
	CRITERIA	B.1. Building Envelop and Opening	**POINT**	17	Evaluation Item

PURPOSE AND METHODS

PURPOSE

Building energy consumption is closely related to greenhouse gas emissions from the use of fossil fuels. Energy savings in buildings lead to reductions in greenhouse gas emissions. In this context, pre-evaluation of energy consumption in building operations, which account for the largest portion in the building’s lifecycle energy consumption, contributes to saving energy and reducing greenhouse gas emissions.

SDGs

METHOD

Performance criteria for each part of the building.

DETAILS

POINTS

17 (Evaluation Item)

RATING TARGET

Residential Building (Including Community Centers)

Non-residential Building (Excluding Parking Lots, Mechanical Equipment Rooms, Electrical Rooms, etc.)

RATING STANDARD

- Score = (Weight) x (Points Allocated)

Level	Element-specific criteria										Weight
	Overall heat	Overall heat transmission	Window and door area	Overall heat transmission	Overall heat transmission	Overall heat transmission	Insultation type	Airightness (50 Pascal)	Boiler efficiency	Waste heat recovery unit	
1	1.0	1.6	≤ 20%	0.15	0.15	0.15	External	0.6 times /hour	≥ 87%	Yes	1.0
2	1.4	2.0	≤ 25%	0.20	0.16	0.19	External	-	≥ 87%	Yes	0.85
3	1.8	2.4	≤ 25%	0.25	0.17	0.23	-	-	≥ 87%	-	0.70
4	2.1	2.8	≤ 25%	0.30	0.18	0.27	-	-	≥ 87%	-	0.55
5	2.4	3.2	≤ 25%	0.36	0.20	0.30	-	-	≥ 87%	-	0.40

	※Overall thermal transmission of windows, doors, walls, roofs, and floors based on their minimum values - Also consider the Energy Conservation Building provisions.
REFERENCE MATERIALS & SUBMISSION DOCUMENT	
REFERENCE MATERIALS	- Building energy efficiency rating regulations in Pakistan
SUBMISSION DOCUMENT	- Supporting data to determine the energy efficiency rating (Drawings, test results, or estimation of insulation properties and thermal transmission, etc.)

PAKISTAN GREEN BUILDING CODE

CATEGORY	B. Energy & Environmental Pollution			
CRITERIA	B.2. Prohibition of Specific Materials to Protect Ozone Layers	**POINT**	3	Evaluation Item

PURPOSE AND METHODS

PURPOSE	Reduce the use and emissions of certain ozone depleting substances to combat global warming
SDGs	11 SUSTAINABLE CITIES AND COMMUNITIES 12 RESPONSIBLE CONSUMPTION AND PRODUCTION 13 CLIMATE ACTION 15 LIFE ON LAND
METHOD	Ozone depleting substance standards to address global warming

DETAILS

POINTS	3 (Evaluation Item)
RATING TARGET	Residential Building (Including Community Centers) Non-residential Building (Excluding Parking Lots, Mechanical Equipment Rooms, Electrical Rooms, etc.)

RATING STANDARD

- Sum of item-specific scores

Reducing ozone depleting substances	Point
Refrigerant's ozone depletion potential (ODP) ≤ 0.03 or global warming potential (GWP) ≤ 1,600	1
More than 80% of insulation materials' ODP ≤ 0.03 or GWP ≤ 1,600	1
Installing halon-free fire extinguishers	1

REFERENCE MATERIALS & SUBMISSION DOCUMENT

REFERENCE MATERIALS

- Pakistani laws and regulations equivalent to Korea's Act on Regulation of Manufacture of Certain Substances for Protection of Ozone Layers

- IPCC Fourth Assessment Report: http://www.ipcc.ch/ipccreports/ar4-wg1.htm), Chapter2

- Kyoto Protocol to the United Nations Framework Convention on Climate Change

- Halon control measures under the Montreal Protocol

- Ozone depletion potential (ODP) is the ratio of the impact on ozone of a chemical compared to the impact of a similar mass of CFC-11 being 1.

- Global warming potential (GWP) is the relative impact of a substance on global warming compared to the global warming impact of carbon dioxide (CO2) being 1.

	- This criteria consider the need to apply a GWP with a duration of 100 years as per the Intergovernmental Panel on Climate Change's (IPCC) "Climate Change 2007" Fourth Assessment Report.
SUBMISSION DOCUMENT	- Details of refrigerants used in the air conditioning system. - Types of insulation materials and specifications of specific materials used. - Fire extinguisher performance certificate ※Specifications may be used in lieu.

	PAKISTAN GREEN BUILDING CODE				
	CATEGORY	B. Energy & Environmental Pollution			
	CRITERIA	B.3. Use of Renewable Energy Sources	**POINT**	Residential: 8 Non-residential: 6	Evaluation Item

PURPOSE AND METHODS	
PURPOSE	The use of renewable energy sources contributes to reducing the use of fossil fuels and the greenhouse gas emissions therefrom. This item is intended to encourage and promote the use of renewable energy.
SDGs	7 AFFORDABLE AND CLEAN ENERGY 9 INDUSTRY, INNOVATION AND INFRASTRUCTURE 11 SUSTAINABLE CITIES AND COMMUNITIES 13 CLIMATE ACTION
METHOD	Percentage of renewable energy supply installations
DETAILS	
POINTS	Residential: 8 (Evaluation Item) Non-residential: 6 (Evaluation Item)
RATING TARGET	Residential Building (Including Community Centers) Non-residential Building (Excluding Parking Lots, Mechanical Equipment Rooms, Electrical Rooms, etc.)

