From Technology Roadmap to Climate Investment: Leveraging CTCN Support for NDC Implementation in Pakistan

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Development Challenge - Water

Global Standing & Human Impact

3RD

Most Water-Scarce Country

IMF ranks Pakistan third globally for extreme water scarcity.

TOP 10

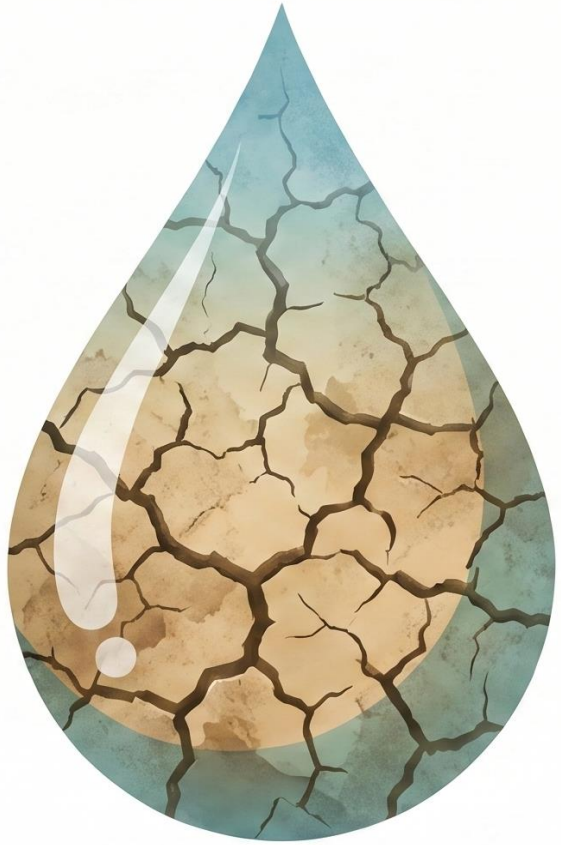
Climate-Vulnerable Nation

Consistently ranked by Germanwatch as one of the world's most at-risk countries.

80%

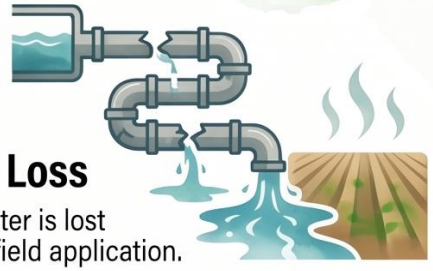
of Population Affected

Four out of five Pakistanis already face immediate water scarcity.



Infrastructure & Resource Gaps

60%



Irrigation Water Loss

Over half of irrigation water is lost during conveyance and field application.

30-DAY

Storage Capacity

Pakistan can only store enough water to meet 30 days of national needs.

1%

Wastewater Treatment

Pakistan has the lowest ratio of treated wastewater in the entire world.

Development Challenge - Waste

Annual Waste Generation

50.79 Million Tons Per Year

Growing at 2.4% Annually

90,000 Tons of Waste Generated Weekly

Major Cities Produce the Bulk of Waste

Collection & Disposal System

60–70% Waste Collected

Open Truck Tractor Trolley Donkey Cart

Disposal in Open Dump Sites

Waste Composition

Municipal Solid Waste Breakdown:

30% Food Waste

18% Ash, Bricks & Dirt

14% Yard Waste

9% Plastic

Remaining:

Cardboard, Glass, Paper, Metals, Textiles, Wood, Leather, Rubber

Pakistan: Enabling Mitigation in Waste & Water Sectors

CTCN Intervention: Targeted assessment of technology needs, the NDC Technology Roadmap for the water and waste sectors — prioritized technologies, readiness assessment, and a time-bound action plan.

- Development of **national Technology Roadmap for NDC implementation** with **Ministry of Climate Change and Environmental Coordination**
- **Duration:** Jun 2023 – Mar 2025

Sector focus:
  - Waste (methane mitigation, circular economy)
  - Water (efficiency, climate resilience)
- **Implemented by Global Green Growth Institute (GGGI)**

Key Outputs
- National Technology Roadmap
- Sectoral technology assessments (waste & water)
- 4 investment-ready concept notes for scale-up

How Was the Roadmap Built?

A phased, working-group-verified process from baseline to bankability

PHASE 1

Planning & Preparation

- Kick-off workshop
- Stakeholder sensitization
- Working groups established
- Desk review & baseline

PHASE 2

Sector Prioritization

- Sector-level assessment
- Technology longlisting & prioritization
- Gender & social assessment
- Working group feedback

PHASE 3

Roadmap Development

- Working group verification of prioritization
- Action plan drafting
- Final roadmap validation

PHASE 4

Investment Preparation

- Idea notes for funding
- Four project concepts
- Coordination with the financial sector
- Feasibility and preparation support for investments

Stakeholder consultation

Implementation was designed in from the start — the roadmap is a starting point for investment, not an end product.

