Closure Report

Technical Assistance for
Enabling Readiness for Up Scaling Investments in Building Energy Efficiency for Achieving NDC Goals in Thailand

Submitted to:

Climate Technology Centre and Network
United Nations Industrial Development Organization

Submitted by:

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Technical Assistance Closure Report

1. Basic information

Title of response plan	Enabling Readiness for Up Scaling Investments in Building Energy Efficiency for Achieving NDC Goals in Thailand
Technical assistance reference number	UNEP/2020/252 (4700019197)
Country / countries	Thailand
NDE organisation	Office of National Higher Education Science Research and Innovation Policy Council (NXPO), Thailand
NDE focal point	Mr. Surachai Sathitkunarat, Assistant Director General
NDE contact information	Email: surachai@nxpo.or.th
Proponent focal point and organisation	Dr. Natthanich Asvapoositkul, Office of Natural Resources and Environmental Policy and Planning (ONEP), Email: gcfundthailand@gmail.com
Designer of the response plan	NERL and GIZ
Implementer(s) of technical assistance	International Institute for Energy Conservation (IIEC)
Beneficiaries	Department of
Sector(s) addressed	1. Energy Efficiency sector for Buildings 2. Infrastructure and Urban planning sector
Technologies supported	Energy Efficiency and Renewable Energy technologies. Building codes and Building construction
Implementation start date	03.08.2020
Implementation end date	31.12.2021
Total budget for implementation	US$ 206,000 in-cash Additional in-kind support by the NDE and the Department of Alternative Energy Development and Efficiency (DEDE) for inter-ministerial collaboration, including TA activities.
Description of delivered outputs and products as well as the activities undertaken to achieve them. In doing so, review the log frame of the original response plan and refer to it as appropriate	Output 1: Energy and GHG baselines and consumption benchmarks in place for each building type of new, yet to be constructed buildings, covered in BEC. 1.1: Assessment of available existing energy consumption data and methodology for final energy baselines and benchmarks for five building types as defined in the BEC. 1.2 Energy and GHG emission baselines and benchmark for five building types. 1.3 A simulation and parametric run to design energy and GHG emission benchmarks 1.4 Validation of established energy and GHG baselines and energy benchmarks for the five building types, analysis and recommendations

	Output 2: Technology assessment for five buildings types within the BEC framework 2.1 Assessment of relevant technologies with BEC compliance 2.2 Long and short list of relevant technologies with BEC compliance 2.3 Workshop to disseminate technology assessment results Output 3: Financial assessment for new buildings within the BEC framework 3.1 Energy performance simulation for 5 building types 3.2 Assessment of financial aspects of technology 3.3 Workshop to present recommended technology options Output 4: Energy audit of five building types: Office, Medical Center, Hotel, Department store and Condominium 4.1 Energy audits for technology recommendations for retrofitting existing buildings as an input for future policies and regulations 4.2 Simulation model to calculate the actual GHG emission and energy saving potential in the existing buildings Output 5: MRV framework for existing and new building types within the BEC framework 5.1 Streamlining of data for developing an operational MRV 5.2 Identification of key indicators 5.3 Development of a draft MRV framework for five building types 5.4 Stakeholder consultation to finalize the MRV framework for five building types Output 6: Monitoring and communication materials 6.1 Development of 3 handbooks to increase awareness of the BEC standards and provide guidelines on ensuring compliance.
Methodologies applied to produce outputs and products	• Review of Thailand's available existing BEC compliance database, and analysis • Secondary data collection and analysis • Communication process arrangement and one-on-One meetings with key beneficiaries organization and relevant stakeholders. • Site visits and online interview with selected buildings • Organization of face-to-face and virtual stakeholder consultation workshops • Utilize of key findings from CTCN TA outputs to develop dissemination document

Reference to knowledge resources	No UNFCCC TEC knowledge products were used. However, the following international methodologies and protocols have been referenced: • Clean Development Mechanism Methodologies - CDM Methodology Booklet, 2020, UNFCCC • International Performance Measurement and Verification Protocol (IPMVP) - Measurement & Verification – Issues and Examples, IPMVP, EVO 10300-1: 2019 • MRV Framework for Energy Conservation Building Code for Large Commercial Buildings, 2020, ICAT
Deviations	1. The prolonged period of the COVID-19 pandemic in Thailand have the building site visits to conduct the energy audit activities under Task 4. Site visit to hospital building was not allowed due to the COVID-19 situation. Some buildings requested the project team to conduct virtual energy audits through interviewing persons involved in BEC during design and/or managing current building operations The virtual energy audits were organized for condominium and office buildings and, virtual conferences were arranged for the interviews together with completed survey forms and submission of energy consumption, building activity data, and photos 2. With the restriction imposed by the Thai government during the COVID-19 pandemic, the 2nd and 3rd stakeholder workshops were organized via a virtual online meeting platform. 3. The two workshops (for Task 2 and Task 3) to disseminate technology and financial assessment results was combined, and the number of participants in the workshop was increased from 20 persons per workshop to 60 persons in total. 4. For Task 6, DEDE requested NDE and the project team to translate the revised BEC Ministerial regulation to English for dissemination, instead of development the Handbook-1 Regulation for Local Administration Organizations (LoA).
Anticipated follow-up activities and next steps	1. Submission of the outputs developed by the CTCN to DEDE for enhancing the existing BEC assessment database and BEC training process. 2. Development of a dedicated BEC database system for energy consumption and building operational data for different BEC-compliant building types. 3. Development of data collection and reporting system to enhance the scope of BEC audits after construction completion to include a collection of building activity data

	and establishment of reporting structure, and integrate data into the BEC database system. Conduct of additional SEC studies for other BEC-compliant building types to establish baseline and calculating of GHG emission reduction.