RATING STANDARD

- Score = (Weight) x (Points Allocated)

Level	Percentage of renewable energy supply installations	Weight
1	Sum of scores for renewable energy installations ≥ 3	1.0
2	Sum of scores for renewable energy installations ≥ 2	0.8
3	Sum of scores for renewable energy installations ≥ 1	0.6
4	Renewable energy has been installed	0.4

Category	Renewable energy system (Unit or household average)	Point
Solar (fixed, tracking, BIPV)	3kW or more	3
	2kW or more	2
	1kW or more	1
Solarthermal	30 ㎡ or more	3

		(flat panel, single vacuum tube, dual vacuum tube)	20 ㎡ or more	2	
			10 ㎡ or more	1	
		Small wind	3kW or more	3	
			2kW or more	2	
			1kW or more	1	
		Geothermal (vertically enclosed)	17.5kW or more	3	
			10kW or more	2	
		Fuel cells	1.0kW or more	3	
			0.6kW or more	2	

REFERENCE MATERIALS & SUBMISSION DOCUMENT

REFERENCE MATERIALS	- Pakistani laws and regulations equivalent to Korea's New Energy and Renewable Energy Development, Use and Supply Promotion Act - Guidelines provided by Pakistan's Energy Management Authority, etc.
SUBMISSION DOCUMENT	- Renewable energy facility installation drawings and ratio calculations - On-site installation photos (for implementation)

PAKISTAN GREEN BUILDING CODE

CATEGORY	B. Energy & Environmental Pollution			
CRITERIA	B.4. Lighting Energy Saving	**POINT**	Non-residential 2	Evaluation Item

PURPOSE AND METHODS

PURPOSE

Save energy and ensure a comfortable vision for users with efficient lighting design.

SDGs

7 AFFORDABLE AND CLEAN ENERGY; 11 SUSTAINABLE CITIES AND COMMUNITIES; 12 RESPONSIBLE CONSUMPTION AND PRODUCTION; 13 CLIMATE ACTION

METHOD

Business, schools, and retail facilities: Evaluation of lighting density and methods

DETAILS

POINTS

Non-residential: 2 (Evaluation Item)

RATING TARGET

Non-residential Building : Entire Building (Excluding Parking Lots, Mechanical Equipment Rooms, Electrical Rooms, etc.)

RATING STANDARD

- Score = Level-specific (Weight) × (Points)

Business			School			Retail		
Level	**Score**	**Weight**	**Level**	**Score**	**Weight**	**Level**	**Score**	**Wegith**
1	10 or higher	1.0	1	9 or higher	1.0	1	10 or higher	1.0
2	8 or higher	0.8	2	6 or higher	0.7	2	8 or higher	0.8
3	7 or higher	0.6	3	3 or higher	0.4	3	7 or higher	0.6
4	4 or higher	0.4	-	-	-	4	4 or higher	0.4

Criteria	Business/school	Retail	Point
Average ceiling lighting density of various spaces used for different purposes	≤ 9 W/m2	≤ 2.25 W/(m2·100Lux)	9
	≤ 12 W/m2	≤ 3.00 W/(m2·100Lux)	6
	≤ 15 W/m2	≤ 3.75 W/(m2·100Lux)	3
Natural lighting	Daylight sensors to automatically adjust illumination to take advantage of natural light		2
Lighting density and lighting control in indoor parking lots	Designed ≤ 2 W/m2 or daylight sensors to automatically adjust illumination		1

	- Louvers should be installed on fixtures to prevent glare, if direct lighting (office areas in business buildings and classrooms in schools). - Evaluated if the space used for the primary use of the building meets the standard illuminance for the work area according to KS A 3011 (400 Lux for business/school facilities).
REFERENCE MATERIALS & SUBMISSION DOCUMENT	
REFERENCE MATERIALS	- Building energy efficiency rating regulations in Pakistan
SUBMISSION DOCUMENT	- Supporting data to determine energy efficiency rating

PAKISTAN GREEN BUILDING CODE

CATEGORY	C. Resource Efficiency			
CRITERIA	C.1. Building Material Substantiality	**POINT**	6	Evaluation Item

PURPOSE AND METHODS

PURPOSE	Evaluate the use of eco-friendly certified products for resource recycling to achieve resource circulations, intrinsic energy reduction, and environmental pollution mitigation.
SDGs	9 INDUSTRY, INNOVATION AND INFRASTRUCTURE 11 SUSTAINABLE CITIES AND COMMUNITIES 12 RESPONSIBLE CONSUMPTION AND PRODUCTION
METHOD	Use of Eco-label certified products, Good Recycled Product certified products and equivalent

DETAILS

POINTS	6 (Mandatory item: Minimum score 2.4)
RATING TARGET	Residential Building (Including Community Centers) Non-residential Building (Excluding Parking Lots, Mechanical Equipment Rooms, Electrical Rooms, etc.)

RATING STANDARD

Score = Level-specific score (Weight) × (Point)

Level	Use of certified green products	Weight
1	9 products or more	1.0
2	7 products or more	0.8
3	5 products or more	0.6
4	3 products or more	0.4

REFERENCE MATERIALS & SUBMISSION DOCUMENT

REFERENCE MATERIALS

- Green products as defined by relevant codes in Pakistan, comparable to the Green Products Promotion Act in Korea (Eco-label certification, Good Recycled certification, etc.)