Three Stakeholder Working Groups

Central and provincial government convened to understand the technical and policy environment and needs

4 meetings

Water Working Group

MoCC&EC, MoWR, FFC, provincial EPDs, irrigation, energy, and WASA representatives, plus experts and academia. Selected agriculture, hydropower & domestic sub-sectors; provided baselines, gap analysis, and provincial governance insight.

4 meetings

Waste Working Group

MoCC&EC, Food Security, PBS, provincial EPDs, agriculture and waste management representatives, plus experts and academia. Selected municipal solid waste, agricultural waste & plastic waste sub-sectors; validated priorities.

2 meetings

Policy Working Group

Science & Technology, Industries & Production, PCRET, PCSIR, IT departments, and academia. Finalized the scoring criteria and roadmap outline; shaped the enabling policy environment for technology deployment.

Federal ministries + provincial departments + research & academia — ten working sessions in total.

From 50+ Technologies to 10 Priorities

Expert technical and economic assessment narrowed a broad longlist to a focused investment agenda

50+

Longlist

Technologies identified through desk review, baseline assessment, and working group consultation across both sectors

11

Shortlist

Expert technical assessment — market analysis, gender assessments, SWOT, climate impact, cost economics including sector cost curves

4

Prioritized

Using technical analysis and working group verification the project prioritized two **existing** and two **emerging** technologies in water and waste for dedicated investment and support

Scoring pillars (1–5 scale, weighted; verified by the working groups):

- **Legal, Regulatory & Financial Landscape**
- **Economic & Technical Feasibility**
- **Inclusivity & Climate Impact (incl. gender)**

COP 29 (Baku)

Ministry of Climate Change and Environmental Coordination launched the NDC Technology Roadmap in collaboration with GGGI

GGGI and Ministry of Climate Change presenting the NDC technology roadmap at COP29 in 2024.

From Technology Roadmap to Bankable Mitigation Investments

Bridging Technology → Finance (Core Value of CTCN TA)

Investment Pipeline Developed

- Biochar production from agricultural residues
- AI-integrated water resource management systems
- Climate-smart irrigation solutions
- Methane mitigation strategy for organic waste

Financing Outcomes

- Investment pipeline identified
- Initial funding mobilized through:
  - **Korean Green New Deal Trust Fund (Jun 2024 – Aug 2025)**
- Pathway towards:
  - Scaling into national-level programmes
  - Bilateral/ GCF concept notes

Enabling Factors

- Strong government ownership (Ministry of Climate Change and Environmental Coordination)
- Structured stakeholder coordination mechanism (13+ events, 300+ participants)
- Integration of **policy + technology + finance**

Key Lessons for Scaling Industrial Mitigation

Linking Sectoral Technologies to Finance is Critical

- Technology identification alone is insufficient
- Early development of **bankable concept notes accelerates investment**

Industrial Mitigation Opportunities in "Non-traditional" Sectors

- Waste → methane reduction, **circular economy**
  - Agriculture-waste → **biochar**, value chains
- Water systems → energy efficiency, resilience

Role of CTCN as an Enabler

- De-risking early-stage investments
- Connecting countries with Technology providers & Financial partners
- Translating NDCs into **implementable investment pipelines**

Replication Potential

- Model applicable to other developing countries & cross-sector industrial decarbonization pathways

Picture credits: Dawn newspaper, 2025

Biochar in Pakistan

Case Study-1

Case Study 1: From Waste to Value: GGGI support to unlocks Pakistan's Biochar Potential

1 NDC Technology Road Map for Waste Sector

Identifying the need

- Selection of subsectors and sub-listing of technologies
- Prioritization of 5 technologies
- Roadmap development

2 Pre-Feasibility Readiness

Assessing the potential

- Additional financing support from KGNDTF
- Technical feasibility studies for Biochar conducted as a climate-smart solution and developing bankable project.

3 Upscaling Biochar

Scaling up bankable projects

- Replicate experiences from the Philippines
- GGGI supported the private sector to link its industrial-scale biochar plants to VCM carbon credits by supporting international verification via puro.earth.
- Bankable project development, donor engagement and RM.