2. Lessons learned

	Lessons learned	Recommendations
Lessons learned from the CTCN TA process	1. The CTCN TA process extensively relies on coordination with multiple agencies attached different ministries. Some key agencies include: the Office of National Higher Education Science Research and Innovation Policy Council (NXPO), and GCF's National Designated Agency (NDA) - Office of Natural Resources and Environmental Policy and Planning (ONEP)-under Ministry of Natural Resources and Environment (MoNRE), and the Department of Alternative Energy Development and Efficiency (DEDE)-under Ministry of Energy (MOE). This led to delays in the project initiation/ pre implementation phase of TA.	The main TA activities were designed to support the implementation of energy efficiency in the Thai building sector through compliance with the BEC. DEDE is the lead agency responsible for developing and promoting the BEC in Thailand and is the key beneficiary of this TA support. It is recommended for CTCN to include the key beneficiary of the TA. A simple agreement, e.g., MOU between NDE and the key beneficiary, could be established to ensure the smooth coordination during and after the project preparation phase. This will increase the likelihood of success of TA activities and encourage ownership and enhance collaboration among the relevant stakeholders.
Lessons learned related to climate technology transfer	1. Data availability and accessibility to the BEC assessment database was the main challenge. The data stored in the BEC assessment database is not in a standardized format. Considerable efforts were taken to clean, interpret and standardize the data before the detailed analysis could be performed.	The BEC assessment database is still a powerful tool for the analysis and planning of the BEC program. To make it fully usable, it is recommended that the BEC assessment database under DEDE be reviewed and all duplications and incompletions be cleaned. . Adding automatic data export and analysis features are worth considering to enhance its usefulness in the future, especially when the full enforcement of BEC becomes effective in the coming years.
	2. Physical site visits was not possible due to the COVID-19 pandemic, and the project overcame this challenge in the energy audit activities through development of	The online data-gathering forms can be further enhanced by DEDE to develop a reporting structure for BEC-compliance and non-designed BEC buildings for submission of energy

	Lessons learned	Recommendations
	energy audit and data gathering forms and conduct of energy audits through an online meeting platform. Extensive following up and alternative secondary sources of information were also used to fulfil missing data.	consumption and building operational data on an annual basis. The scope of BEC audits after construction completion can be expanded to include a collection of building activity data.
	3. The TA mainly provided recommendation to establish the MRV framework for the Thai BEC program. Following the analysis and consultation with stakeholders, it is concluded that the Thai BEC assessment program is designed for design benchmarking and certification proposes. Building energy consumption are roughly estimated assuming fixed parameters for the whole building. The calculation result is one-time based on designed building envelop, building equipment and system. No operation factor is taken into consideration. Another main challenge is identification of existing data resources which could be practically utilized to support establishment and operationalization of the proposed MRV framework.	It is recommended for Thailand to estimate GHG emission of the BEC program through collection of actual building energy consumption, and also utilize specific energy consumption (SEC) data studied by DEDE and TGO for different types of building. Utilization of SEC data allows for adjustment of building usage and better confident in estimation of GHG emission reduction. It is also recommended for Thailand to develop a dedicate BEC database system for energy consumption and building operational data for different BEC-compliant building types, and develop a new reporting system for non-designated BEC building for submission of energy consumption and building operational data on an annual basis.

3. Illustration of the TA and photos

Objectives of TA

To support Thailand in achieving national targets for energy efficiency in the building sector as defined in Energy Efficiency Plan of 2015, in NAMAs, and in Thailand's NDC. The NDC Road Map aims to reduce 113 million tonnes GHG emissions through energy efficiency (EE) and renewable energy (RE) with around 26.1 million tonnes in the building sector through compliance with the Building Energy Code (BEC), sustainable building materials and effective construction practices.

The BEC serves as the cornerstone in meeting Thailand's GHG emission reduction targets in the building sector and it sets out the mandatory energy standards for new buildings. There are several challenges to the adoption of the BEC standards by the respective stakeholders primarily due to the lack of information relating to energy efficient and analysis of cost-effective technologies and lack of resources in the government agencies for enforcement.

The overall objectives of the technical assistance is to

- To develop of existing energy and GHG emission baselines and benchmarks for the five building types, considering new buildings;
- To support for technical and financial assessment of non-implemented, yet available and accessible technologies for BEC compliance in the five building types, considering new buildings;
- Development of MRV framework to assesses energy savings and GHG emission reductions for existing and new buildings.

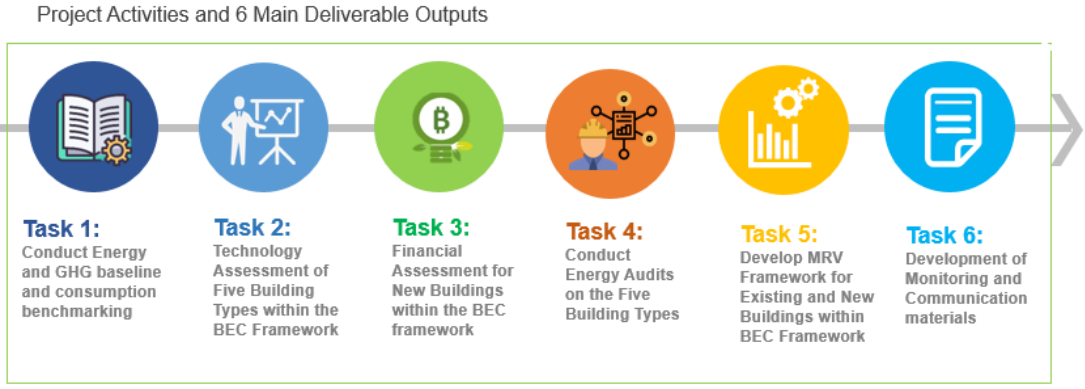
Methodology and Deliverables:

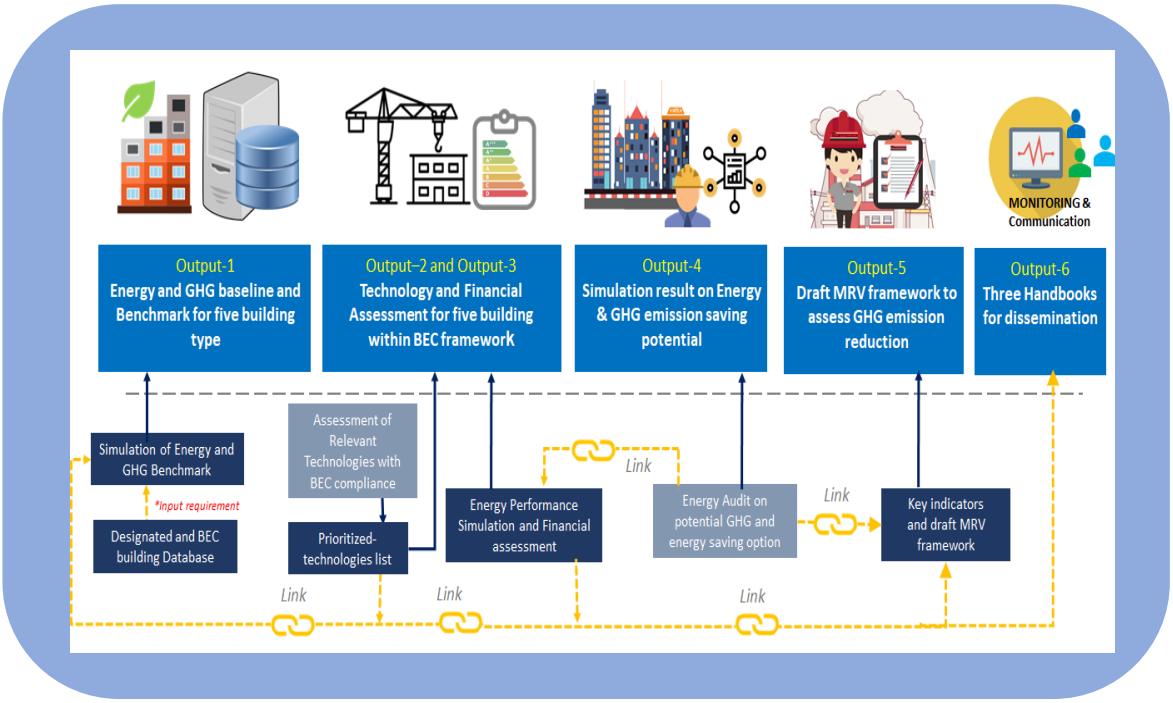
Preparation of implementation plan and communication documents

- Detail work plan
- Monitoring and Evaluation Plan
- CTCN Impact Statement
- Closure and data collection report

The TA was designed to deliver the various outputs related to five building types as defined in the BEC framework: office, hotel, department store, medical center and condominium with floor area exceeding 2,000 m^2, considering six main areas of performance indicators as defined in the BEC, building envelope, lightning system, air conditioning system, hot water generation system, renewable energy utilization and whole building performance:

The consequential step of TA methodology, activities and deliverable outputs from the TA are briefly presented below.





The TA results of output 1 to 6 are expected to promote greater compliance with BEC and contribute toward reaching the country's emission target. Capacity building of representatives of stakeholder groups such relevant government agencies, local authorities, building developers, designer and architects, engineers, technology providers, building owners, project developers, banks and investors in the BEC standards through their involvement in the project activities; and disseminating the results of the project to a wider audience through stakeholder consultation workshops.

Stakeholders Consultation

Under the project, a series of consultation workshops was designed to share project findings with local stakeholders, and to seek their comments and suggestions to strengthen the BEC compliance effort. The first stakeholder consultation workshop was successfully held in March 2021, and participated by more than 26 participants representing policy and regulatory bodies, and advocacy organizations in the Thai building sector.

Due to the COVID-19 pandemic, the second stakeholder consultation workshop was organized as an online workshop in October 2021 to disseminate the outcomes of technology assessment and financial assessment to the relevant stakeholders. The workshop was attended by 62 participants from 40 organizations, representing policy and regulatory authorities, private sector developers, builders, academic institutes, as well as building designers, BEC-certified engineers/auditors, and construction companies.

The third stakeholder consultation workshop was organized as an online workshop on December 22nd, 2021 to propose framework for MRV for the BEC program in Thailand. The online consultation workshop was participated by 30 participants from 21 organizations representing government agencies, private sector organization and academia.