- Criteria for granting green label certification (e.g., http://el.keiti.re.kr)

- Pakistani certification bodies and quality standards comparable to the Good Recycled Products Certification (e.g., http://www.kats.go.kr/gr, www.ripa.or.kr)

- Green product information (e.g., http://www.greenproduct.go.kr)

- Good Recycled product certification guide

- Laws and enforcement decrees/regulations on the conservation of resources and recycling promotion

SUBMISSION DOCUMENT	- Material-specific certificates and track records ※Confirmation of intended application may be used in lieu. - (For implementation) Photos of products installed on-site

PAKISTAN GREEN BUILDING CODE

CATEGORY	C. Resource Efficiency			
CRITERIA	C.2. Water Efficiency	**POINT**	6	Evaluation Item

PURPOSE AND METHODS

PURPOSE	Growing water demand driven by urban population growth leads to deteriorating water quality and increasing costs of municipal sewage treatment. Evaluating domestic water consumption contributes to reducing energy, water supply, and sewage treatment facilities and costs.
SDGs	6 CLEAN WATER AND SANITATION 12 RESPONSIBLE CONSUMPTION AND PRODUCTION 13 CLIMATE ACTION
METHOD	Application of Eco-label certified water saving products

DETAILS

POINTS	6 (Mandatory item: Minimum score 2.0)
RATING TARGET	Residential Building (Including Community Centers) Non-residential Building (Excluding Parking Lots, Mechanical Equipment Rooms, Electrical Rooms, etc.)

RATING STANDARD

Sum of item-specific scores

At least 80% of the Eco-label certified products applied to all floors

Eco-label certified products		**Point**
Water-saving faucets	Instantaneous blocking (electromagnetic, pedal, and foot valve), self-closing, quantitative blocking, and water-saving faucet attachments (for basins only).	2.0
Showerheads	Showerheads with valves, on/off showerheads, instantaneous blocking showerheads, and other water-saving showerheads	2.0
Water-saving toilets and urinals	Water-saving toilets, toilet fittings, urinals, etc.	2.0

※Excluding faucets for washing machines, etc., where water-saving features are deemed unnecessary.

※ Excluding faucets outside residential units.

REFERENCE MATERIALS & SUBMISSION DOCUMENT

REFERENCE MATERIALS

Pakistani laws relevant or similar to the following:

- Water laws
- Environmental technology and environmental industry support laws

	- Eco-labeling system - Products eligible for eco-label certification and certification standards (e.g., http://el.keiti.re.kr)
SUBMISSION DOCUMENT	- Related design documents - Marks or documents demonstrating the green labeling of the product

PAKISTAN GREEN BUILDING CODE

CATEGORY	C. Resource Efficiency			
CRITERIA	C.3. Rainwater Management	**POINT**	3	Evaluation Item

PURPOSE AND METHODS

PURPOSE	Utilizing stormwater can help reduce water consumption, suppress stormwater runoff during rainfall, and recycle stormwater as water resources. It also contributes to energy savings and the downsizing of public facilities and the efficient use of water resources.
SDGs	6 CLEAN WATER AND SANITATION 11 SUSTAINABLE CITIES AND COMMUNITIES 13 CLIMATE ACTION 15 LIFE ON LAND
METHOD	Presence of stormwater retention facilities for sprinkler water, landscaping water, etc.

DETAILS

POINTS	3 (Evaluation Item)
RATING TARGET	Residential Building (Including Community Centers) Non-residential Building (Excluding Parking Lots, Mechanical Equipment Rooms, Electrical Rooms, etc.)

RATING STANDARD

- Score = (Level-specific weight) × (Point)

Points for installing a reservoir or basin on the site or building to retain stormwater and use it for sprinkling, landscaping, flushing, cleaning, etc.

※Rainwater tanks or rainwater storage containers included.

Level	**Stormwater retention facility capacity (m^3)**	**Weight**
1	Stormwater retention facilities with a capacity of building area (m²) × 0.05 or land area (m²) × 0.02 or more	1.0
2	Stormwater retention facilities with a capacity of building area (m²) × 0.03 or land area (m²) × 0.01 or more	0.7
3	Stormwater retention facilities with a capacity of building area (m²) × 0.01 or land area (m²) × 0.005 or more	0.4

REFERENCE MATERIALS & SUBMISSION DOCUMENT

REFERENCE MATERIALS	* To be adjusted depending on the maturity of the relevant technologies, market conditions, and demand in Pakistan • Pakistani laws relevant or similar to the following: - Pakistan water code and enforcement rules including the installation of rainwater collection facilities and standards for rainwater collection facilities. - Rules for the determination, structure and installation standards for urban planning facilities. • Studies and guidelines related to the following: - Research on stormwater runoff reduction facility installation - Municipal stormwater retention facility installation guidelines
SUBMISSION DOCUMENT	- Drawings and capacity estimates for stormwater retention facility installation

PAKISTAN GREEN BUILDING CODE

CATEGORY	C. Resource Efficiency			
CRITERIA	C.4. Solid and Liquid Waste Management	**POINT**	6	Evaluation Item

PURPOSE AND METHODS

PURPOSE

Promote the recycling of domestic waste by separating solid waste in domestic waste from the site.

SDGs

6 CLEAN WATER AND SANITATION
11 SUSTAINABLE CITIES AND COMMUNITIES
12 RESPONSIBLE CONSUMPTION AND PRODUCTION
14 LIFE BELOW WATER

METHOD

Recyclable domestic waste storages and sorting of recyclables

DETAILS

POINTS

6 (Evaluation Item)

RATING TARGET

Residential Building (Including Community Centers)

Non-residential Building (Excluding Parking Lots, Mechanical Equipment Rooms, Electrical Rooms, etc.)

RATING STANDARD

- Score = (Weight) x (Points Allocated)

Level	Separation of recyclable domestic waste	Weight
1	Installing a recyclable domestic waste storage Containers for at least 4 types of recyclable waste	1.0
2	Containers for at least 3 types of recyclable waste	0.7
3	Containers for at least 2 types of recyclable waste	0.4

※ Recyclable waste containers should be placed in a covered area to protect them from snow, rain, etc.