4 Pakistan LT-LEDS (Being developed)

Biochar Feasibility Studies

Biochar: Powering Pakistan's Sustainable Agricultural Future

BIOMASS POTENTIAL & ENERGY CAPACITY

Data Widget 1

114 MILLION TONNES
of Annual Crop Harvesting Residue

448,990 GWh/yr

Based on World Bank data, this vast volume represents immense energy potential.

Data Widget 2

25.3 MILLION TONNES
of Crop Processing Residue

61,838 GWh/yr

Specifically derived from processing activities, this residue can contribute significantly to the national grid.

PUNJAB AND SINDH: THE BIOMASS HUBS - Regional feasibility is highest in these provinces.

POLICY FRAMEWORK & FARMER SUPPORT

EMPOWERING SMALL-SCALE FARMERS

National policies must provide subsidies and incentives for biochar equipment to minimize market failures for smallholders.

INTEGRATION WITH CLIMATE-SMART AGRICULTURE

Biochar should be formalized within provincial and national programmes promoting sustainable farming and renewable energy.

INSTITUTIONAL CAPACITY BUILDING

Strengthening public institutions and R&D is essential to explore the full bioenergy potential.

ECONOMIC VIABILITY & REVENUE STREAMS

FEEDSTOCK COST AS THE ECONOMIC DRIVER

The financial feasibility of biochar is primarily shaped by regional prices, seasonal availability, and logistics of the raw feedstock.

DIVERSE AGRICULTURAL REVENUE

Revenue is generated through soil amendments, composting additives, and the use of biochar for **LIVESTOCK BEDDING**.

CLIMATE MITIGATION & CARBON CREDITS

A significant revenue stream exists in the potential for **CARBON CREDIT** generation and the production of sustainable bio-fuels.

Pakistan Biochar Circular Economy Investment Platform (PB-CIP)

Pakistan Biochar Circular Economy Investment Platform (PB-CIP)

Project Goal: Establishing commercially viable, investment-ready biochar value chains in Pakistan through validated business models, policy frameworks, and private climate finance.

Geographic Focus: Priority deployment across the agricultural heartlands of Punjab and Sindh.

[THE CATALYST]

THE CHALLENGE

142 Million Tons

Annual agricultural residue generated in Pakistan (with 92M tons in Punjab alone).

The Burning Problem: Rampant open crop residue burning causes severe air pollution, massive greenhouse gas emissions, and the rapid degradation of vital soil health.

THE SOLUTION

Circular Economy Transformation: Converting underutilised, hazardous waste biomass (wheat, rice, cotton residues) into high-value biochar.

The Mechanism: Controlled pyrolysis that transforms an environmental liability into a climate, agricultural, and economic asset.

[THE ENGINE]

The Four Pillars of Execution

1. Feedstock Assessment & Commercial Readiness
Identifying commercially viable biomass supply corridors, testing feedstock quality, and mapping market demand to prioritise investment locations.

2. Policy & Carbon Finance Enablement
Developing MRV (Measurement, Reporting, and Verification) frameworks, digital monitoring, and establishing carbon market readiness (e.g., Article 6, Verra) to monetise carbon removal.

3. Pilot Development & Commercial Validation
Deploying co-located continuous-feed pyrolysis bio-clusters (integrated with rice mills and cotton gins) to validate technical performance and prove commercial bankability.

4. Investment Mobilisation & Scaling
Structuring financial models, mitigating investor risk, and engaging ESG-focused private sector partners (e.g., textile supply chains) to mobilise large-scale climate finance.

[THE YIELD]

Expected Impact

Improved Livelihoods: Creating green jobs, establishing circular agricultural value chains, and providing new revenue streams for rural farming communities.

Enhanced Resilience: Improving soil organic carbon, boosting water retention, and reducing reducing farmer dependence on costly chemical fertilisers.

Reduced Emissions: Halting toxic agricultural residue burning and delivering high-integrity, long-term carbon sequestration in soils.

Mobilised Carbon Finance: Unlocking global voluntary carbon markets and ESG investments to ensure long-term financial sustainability without donor dependence.

Case Study 2: Smart Solar Irrigation

Why Pakistan Needs It

>90%

of Pakistan's freshwater is consumed by agriculture.

Excessive and unregulated groundwater extraction is causing rapid depletion of aquifers, particularly in Punjab and Balochistan.

Climate change- Increase in drought frequency, rainfall variability, and irrigation demand.

Flat electricity tariffs and diesel pumps encourage inefficient water use. Limited real-time monitoring makes groundwater governance difficult.