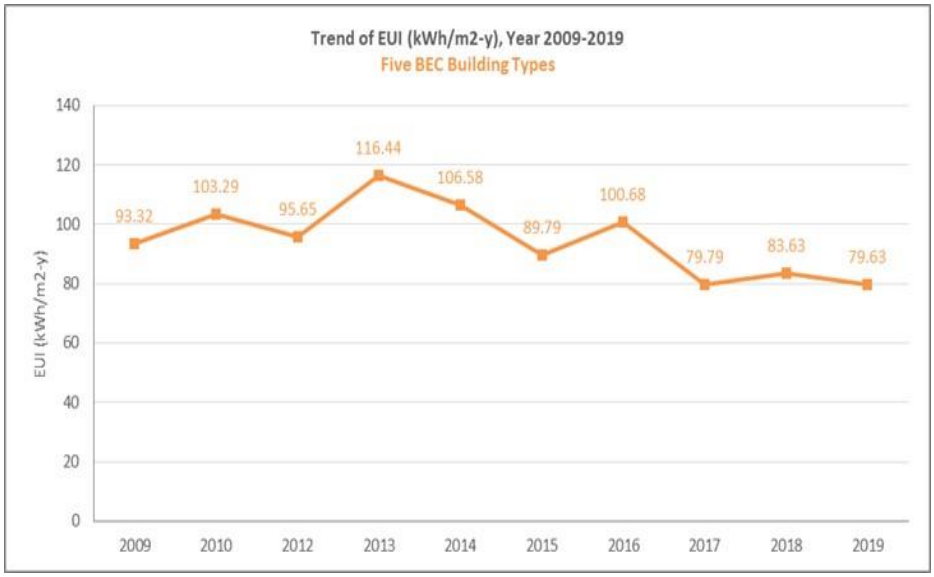
Three Handbook for Disseminations

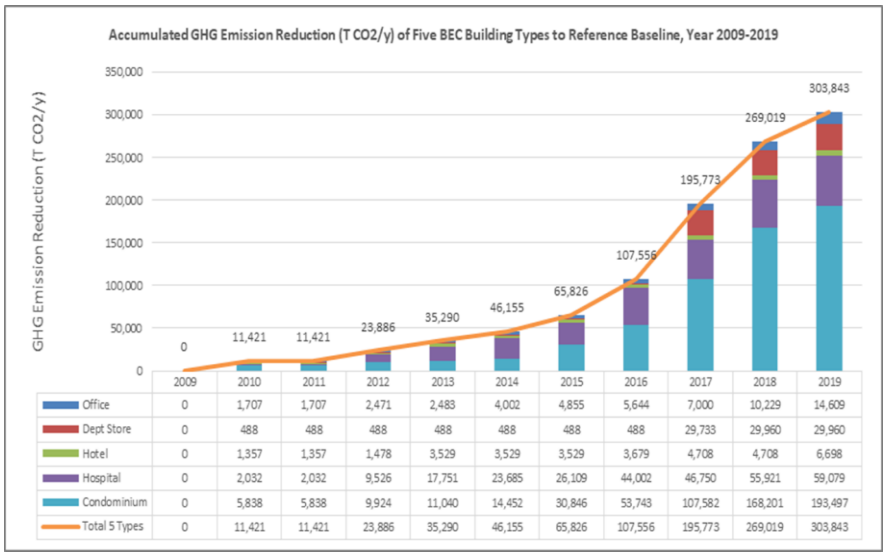
Furthermore, three handbooks were developed to increase awareness of the BEC standards and provide guidelines on ensuring compliance for; local authorities, practitioners (engineers, architects, and developers), and investors. The handbooks were developed using the TA outputs, and they will be handed over to DEDE for distribution.

Summary of Output 1-5

Output 1: Energy and GHG Baseline and BEC Benchmark for five building types

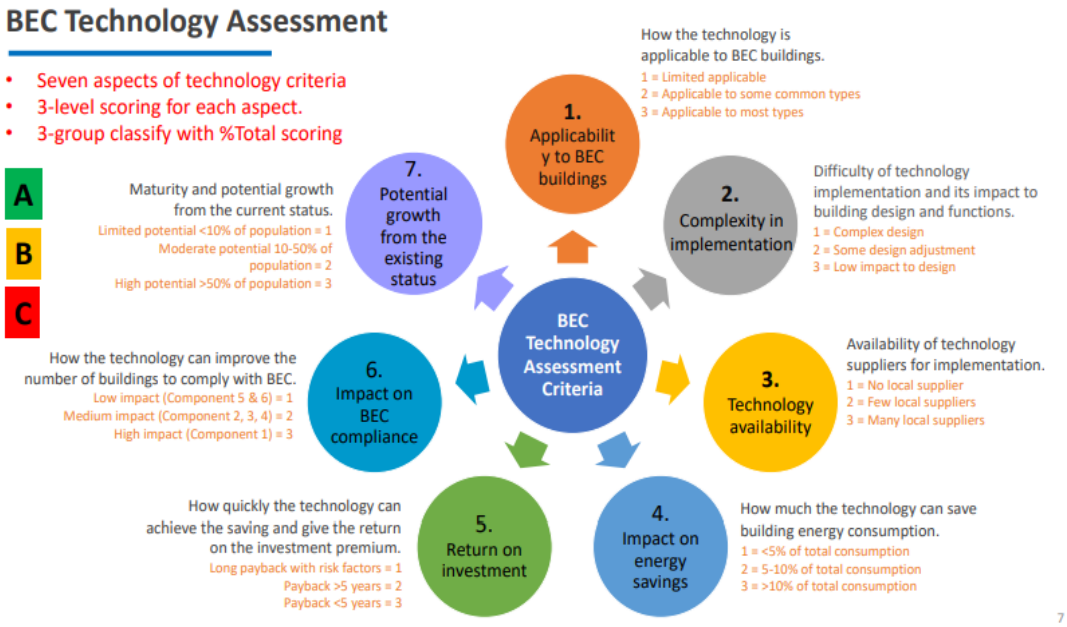
The TA analyzed the BEC assessment database which has collected 10-year BEC implementation data from 2009 to 2019. The average energy use intensity (EUIs) in kWh/m^2/year is used as an indicator for energy efficiency. The results show a decreasing trend of the average 15% reduction of EUI from 2009 to 2019, from 93.3 kWh/m^2-y to 79.6 kWh/m^2-y. Based on the BEC assessment database, the BEC implementation of five building types can avoid GHG emission by the grid in the year 2019 at 303,843 tCO_2/year compared with the reference baseline scenario.





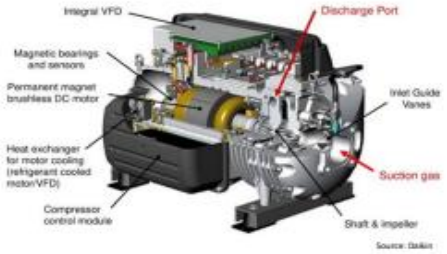
Output 2: Technology Assessment by BEC Components

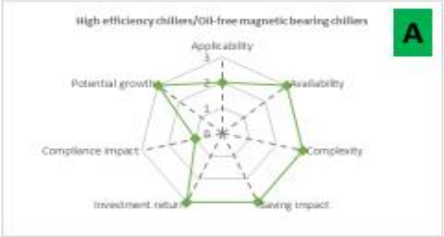
To perform technical assessment of technologies for the six BEC components, the assessment aspects and scoring criteria are defined. Each technology is evaluated individually on the same criteria. Three levels scoring on the scale of 1 to 3 is given for each technology on every aspect. For each BEC component, the current status of technologies being implemented and a list of potential technologies are given. All technologies will be ranked by the total score from all aspects with scoring criteria defined. The assessment scores classify technologies into priority groups of top (A), medium (B) and low priority (C).