※Examples of recyclable domestic waste containers: bottles, metal cans, plastics, paper, scrap metal, fluorescent bulbs, used batteries, clothing, etc.

REFERENCE MATERIALS & SUBMISSION DOCUMENT

REFERENCE MATERIALS

- Laws stipulating the conservation of resources and the promotion of recycling

Provisions on the storage of waste, separate collection of recyclable waste resources, etc.

SUBMISSION DOCUMENT	- Design drawings indicating the presence of domestic waste storage Design drawings indicating the installation of recyclable waste containers ※ Specifications may be used in lieu.

PAKISTAN GREEN BUILDING CODE

CATEGORY	D. Indoor Environmental Quality			
CRITERIA	D.1. Use of Low Indoor Air Pollutant Discharging Materials	**POINT**	9	Evaluation Item

PURPOSE AND METHODS

PURPOSE	Encourage the use of materials that discharge less formaldehyde and volatile organic compounds, which can be released into indoor air from interior materials to have a direct adverse impact on residents.
SDGs	3 GOOD HEALTH AND WELL-BEING 11 SUSTAINABLE CITIES AND COMMUNITIES 12 RESPONSIBLE CONSUMPTION AND PRODUCTION
METHOD	Use of low VOC materials

DETAILS

POINTS	9 (Evaluation Item)
RATING TARGET	Residential Building (Including Community Centers) Non-residential Building (Excluding Parking Lots, Mechanical Equipment Rooms, Electrical Rooms, etc.)

RATING STANDARD

- Weighted average per floor based on sum of scores

Use of low indoor air pollutant discharging materials		**Coverage**	
		50%	**70%**
Application	Walls	0.5	1
	Ceilings	0.25	0.5
	Floors	0.5	1
	Adhesives	0.25	0.5

- Formaldehyde (HCHO) emissions < 0.015 mg/m2-h
- Total volatile organic compound (TVOC) emissions < 0.1 mg/m2-h
- Coverage levels based on the surface area

REFERENCE MATERIALS & SUBMISSION DOCUMENT

REFERENCE MATERIALS	- To be adjusted depending on the maturity of the relevant technologies, market conditions, and demand in Pakistan - Laws and enforcement rules on environmental technology and environmental industry support

	- Government standards for the appearance and quality of fiberboard for the construction industry, comparable to KS F 3200 in Korea - Pakistan's building indoor air quality process testing standards or similar legislation
SUBMISSION DOCUMENT	- Basic documentation - Indoor finishing materials list - Low VOC materials calculations - Supporting data for emissions

PAKISTAN GREEN BUILDING CODE

CATEGORY	D. Indoor Environmental Quality			
CRITERIA	D.2. Tobacco Smoke Control	**POINT**	1	Evaluation Item

PURPOSE AND METHODS

PURPOSE	Prevent indoor air from being contaminated by tobacco smoke and supply fresh air into the indoor space to improve workers' health, productivity, and performance.
SDGs	3 GOOD HEALTH AND WELL-BEING 11 SUSTAINABLE CITIES AND COMMUNITIES
METHOD	Smoke-free building or smoke-free policy

DETAILS

POINTS	1 (Evaluation Item)
RATING TARGET	Residential Building (Including Community Centers) Non-residential Building (Excluding Parking Lots, Mechanical Equipment Rooms, Electrical Rooms, etc.)

RATING STANDARD

- Sum of scores

Smoke-free building or smoke-free policy	Point
No smoking and smoke-free policy signs in the building	0.5
Separate smoking areas with separate air distribution units to allow for complete exhaust	0.5

- No smoking policy signs posted within 3 meters from the building entrance
- Separate smoking areas should be accompanied by a designated smoking area sign

REFERENCE MATERIALS & SUBMISSION DOCUMENT

REFERENCE MATERIALS

- This item can be modified or removed in consideration of local culture or conditions.

SUBMISSION DOCUMENT	- Basic drawings (non-smoking, smoking areas) - Smoke-free policy statement

PAKISTAN GREEN BUILDING CODE

CATEGORY	D. Indoor Environmental Quality			
CRITERIA	D.3. Natural Lighting	**POINT**	Residential: 6 Non-residential: 0	Evaluation Item

PURPOSE AND METHODS

PURPOSE	Maximize the use of natural light to illuminate work surfaces and ensure a comfortable vision for residents.
SDGs	3 GOOD HEALTH AND WELL-BEING 7 AFFORDABLE AND CLEAN ENERGY 11 SUSTAINABLE CITIES AND COMMUNITIES
METHOD	Minimum natural light performance measured as average daylight factor (DF) and uniformity factor

DETAILS

POINTS	Residential: 6 (Evaluation Item) Non-residential: 0 (Evaluation Item)
RATING TARGET	Residential Building : Entire Building (Including Community Centers)

RATING STANDARD

- Score = (Weight) x (Points Allocated)

Level	Average daylight factor (DF) and uniformity factor	Weight
1	Average DF ≥ 2.0%, uniformity factor ≥ 0.3%	2
2	Average DF ≥ 2.0%	1.6
3	Average DF ≥ 1.5% and < 2.0%	1.2
4	Average DF ≥ 1.0% and < 1.5%	0.8