How the Technology Works

Cloud-based dashboard provides

Remote monitoring,
Automated irrigation scheduling,
Alerts for excessive pumping,
Data analytics for decision-making

IoT sensors monitor:

Soil moisture
Groundwater levels
Water flow
Weather conditions
Pump operation

Solar-powered water pumps reduce dependence on diesel and grid electricity.

Key Benefits include-

Environment

- Efficient Water Resource management
- Mitigate climate effects

Economy & Policy

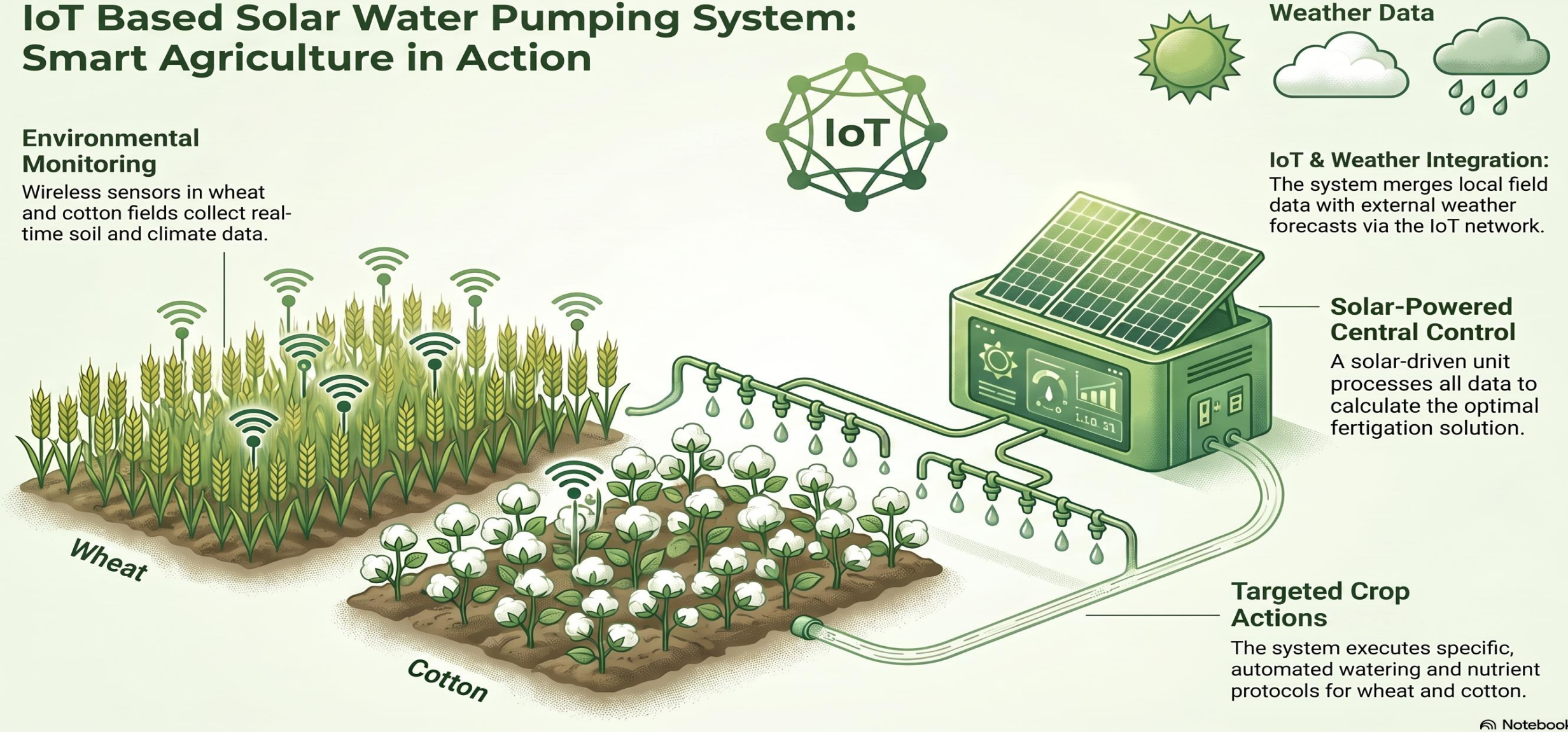
- Significant economic benefits
- Alignment with NAP

Future Capability

- Facilitates digital agriculture
- Precision agriculture techniques

Smart Solar Irrigation: What it Looks Like?

IoT Based Solar Water Pumping System: Smart Agriculture in Action



From technological intervention to strengthening agricultural value chains

- Stakeholder consultation and partners engagement
- Government/NDA ownership
- Proposal development
- Submission to NDA for endorsement and submission to GCF

Picture credits: Dawn newspaper, 2018

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