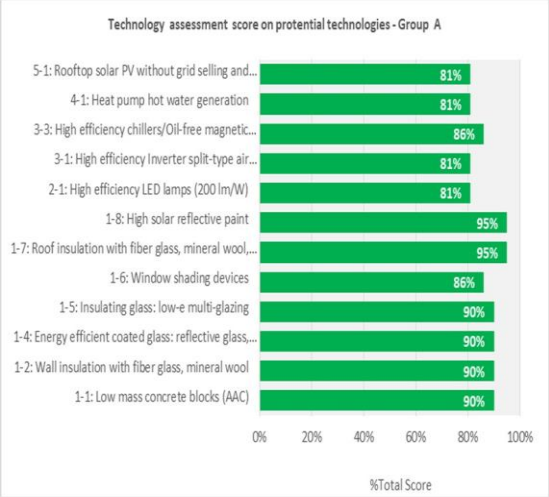


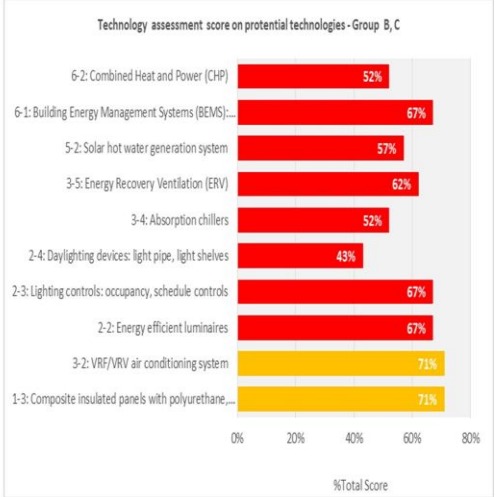
BEC Component 3: Air Conditioning System

Technology	High efficiency chillers/Oil-free magnetic bearing chillers
Baseline technology	Standard electric chillers.
Applicability	Medium to large sized buildings with central chilled water air conditioning system.
Availability	Many local suppliers.
Implementation Complexity	Replacement of same capacity chiller with minor modification.
Savings	▪ Reduced air conditioning consumption.
Return on investment	▪ Good payback normally <5 years.
Compliance contribution	▪ Air conditioning system - AC. ▪ Whole building energy consumption.
Potential growth	▪ Become commonly used. ▪ High growth potential.
Applicable standard	▪ Ministerial of Energy notification prescribing high efficiency chillers for air conditioning systems, 2009.
Other consideration factors	▪ Part-load efficiency to cooling load variations. ▪ Comparison with high efficiency chillers.





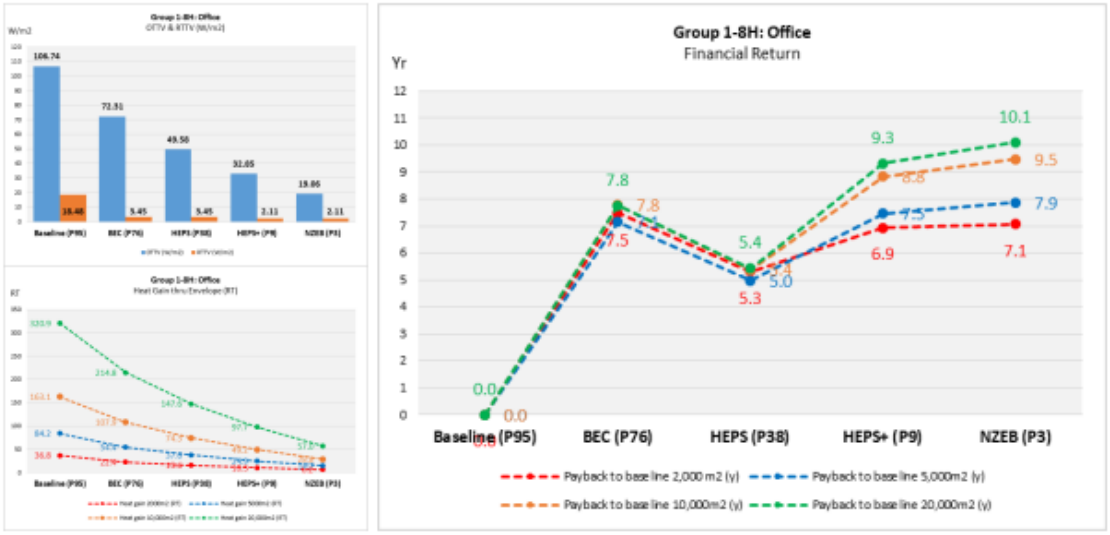




Output 3: Assessment of Financial Aspects of Technology

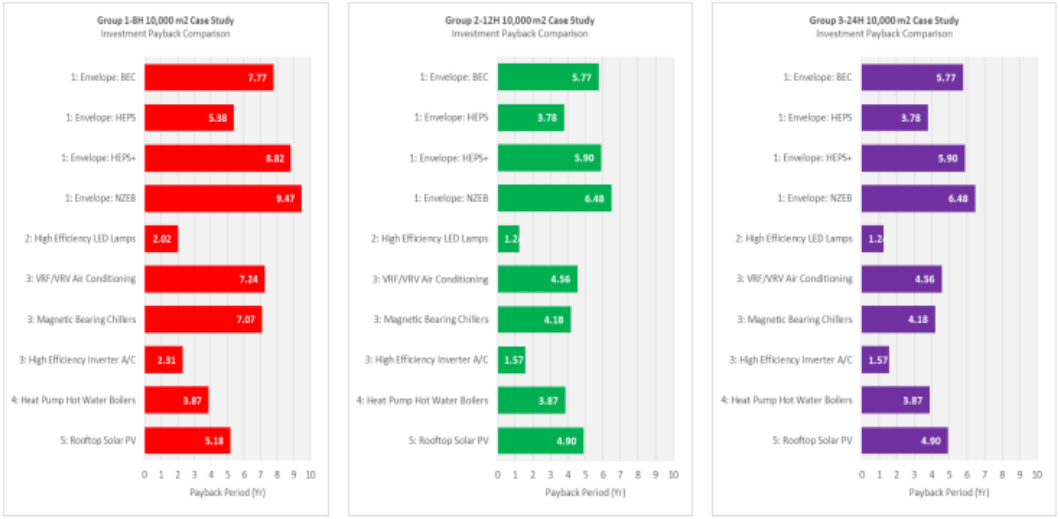
From the list of prioritized technology, energy performance simulation and financial assessment are conducted for the high potential technologies to enhance the BEC implementation. The simulation models are developed to estimate savings from the implementation of these BEC technologies. The financial assessment analyzes the scale of investment and financial return on investment for each of the listed BEC technologies. The financial assessment results show good savings with moderate to high return on investment from the identified technologies.