- Average DF = Average work plane illumination indoors (Ei)) / Horizontal illumination on the roof at overcast sky (E0) x 100 (%)
- Uniformity factor = Minimum work plane illuminance (Emin) / Average work plane illuminance indoors at overcast sky (Eavg) x 100 (%)
- Average daylight illuminance averaged over 80% of the floor area and calculated for a height of 0.8 m from the floor surface
- Daylight illuminance as indoor light evaluation, calculated as the ratio of the average work plane illuminance indoors (Ei) to illuminance outdoors (E0) at the CIE overcast sky
- Uniformity factor as a measure of the homogeneity of light entering the space, calculated as the ratio of the minimum work plane illuminance (Emin) to the average work plane illuminance indoors (Eavg) at overcast sky

REFERENCE MATERIALS & SUBMISSION DOCUMENT

REFERENCE MATERIALS	-
SUBMISSION DOCUMENT	- Basic drawings (window design, etc.) - Natural daylight calculations - Simulation-related input conditions and results - (For implementation) Site photography

PAKISTAN GREEN BUILDING CODE				
CATEGORY	D. Indoor Environmental Quality			
CRITERIA	D.4 Designated Areas to Rest and Refresh	**POINT**	Non-residential: 6	Evaluation Item

PURPOSE AND METHODS

PURPOSE	Create dedicated break areas for customers or employees, allowing them rest and refresh themselves in a comfortable environment.
SDGs	3 GOOD HEALTH AND WELL-BEING 11 SUSTAINABLE CITIES AND COMMUNITIES
METHOD	Designated areas for building users (customers/employees) to rest and refresh

DETAILS

POINTS	Non-residential 6 (Evaluation Item)
RATING TARGET	Non-residential Building (Excluding Parking Lots, Mechanical Equipment Rooms, Electrical Rooms, etc.)
RATING STANDARD	• Score = (Weight) x (Points Allocated) ※Smoking areas excluded from dedicated resting areas.

Level	Dedicated resting area	Weight
1	Level 2 + Dedicated resting area (15 m2 or more) in the building for employees to rest and refresh (water or planting space may be installed in the resting area)	1.0
2	Dedicated resting area (15 m2 or more) in the building for customers to rest and refresh (water or planting space may be installed in the resting area)	0.7

REFERENCE MATERIALS & SUBMISSION DOCUMENT

REFERENCE MATERIALS	-
SUBMISSION DOCUMENT	- Design drawings that include rest areas or water/planting areas

<table>
<tr><td rowspan="3"></td><td colspan="5">PAKISTAN GREEN BUILDING CODE</td></tr>
<tr><td>CATEGORY</td><td colspan="4">D. Indoor Environmental Quality</td></tr>
<tr><td>CRITERIA</td><td>D.5. Natural and Controlled Ventilation</td><td>POINT</td><td>8</td><td>Evaluation Item</td></tr>
<tr><td colspan="6">PURPOSE AND METHODS</td></tr>
<tr><td>PURPOSE</td><td colspan="5">Provide controllable and fresh ambient air for occupants.</td></tr>
<tr><td>SDGs</td><td colspan="5">3 GOOD HEALTH AND WELL-BEING
7 AFFORDABLE AND CLEAN ENERGY
11 SUSTAINABLE CITIES AND COMMUNITIES
13 CLIMATE ACTION</td></tr>
<tr><td>METHOD</td><td colspan="5">Installation of windows and ventilation systems for residents to control to bring in fresh air</td></tr>
<tr><td colspan="6">DETAILS</td></tr>
<tr><td>POINTS</td><td colspan="5">8 (Evaluation Item)</td></tr>
<tr><td>RATING TARGET</td><td colspan="5">Residential Building (Including Community Centers)
Non-residential Building (Excluding Parking Lots, Mechanical Equipment Rooms, Electrical Rooms, etc.)</td></tr>
<tr><td>RATING STANDARD</td><td colspan="5">Weighted average per floor based on sum of scores
Score = (Weight) x (Points Allocated) × Number of units applied / total units
※ Ratio of openable window area: Sum of openable window area / sum of floor area
<table>
<tr><th>Installation of ventilation devices or systems and the level of ventilation design</th><th>Weight</th></tr>
<tr><td>Openable window area ≥ 10% of floor area</td><td>1.0</td></tr>
<tr><td>Vents (including vent slots) per 20 m2 of perimeter boundary in heated or cooled space</td><td>1.0</td></tr>
</table>
Perimeter boundary: floor area up to 5 meters from the interior end of the exterior wall.
Controllable windows/vents: A mechanism or device installed on the wall, window frame, or window glass facing outdoors, which allows fresh air to be introduced without opening the window and the user to directly control the amount of ventilation or automatically opens and closes driven by factors such as humidity, CO2, etc.</td></tr>
<tr><td colspan="6">REFERENCE MATERIALS & SUBMISSION DOCUMENT</td></tr>
</table>

REFERENCE MATERIALS	- Rules regarding the building facility standards in Pakistan - Materials on smoke elimination equipment - Smoke elimination window effective area calculation criteria
SUBMISSION DOCUMENT	- Detailed window design - Openable window area calculations

PAKISTAN GREEN BUILDING CODE				
CATEGORY	E. Post-Completion Green Building Actions			
CRITERIA	E.1. Environmentally-friendly Space Planning and Management	**POINT**	2	Evaluation Item

PURPOSE AND METHODS

PURPOSE	Promote green building by integrating green building design into the initial design stages.
SDGs	8 DECENT WORK AND ECONOMIC GROWTH 11 SUSTAINABLE CITIES AND COMMUNITIES 12 RESPONSIBLE CONSUMPTION AND PRODUCTION 13 CLIMATE ACTION 15 LIFE ON LAND
METHOD	Building's green elements and engagement of green building certified professionals in design

DETAILS

POINTS	2 (Evaluation Item)
RATING TARGET	Residential Building (Including Community Centers) Non-residential Building (Excluding Parking Lots, Mechanical Equipment Rooms, Electrical Rooms, etc.)