BEC Component 1: Building Envelope Group 1-8H



Financial Return on BEC Technologies

Case Study of Simulated 10,000 m2 Buildings



Output 4: Energy Audit for Five Building Types

The energy audits were used to confirm the validity of technology and provide inputs for designing of MRV framework in task 5, and developing recommendations for future BEC policies and regulations.

Output 5: MRV framework

The MRV framework which estimates GHG emission of the BEC program through collection of actual building energy consumption is proposed. This specific MRV framework can utilize specific energy consumption (SEC) data studied by DEDE and TGO for different types of buildings. Utilization of SEC data allows for adjustment of building usage and intensity of project activities over time which will lead to an adjusted baseline data and better confidence in estimation of GHG emission reduction.

4. Impact Statement

The information in the table below will be used to communicate results and anticipated impacts of this technical assistance publicly. Please copy information from impact statement developed in the M&E Plan and update as relevant.

Challenge	The overall objective is to support Thailand in achieving national targets for energy efficiency in the building sector as defined in Energy Efficiency Plan of 2018, in NAMAs, and in Thailand's NDC. The NDC Road Map aims to reduce 113 million tonnes GHG emissions through energy efficiency (EE) and renewable energy (RE) with around 26.1 million tonnes in the building sector through compliance with the Building Energy Code (BEC), sustainable building materials and effective construction practices
CTCN Assistance	Technical Assistance for: • Establishment of Energy and GHG baselines and consumption benchmarks for buildings sector • Techno-economic assessment of technologies for 6 different building energy components under BEC compliance- building envelope, lightning system, air conditioning, system, hot water generation system, renewable energy utilization and whole building performance • Development of MRV Framework for existing and new buildings
Anticipated impact	• Effective baselines and benchmark data, and the technology and financial assessment results, including the dissemination handbooks, will promote greater compliance with the BEC, and contribute to reduce GHG emission in the building sector. • Contribution toward reaching the country's emission target as specified in the EEP2015 by adopting the revised BEC compliance and implementing the MRV framework for monitoring and reporting. • It is anticipated impact of the direct beneficiaries of 100 government and private buildings per year, and anticipated 20-25% saving of metric tons of CO2 equivalent (tCO2e) emissions reductions in compliance to BEC, according to DEDE's BEC roadmap.
Co-benefits: Achieved or anticipated co-benefits from the TA	• The TA will help DEDE, and local authorities foster implementing the BEC compliance program and support better monitoring for BEC enforcement; • Supporting the capacity building among developers, architects, and construction industry by implementing technologies to conform to BEC requirements; • Will enhance enabling environment for investments for the private sector in compliance to BEC.
Gender aspects of the TA	A gender aspect has been included in the various activities, especially in the stakeholder consultations while implementing the TA as follows: • Providing equal opportunities for both genders in participate and given comments and suggestions in each stakeholder consultation workshop; • Enhanced capacity building to DEDE staff through various TA activities and results, including but not limited to workshop learning and on-site visiting auditing;

	• The number of women participants was 36% in total for three stakeholder workshops and TA activities.
Anticipated contribution to NDC	• Establishment of energy consumption baseline and GHG emission reduction under BEC compliance in the building sector. • Priority listing of applicable energy efficiency and renewable technologies for different building energy components under BEC framework. • Established MRV Framework to access and report on climate impacts of BEC implementation
The narrative story	The NDC Road Map aims to reduce 113 million tonnes GHG emissions through energy efficiency (EE) and renewable energy (RE) with around 26.1 million tonnes in the building sector through compliance with the Building Energy Code (BEC), sustainable building materials and effective construction practices. The BEC serves as the cornerstone in meeting Thailand's GHG emission reduction targets in the building sector and it sets out the mandatory energy standards for new buildings while the standards for existing buildings are only voluntary. There are several challenges to the adoption of the BEC standards by the respective stakeholders primarily due to the lack of information relating to energy efficient and cost-effective technologies and the lack of resources in the government agencies for enforcement. The implementation of EE measures following energy audits have been slow due to lack of benchmarks and technology options; and this needs to be addressed if implementation were to be increased. The scope focuses on five building types, namely, offices, hotels, department stores, medical centers and condominiums of floor area equivalent to or exceeding 2,000 sqm, and consistent with the performance indicators outlined in the BEC.
Contribution to SDGs A complete list of SDGs and their targets is available here: https://sustainabledevelopment.un.org/partnership/register/	The proposed CTCN TA support directly contributes to the UN Sustainable Development Goal as follows: **SDG 7: Affordable and clean energy,** with Goal 7.a - Enhance international cooperation to facilitate access to clean energy research and technology, including energy efficiency and renewable energy technology, and promote investment in energy infrastructure and clean energy technology in the building sector. Indirectly, contributes to **SDG 13: Climate Action;** 13.3 - Improve education, awareness-raising and human and institutional capacity on climate change mitigation, adaptation, impact reduction and early warning. Finally, the project, given it explicit output can also be one way to achieve **"Goal 9: Industry, Innovation and infrastructure**-by 2030 upgrade infrastructure and retrofit industries to make them sustainable, with increased resource-use efficiency and greater adoption of clean and environmentally sound technologies and industrial processes, with all countries".

Annex 1 Technical assistance data collection

A. Output and outcome indicators

Indicator	Quantitative value	Qualitative description
Total number of events organized by proponents and implementing partners	**10**	1) Three stakeholder consultation workshops were arranged to share the TA findings result with local stakeholders, and to seek their comments and suggestions to strengthen the BEC compliance effort 2) Seven internal consultation meetings with DEDE and 2e-building consultant, KMUTT, NDE, NDA were arranged for BEC data gathering and TA activities follow up and discussion
Number of participants in events organized by proponents and implementing partners	**134**	• Three stakeholder consultation workshop had total of 118 participants • Internal consultation meeting with DEDE and relevant proponent organization had total of 20 participants
a) Number of men	88	*Three stakeholder consultation workshops had total 76 men participants* *Seven Internal consultation meeting had total 12 men participants*
b) Number of women	50	*Three stakeholder consultation workshops had total 42 women participants* *Seven Internal consultation meeting had total 8 women participants*
Number of climate technology RD&D related events	***10***	Ten buildings under five BEC building types covered in the project scope are selected as representative audit sites.
Number of participants in climate technology RD&D events	***26***	*Each energy audit had at least 2 representative staff from TA implementing agency, 2 representatives from DEDE and 2e-building. Representative staff from individual audit sites had at least 2-3 persons, depend on each building.*
a) Number of men	*20*	*Ten building audit had total 20 men participants*
b) Number of women	*6*	*Ten building audit had total 6 women participants*
Number of training organized by proponents and implementing partners	0	
Number of participants in trainings organized by proponents and implementing partners	0	
a) Number of men	0	
b) Number of women	0	