RATING STANDARD

Sum of scores

Environmentally-friendly space planning and management	Point
Site-specific signage about green building technologies and products	0.4
Presence of spaces to promote green building	0.4
Presence of a status board for renewable energy power generation, energy monitoring, etc.	0.4
One or more spaces that can be partitioned or consolidated using lightweight walls, dry walls, etc. to better utilize the space	0.4
Certified green building professionals' engagement in design	0.4

- Submit space utilization plans for spaces that can be partitioned or consolidated.

- Use Eco-label certified materials for lightweight walls, dry walls, etc.

※ Scoring for certified green building professionals' engagement in design

- Green building professionals who have completed relevant training in accordance with Article 21 of the Green Building Support Act and Article 8, Paragraph 3 of the Rules on Green Building Certification.

	- Certified green building professionals should provide knowledge on green building and engage in the design process to ensure that green building design is integrated into the early stages of building design.
REFERENCE MATERIALS & SUBMISSION DOCUMENT	
REFERENCE MATERIALS	-
SUBMISSION DOCUMENT	- Photography of installed products - Green building professionals' qualification documents - Proof of certified green building professionals' engagement

PAKISTAN GREEN BUILDING CODE

CATEGORY	E. Post-Completion Green Building Actions			
CRITERIA	E.2. Construction Site Environment Management	**POINT**	2	Evaluation Item

PURPOSE AND METHODS

PURPOSE	To create a green construction site, evaluate eco-friendly activities in and around the site and site management activities to minimize environmental impact.
SDGs	11 SUSTAINABLE CITIES AND COMMUNITIES 12 RESPONSIBLE CONSUMPTION AND PRODUCTION 15 LIFE ON LAND
METHOD	Contractors' ISO 14001 (Environmental Management System) certification, environmental management policy, and the establishment and implementation of environmental management plans for the construction site.

DETAILS

POINTS	2 (Evaluation Item)
RATING TARGET	Outdoor Space of Residential, Non-residential Buildings

RATING STANDARD

Score = (Weight)×(Point)

Level	Construction site environment management	Weight
1	The contractor has ISO 14001 certification, an on-site environmental management organization based on ISO 14001, and an environmental management plan.	1.0
2	The contractor has an internal operation policy that prioritizes the environment, an on-site environmental management organization, and an environmental management plan.	0.8
3	The construction site has a documented environment management plan, an organization to implement that plan, and an environmental management plan.	0.6
4	The construction site has an organization to implement environment management and an environmental management plan.	0.4

- The environmental management plan should be established separately from the environmental management organization at the headquarters or on site. It should specify matters related to the environmental management organization and tasks required for the construction of the building to be certified.

REFERENCE MATERIALS & SUBMISSION DOCUMENT

REFERENCE MATERIALS	- Construction Technology Promotion Act, Ministry of Land, Infrastructure, and Transport - Construction Environmental Management Standard Specifications, Ministry of Land, Infrastructure, and Transport - Sustainable Management Academy website (http://www.ksasma.or.kr), Korean Standards Association - ISO 14001 (Environmental Management System)
SUBMISSION DOCUMENT	- ISO 14001 certificate - Contractor's environmental management policy - Site environment management plan ※ Application plans can be used in lieu. - Construction site environment management report - Photography as proof of documents submitted

PAKISTAN GREEN BUILDING CODE				
CATEGORY	E. Post-Completion Green Building Actions			
CRITERIA	E3. Operation and Maintenance	**POINT**	3	Evaluation Item

PURPOSE AND METHODS

PURPOSE	Prepare information on the operation of building facilities and equipment (including electronic documents) and provide the users with manuals to ensure that the building operates at maximum efficiency and is maintained as initially intended.
SDGs	11 SUSTAINABLE CITIES AND COMMUNITIES 12 RESPONSIBLE CONSUMPTION AND PRODUCTION 13 CLIMATE ACTION
METHOD	Provision of necessary documentation for the management of the building, the operation and maintenance of its facilities and equipment, and user manuals in the electronic document formats that are accessible through an information processing system.

DETAILS

POINTS	3 (Evaluation Item)
RATING TARGET	Residential Building, Non-residential Building

RATING STANDARD

Sum of scores

Level	Operation/maintenance documentation and manuals	Point
1	Level 2 + 8 of operation/maintenance documentation and manuals	3.0
2	Level 3 + 7 of operation/maintenance documentation and manuals	2.0
3	Level 4 + 6 of operation/maintenance documentation and manuals	1.0
4	Necessary documentation + 1-5 of operation/maintenance documentation and manuals	0.5

Necessary documentation
(1) As-built drawings (architectural, structural, mechanical, electrical, fire, landscape, civil engineering, etc.) (2) As-built documents (geological survey reports, structural calculations, specifications, etc.) (3) Periodic inspection documents as per the periodic inspection list (periodic inspection manual based on the Detailed Guidelines for Safety Inspection and Precision Safety Diagnosis)