Total number of institutions participated in stakeholder consultation workshops	**42**	A total of 118 participants from 42 institutions were participated in three stakeholder consultation workshops.
a) Governmental (national or subnational)	**8**	1) Office of Natural Resources and Environmental Policy and Planning (ONEP) 2) Office of National Higher Education Science Research and Innovation Policy Council (NXPO) 3) Department of Alternative Energy Development and Efficiency (DEDE) 4) Thailand Institute of Scientific and Technological Research 5) Provincial Electricity Authority of Thailand (PEA) 6) Electricity Generating Authority of Thailand (EGAT) 7) Thailand Greenhouse Gas Management Organization (TGO) 8) National Housing Authority (NHA)
b) Private sector (bank, corporation, etc.)	**21**	1) Thailand Facility Management Association (TFMA) 2) Gigajule Co., Ltd. 3) 3M Thailand Limited 4) Asset World Corp public company limited 5) Azbil(Thailand) 6) CP Land Co., Ltd 7) CPN KORAT CO.,LTD. 8) Delta Infra One Co., Ltd 9) Double Nine CND Co., Ltd. 10) Energy Conservation Technology Co., Ltd 11) Future Engineering Consultants Co., Ltd. 12) ITEM Co. ltd 13) LPN Wisdom Co., Ltd 14) Nongkae Cogeneration Power Plan 15) PTT Global Chemical Public Company Limited (PTTGC) 16) Quality Construction Product Co., Ltd 17) Rachata Co., Ltd. 18) Siam Cement Group (SCG) 19) SPKW Energy Auditor 20) Power Supply and Management Services Co., Ltd. 21) Independent BEC auditors/consultants
c) Nongovernmental (NGO, University, etc.)	**13**	1) King Mongkut's University of Technology Thonburi (KMUTT) 2) King Mongkut's Institute of Technology Ladkrabang (KMITL)

		3) Faculty of Architecture, Chulalongkorn University (CU) 4) Faculty of Architecture, Kasetsart University (KU) 5) Faculty of Architecture, Silpakorn University (SU) 6) Faculty of Architecture, Thammasat University (TU) 7) Faculty of Technology Udon Thani Rajabhat University 8) Rajamangala University of Technology Lanna Phitsanulok 9) Rajamangala University of Technology Thanyaburi (RMUTT) 10) Naresuan University (NU) 11) Bangkok University 12) Thailand Green Building Institute (TGBI) 13) Thailand Environment Institute (TEI)
Percentage of participants reporting satisfaction with CTCN TA results (from CTCN Workshop feedback form)	**>65%**	• 65% of the respondents satisfied with the overall workshop arrangement, the provided content, including the Q&A session • 80% of the respondents were satisfied with the presented information and discussion topics, and realized the benefits on BEC implementation and policy development. • 67% satisfied with gender equality; everyone had the same opportunity to express their opinion.
Percentage of participants reporting increased knowledge, capacity and/or understanding as a result of CTCN TA (from CTCN workshop feedback form)	**>50%**	• 50% of participants agreed that the technology assessment and financial results are helpful to BEC auditors, BEC developers, designers, and investors. • 76% of respondents agreed that the results are helpful to support policy implementation
a) Percentage of men	76%	76% of men participants were satisfied with the overall BEC study results
b) Percentage of women	70%	70% of women participants were satisfied with the overall BEC study results
Total number of deliverables produced during the assistance (excluding mission, progress and internal reports)	*22*	Inception report, Progress report of Task 1 to Task 5, Three Handbooks, and Power point presentation and CTCN documents
a) Number of communication materials, including news releases, newsletters, articles, presentations, social media postings, etc.	**3**	Three handbook developed as a result of CTCN TA of Output 6.1
b) Number of tools and technical documents	**9**	• Inception report

strengthened, revised or developed		• Five progress reported as a result of CTCN TA of Output 1 - Output 5, and one baseline and benchmark database of modified existing BEC assessment data establish in excel format. • CTCN Technical Impact Description • CTCN Monitoring and Evaluation Plan and Impact statement report • CTCN Closure report
c) Number of other information materials strengthened, revised or created (For example training and workshop reports, Power Points, exercise docs etc.)	**9**	• *6 Power point presentations as part of TA results presented in the three stakeholder consultation workshops* • *3 Power point presentation as part of BEC policy updated, presented by DEDE*
Total number of policies, strategies, plans, laws, agreements or regulations supported by the assistance	1	As part of TA activities, will be contributed to support the implementation of BEC compliance program under DEDE.
a) Adaptation related	**0**	*List the type and name of documents supported*
b) Mitigation related	**6**	1) Handbook-1: Enforcement Guideline of BEC Standard Design and Compliance - The Ministerial Regulation and Building Evaluation Procedures 2) Handbook-2: Guideline on Thai BEC Standard Design and compliance for practitioners 3) Handbook-3: Guideline for BEC building development for Investors 4) Report on Energy and GHG emission baseline and benchmark for five building types cover in BEC 5) Report on Technology Assessment of five building types within BEC framework 6) Report on Financial Assessment of five building types within BEC framework
c) Both adaptation- and mitigation related	**0**	
Anticipated number of policies, strategies, plans, laws, agreements or regulations proposed, adopted or implemented as a result of the TA	**1**	As part of TA activities, will be contributed to support the implementation of BEC compliance program under DEDE.
a) Adaptation related	**0**	
b) Mitigation related	**1**	• Proposed MRV Framework for BEC-Compliant Buildings in Thailand
c) Both adaptation- and mitigation related	**0**	
Anticipated number of technologies transferred or deployed as a result of CTCN support	**2**	1) Energy Efficiency and Renewable Energy in building • Appliances and equipment

		• New building design, and materials • Building standards and codes • Renewable energy-solar PV 2) Infrastructure and Urban planning sector • Building codes
Anticipated number of collaborations facilitated or enabled as a result of technical assistance	**1**	
a) Number of South-South collaborations	**0**	
b) Number of RD&D collaborations	**1**	*Department of Alternative Energy Development and Efficiency (DEDE)*
c) Number of private sector collaborations	**0**	
Number of countries with strengthened National System of Innovation as a result of CTCN support	**1**	Thailand

B. Core impact indicators

Please fill in the tables for anticipated impacts of the CTCN assistance. Every technical assistance should contribute to at least one of the indicators below. For guidance on how to report on core indicators see the '[M&E Guidance Document for TA Implementers'](#).