Operation/maintenance documentation and manuals

	(1) Roof waterproofing maintenance manual (2) Building structural and non-load-bearing wall maintenance manual (3) Operation and maintenance manuals for heating and cooling sources and hot water systems (4) Operation and maintenance manuals for elevators, exterior lighting, CCTVs, and parking control facilities (5) Maintenance manuals for lighting facilities and lighting fixtures (6) Landscaping maintenance manual (7) Maintenance manuals for water supply and drainage facilities (including stormwater and gray water) (8) Maintenance manual to prevent condensation in underground parking lots and common areas (9) Maintenance manuals for renewable energy facilities (10) Maintenance manuals for fire protection and fire suppression facilities - The building operation and maintenance manual should include the following: - Current status, inspection methods, regular maintenance checks, cautionary notes for managers, inspection cycles, maintenance personnel contact information, etc.
REFERENCE MATERIALS & SUBMISSION DOCUMENT	
REFERENCE MATERIALS	- Building Design Document Standards, Ministry of Land, Infrastructure, and Transport - Building Maintenance Inspection Manual, Ministry of Land, Infrastructure, and Transport - Detailed Guidelines for Safety Inspection and Precision Safety Diagnosis, Korea Infrastructure Safety Corporation
SUBMISSION DOCUMENT	- Necessary documentation for operation and management - Operation and maintenance manuals ※ Application plans can be used in lieu. - Confirmation of the provision of manuals - Photography as proof of the provision of documents

PAKISTAN GREEN BUILDING CODE

CATEGORY	E. Post-Completion Green Building Actions			
CRITERIA	E.4. Monitoring	POINT	1	Evaluation Item

PURPOSE AND METHODS

PURPOSE	Encourage operations management to reduce carbon dioxide emissions, energy and water consumption to maintain building performance and reduce costs.
SDGs	3 GOOD HEALTH AND WELL-BEING 6 CLEAN WATER AND SANITATION 7 AFFORDABLE AND CLEAN ENERGY 11 SUSTAINABLE CITIES AND COMMUNITIES 12 RESPONSIBLE CONSUMPTION AND PRODUCTION 13 CLIMATE ACTION
METHOD	Continuous monitoring and management plans for energy, water consumption, and air quality data throughout the building lifecycle.

DETAILS

POINTS	1 (Evaluation Item)
RATING TARGET	Residential Building, Non-residential Building

RATING STANDARD

Sum of scores

Level	Monitoring	Point
1	Separate space for monitoring operations and an operation plan	0.5
2	Providing users with energy and water consumption monitoring data	0.5

- Monitoring information as provided through devices that display and allow for control of necessary information, such as smartphone applications or wall pads, or devices installed in common areas such as shared entrances, elevator rooms, etc.
- An operation plan should include maintenance and performance management plans and energy saving measures.

REFERENCE MATERIALS & SUBMISSION DOCUMENT

REFERENCE MATERIALS	- Building Energy Saving Design Standards, Ministry of Land, Infrastructure, and Transport - Smart Home Network Installation and Technology Standards, Ministry of Land, Infrastructure, Transport and Ministry of Trade, Industry and Energy
SUBMISSION DOCUMENT	- Monitoring and management space drawings - Monitoring and management operation plans, handover plans, and other relevant manuals ※ Application plans can be used in lieu.

	- Documentation and photos as proof of installation and features of monitoring and management devices - On-site photography

Quick Questionnaire Survey for Pakistan Green Building Code

Greeting from KICT(Korea Institute of Civil Engineering and Building Technology). We are public research institute in Korea and we are proceeding the research project for Pakistan Green Building Code developing. The project is supported by UN CTCN(Climate Technology Cooperation and Networks). And Pakistan Green Growth Consulting is cooperation partner for this project.

We are conducting a survey to understand the awareness and necessity of green building certification in Pakistan.

This survey aims to gather your awareness, experiences, and opinions about green building certification to inform the development of future green building policies and programs in Pakistan. Additionally, we are interested in understanding your professional background and expertise to better contextualize the responses. Your valuable insights will significantly contribute to fostering a sustainable building culture in your country.

The survey will take approximately 10 minutes to complete,

We appreciate your participation and request your honest feedback.

Your answers will be used strictly for statistical purpose.

Please take time out of your busy day to respond to our survey. Thank you.

Survey holder: National Green Building Center of KICT

Contact: ssm1216@kict.re.kr

■ [Consent to the collection and use of personal information]

1. **Purpose of the collection and use of personal information:** Personal information collected through the survey will be used only for the purpose of data analysis and report preparation.
2. **Collected personal information items:** We are collecting data that requires consent from individuals whose personal information is being collected and used according to Article 15 of the Personal Information Protection Act of the Republic of Korea.
3. **Period of possession and use of personal information:** Collected personal information will be destroyed immediately after the analysis of survey responses.
4. **You may refuse to consent to our collection and use of personal information.** Only those individuals who consent to provide their personal information can take part in the survey

Section 1: Personal Information

1. **Name (e-mail):**
    - ☐ ____________________
2. **Gender:**
    - ☐ Male
    - ☐ Female
    - ☐ Other
    - ☐ Prefer not to say
3. **Age Group:**
    - ☐ Under 18
    - ☐ 18-24
    - ☐ 25-34
    - ☐ 35-44
    - ☐ 45-54
    - ☐ 55-64
    - ☐ 65 and above
4. **Occupation:**
    - ☐ Student
    - ☐ Architect

- ○ ☐ Engineer
- ○ ☐ Builder/Contractor
- ○ ☐ Government Official
- ○ ☐ Environmental Consultant
- ○ ☐ Real Estate Developer
- ○ ☐ Other (please specify): ____________________

5. **Years of Experience in Relevant Occupation:**
   - ○ ☐ Less than 1 year
   - ○ ☐ 1-3 years
   - ○ ☐ 4-6 years
   - ○ ☐ 7-10 years
   - ○ ☐ More than 10 years
6. **Areas of Interest:**
   - ○ ☐ Energy Efficiency
   - ○ ☐ Sustainable Materials
   - ○ ☐ Water Conservation
   - ○ ☐ Indoor Air Quality
   - ○ ☐ Waste Reduction
   - ○ ☐ Renewable Energy
   - ○ ☐ Green Building Certifications
   - ○ ☐ Other (please specify): ____________________

Section 2: General Awareness of Green Building Certification

1. How familiar are you with the concept of green building certification?
   - ○ ☐ Very familiar
   - ○ ☐ Somewhat familiar
   - ○ ☐ Not very familiar

- ☐ Not familiar at all

2. Have you ever been involved in a project that aimed for green building certification?
   - ☐ Yes (please specify): ____________________
   - ☐ No
3. How important do you think green building certification is for Pakistan's future?
   - ☐ Very important
   - ☐ Important
   - ☐ Somewhat important
   - ☐ Not important
4. What do you think are the main benefits of green building certification? (Select all that apply)
   - ☐ Environmental sustainability
   - ☐ Energy savings
   - ☐ Healthier indoor environment
   - ☐ Long-term cost savings
   - ☐ Enhanced property value
   - ☐ Other (please specify): ____________________

Section 3: Understanding of Pakistan's Nationally Determined Contributions (NDC)

1. How familiar are you with Pakistan's Nationally Determined Contributions (NDC) under the Paris Agreement?
   - ☐ Very familiar
   - ☐ Somewhat familiar
   - ☐ Not very familiar
   - ☐ Not familiar at all
2. Do you believe that Pakistan's NDC targets are achievable?
   - ☐ Yes
   - ☐ No
   - ☐ Not sure

3. In your opinion, how important is the role of green building certification in achieving Pakistan’s NDC targets?
   - ○ ☐ Very important
   - ○ ☐ Important
   - ○ ☐ Somewhat important
   - ○ ☐ Not important

Section 4: Participation in the Development of Pakistan’s Green Building Code (Appendix 1)

1. Have you ever participated in the development of Pakistan’s Green Building Code?
   - ○ ☐ Yes
   - ○ ☐ No
2. If yes, in what capacity did you participate? (Select all that apply)
   - ○ ☐ Policy maker
   - ○ ☐ Consultant
   - ○ ☐ Architect/Engineer
   - ○ ☐ Industry representative
   - ○ ☐ Academic/Researcher
   - ○ ☐ Other (please specify): ____________________
3. How would you rate your overall experience with the development process of the Green Building Code?
   - ○ ☐ Very positive
   - ○ ☐ Positive
   - ○ ☐ Neutral
   - ○ ☐ Negative
   - ○ ☐ Very negative

Section 5: Agreement with the Composition of Pakistan's Green Building Code

1. How strongly do you agree with the current components of Pakistan's Green Building Code?
    - ☐ Strongly agree
    - ☐ Agree
    - ☐ Neutral
    - ☐ Disagree
    - ☐ Strongly disagree
2. Which components of the Green Building Code do you find most effective? (Select all that apply)
    - ☐ Energy Efficiency
    - ☐ Water Conservation
    - ☐ Sustainable Materials
    - ☐ Indoor Air Quality
    - ☐ Waste Reduction
    - ☐ Renewable Energy
    - ☐ Other (please specify): ____________________
3. What improvements or additions would you suggest for the Green Building Code?
    - ☐ ____________________

Section 7: Opinions on the KICT-Developed Green Building Certification for Pakistan

1. Are you aware of the green building certification system currently being developed by the Korea Institute of Civil Engineering and Building Technology (KICT) for Pakistan?
    - ☐ Yes
    - ☐ No
2. What concerns or challenges do you foresee with the implementation of the KICT-developed certification in Pakistan? (Select all that apply)
    - ☐ High implementation costs

- ☐ Lack of local expertise
- ☐ Compatibility with existing regulations
- ☐ Industry resistance
- ☐ Other (please specify): ___________________

3. Do you have any suggestions or recommendations for the KICT team to consider in the development of the green building certification system for Pakistan?
    - ☐ ___________________

Thank You for Participating

Thank you for taking the time to participate in this survey. Your insights and feedback are invaluable in shaping the future of green building practices in Pakistan.

Please submit your responses by June 21. Following this, there will be a second survey focused on the draft version of the Pakistan Green Building Code developed by KICT. Your continued participation will be greatly appreciated.

Thank you once again for your valuable contribution.

Sincerely yours,

KICT National Green Building Center

Appendix 12: Proposed section for the Pakistan Green Building Code

(Reference: Vision 2030 for a Green Building Code in Pakistan, switchasia, 2022, Annex 2 Process and institutional set-up for a Green Building Code in Pakistan, Table 7)

A- Site Planning & Development

1. Site Sustainability : Land Use Rules & Zoning Regulations
2. Building Orientation
3. Heat Island Mitigation
4. Green Planning and Design : Building Design Criteria and Construction Standards
5. Effctive Land and Space Use : Integrated Design and Green Buidling Concentration / Landscaping and Stormwater Drainage Requirements

B- Gren Building Construction

6. Building Materials Sustainability
7. Building Envelope and Openings : Climate Zones and Prescriptive Building Envelope
8. Natural and Controlled Ventilation
9. Fire Safety
10. Roof Insulation

C- Resource Efficiency

11. Water Efficiency
12. Rainwater Harvesting
13. Energy Efficiency : Performance Option for Energy Efficiency and Insulation / Precriptive Equipment Efficiency Tables for Alternate and Increased Efficiency
14. Solid and Liquid Wastes Management : Deconstruction and Construction Debris(voluntary and regulatory) / Waste Recovery and Recycling

D- Post-Completion Green Building Action

15. Environemtal Pre-requisties and Assessment : Minimum Green Building Requirements
16. Buidling Inspection & Commissioning : Guidance for GB Functional Performance Testing and Commissioning Process
17. Green Building Code Compliance Rating : Green Building Efficiency and Sustainability Measures
18. Post-Occupation O&M Considerations