Core indicator 1	**Anticipated metric tons of CO_2 equivalent (CO_2e) emissions reduced or avoided as a result of CTCN TA** The avoided GHG emission from this CTCN TA is calculated from the implementation potential technologies identified in Task 3. The core indicator of avoided emission (tCO_2e) is calculated from the energy savings (kW/year) of BEC buildings implementing potential technologies identified in task 3.	
	Anticipated metric tons of CO_2e reduced or avoided as a result of the TA **on annual basis**	Anticipated metric tons of CO_2e reduced or avoided as a result of the TA **in total**
Quantitative value *(emissions reductions)*	156,886 (Based on the number of five types of BEC buildings of 505)	3,137,720 (Conservatively projection over 20 years of project life)
Unit	tCO_2e/year	tCO_2e
GHG assessment boundary (project emissions) Identify expected post-TA activities, associated effects and assess boundary for quantification of GHG emission reductions	The assessment is bounded to five types of BEC buildings covered under this CTCN TA scope including office, department store, hotel, hospital and condominium. With the enforcement of BEC in early 2022 and awareness raising on the identified technologies, it is expected that the identified technologies would be widespread implemented by the target groups.	
Baseline emissions	317,284 tCO_2e/year	6,345,680 tCO_2e

Describe baseline scenario, baseline candidates, emission factors and emissions calculated	The original building design submitted for BEC assessment (pre-assessment) is assumed to represent current building design and materials commonly implemented. The GHG emission results of the benchmark analysis in task 1 are brought for the simulation. (Details provided in Progress report 5)	Based on 20-year of project life.
Methodology Explain the method or process of verifying the indicator and how data was gathered	Pre-assessment EUIs (EUI of the buildings submitted for BEC assessment) from the BEC databases are assumed to represent current building design and considered as business as usual scenario or baseline for GHG reduction. Energy savings from applying the identified technologies to each building type are calculated and collectively added for the number of existing buildings in BEC database (505 buildings for five types under this study) to estimate total potential energy savings in kWh/year. (Details provided in Progress report 5)	
Assumptions Describe assumptions made during calculation and quantification of GHG reductions	The assumptions based on common practices, studies, specifications and relevant experiences are applied to estimate energy savings from the technologies to the target building types. (Details provided in Progress report 4) The GHG emission factor published by the Thailand Greenhouse Gas Management Organization (TGO) is used for conversion of energy saving (kWh) to GHG reduction in kg or tCO_2e. From the latest grid emission factor of 0.5664 kg CO_2/kWh (year 2017) and assumed 10% of transmission and distribution losses, GHG emission factor used for the energy saving for BEC building (GHG reduction from demand-sided electricity saving) is 0.6293 kg CO_2/kWh.	

Core indicator 2	**Anticipated increased economic, health, well-being, infrastructure and built environment, and ecosystems resilience to climate change impacts as a result of technical assistance** *Please provide a **qualitative** description of the anticipated impacts on the categories below*
Infrastructure and built environment Anticipated increased infrastructure resilience (avoided/mitigated climate induced damages and strengthened physical assets)	**N.A**
Ecosystems and biodiversity Anticipated increased ecosystem resilience (areas with increased resistance to climate-induced disturbances and with improved recovery rates)	**N.A**
Economic Anticipated increased economic resilience (e.g. less reliance on vulnerable economic sectors or diversification of livelihood)	**N.A**
Health and wellbeing Anticipated increased health and wellbeing of target group (e.g. improved basic health, water and food security)	**N.A**

Core indicator 3	**Anticipated number of direct and indirect beneficiaries as a result of the TA**	
	Quantitative value	**Means of verification**
Total beneficiaries	*Total number*	
Number of adaptation beneficiaries	100 BEC buildings	Number of the direct beneficiaries of 100 government and private buildings per year to participate in BEC assessment program, according to DEDE's BEC roadmap.
	300 BEC training persons	Number of participants expected to be trained on knowledge of BEC assessment program by 2e-building center, under DEDE's planning activities in 2022
	550 BEC certified auditor	Number of BEC auditors expected to be trained and certified by 2e-building center, under DEDE's planning activities in 2022-2023
Number of mitigation beneficiaries	**N.A**	*Describe calculation methods and assumptions made*
Number of adaptation-and mitigation beneficiaries	**N.A**	*Describe calculation methods and assumptions made*

Core indicator 4	Anticipated amount of funding/investment leveraged (USD) as a result of TA (disaggregated by public, private, national, and international sources, as well as between anticipated/confirmed funding)			
	Quantitative value confirmed *in USD*	**Quantitative value anticipated** *in USD*	**Qualitative description** *List the institutions, timelines, and description or title of the investment*	**Methods** *Describe methods used for quantification of funds leveraged*
Total funding	**N.A**			
Anticipated amount of public funding mobilised from national/domestic sources	**N.A**			
Anticipated amount of public funding mobilised from international/ regional sources	**N.A**			
Anticipated amount of private funding mobilised from national/domestic sources	**N.A**			
Anticipated amount of private funds mobilised from international/regional sources	**N.A**			

Annex 2 (for internal use – to be filled in by the CTCN)

CTCN evaluation

This section will be completed by the relevant CTCN Technology Manager.

- Evaluation of the timeliness of the TA implementation as measured against the timeline included in the response plan;
- Evaluation of TA quality as defined in the response plan;
- Overall performance of the Implementers;
- Overall engagement of the NDE and Proponent;
- Lessons learned on the CTCN process and steps taken by the CTCN to improve.