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Technology Roadmap Workshop - Water

Workshop - May 29, 2024

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List of Abbreviations

ADB	Asian Development Bank
AJK	Azad Jammu and Kashmir
CDA	Capital Development Authority
CTCN	Climate Technology Centre and Network
EPA	Environmental Protection Agency
EWS	Early Warning System
GCF	Green Climate Fund
GCISC	Global Change Impact Studies Centre
GGC	Green Growth Consultants
GGGI	Global Green Growth Institute
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (German Society for International Cooperation)
GLOF	Glacier Lake Outburst Flood
GB	Gilgit-Baltistan
JICA	Japan International Cooperation Agency
KOICA	Korea International Cooperation Agency
KP	Khyber Pakhtunkhwa
M&E	Monitoring and Evaluation
MoCC&EC	Ministry of Climate Change and Environmental Coordination
NDC	Nationally Determined Contribution
PCRWR	Pakistan Council of Research in Water Resources
PPPs	Public-Private Partnerships
PSDP	Public Sector Development Program
R&D	Research and Development
RWH	Rainwater Harvesting
WASH	Water, Sanitation, and Hygiene
WSS	Water Supply System
(E)	Emerging Technology

1. Introduction

Pakistan's NDCs 2021 highlight the need for technology and infrastructure to aid emissions reduction, enhance resilience and adaptive capacity, and support sustainable development. The successful implementation of these commitments requires a collaborative effort, and technological advancements play a crucial role in realizing our climate objectives. To achieve this, the Ministry of Climate Change and Environmental Coordination (MoCC&EC), through the Climate Technology Centre and Network CTCN's technical assistance, has started the development of Pakistan's Technology Roadmap for the waste and water sectors for NDC implementation.

A technology roadmap for NDC implementation is a strategic planning tool that provides a structured approach to identify, prioritize, and sequence the deployment of technologies to address climate change challenges and promote sustainable development. The project is designed to initiate a collaborative process of designing a comprehensive waste and water sector. Technology Roadmap is aligned with Pakistan's development and climate targets. As such, three committees have been formulated to enable data/information sharing, and feedback support for developing a roadmap. These committees include an overarching Roadmap Committee and a technology committee for the waste and water sectors.

The key purpose of the Technical Committees is to ensure alignment with ongoing regulations, plans, and policies, alignment with the needs of multiple stakeholders at national and subnational levels, and to ensure that, the roadmap outlines pathways that are feasible and realistic to accelerate the climate and sustainable development agendas.

The development of the roadmap is under the leadership of the MoCC&EC with support from the Global Green Growth Institute (GGGI) and the Green Growth Consultants (GGC).

2. Objectives

The objective of the first Technology Roadmap Committee meeting was to validate the shortlisted technologies and to finalize a scoring criterion for the analysis of the shortlisted technologies. Moving forward, the aim of this 1-day workshop (3rd Technical Committee meeting & 2nd Technology Roadmap Committee Meeting) was to present the progress of the previous Water and Waste Sector Committee meetings and Technology Roadmap Committee meeting on the water and waste sector technologies and gather feedback on the evaluation of the shortlisted technologies for further prioritization to streamline the development of the NDC technology roadmap for the Water and Waste Sectors.

3. Methodology

The workshop began with a presentation on the NDC Technology Roadmap, providing an overview of sub-sector prioritization, technology shortlisting, and the development of scoring criteria. This session was presented as a key step in evaluating the shortlisted technologies for further prioritization, focusing on four existing technologies and one emerging technology.

A total of 60 participants joined the workshop. The list is attached in **ANNEX-I**. Participants were grouped based on sub-sectors, with discussions on the waste sector held in the morning and the water sector in the evening. These discussions were guided by a questionnaire provided in **ANNEX-II**, focusing on two major components: Enabling Environment and Project Pipeline. The primary focus of the discussions was on the enabling environment. Participants engaged in discussions on sub-sector capacities, and existing and emerging technologies, and provided feedback on the developed technology roadmap outline.

4. Discussion/Outcomes

The discussion was based on two major areas; the first was the enabling conditions or enabling environment for existing and emerging technology adoption in Pakistan, and the second was identifying the projects. The discussion mainly revolved around the enabling environment as the section included more questions and details. The outcomes of the discussion are as follows:

4.1. Enabling Environment

The question for assessing the subsector’s capacities was:

○ Please rank the technology adoption and implementation potential in terms of its subsector’s capacities:

(1-Poor, 2-Fair, 3-Satisfactory, 4-Good, 5-Excellent)

The rankings of the technology adoption as per the subsector’s capacities is given as follows:

	Domestic	Hydropower	Agriculture
Infrastructure	2	3	2
Policy and regulatory landscape	2	3	3
Economic feasibility	2	3	2
Skills and technical capacity	3	3	3
Market and investment opportunities	3	3	3
Social and cultural acceptability	2	3	2

The sub-sector capacities for all domestic, hydropower, and agriculture, were around the **satisfactory and fair rankings**. There might have been fluctuations on an individual level but overall, the rankings revolved around the satisfactory and poor mark for the infrastructure, policy and regulatory landscape, economic feasibility, skills and technical capacity, market and investment opportunities, and social and cultural acceptability indicators.

4.1.1. Domestic

The participants were asked to provide targeted feedback on the technologies selected for the subsectors about enabling environment indicators and suggestions for emerging technologies. Further, the feedback was taken on the outline for the Technology Roadmap.

A) Rainwater Harvesting

The local development departments stressed on to introduce rainwater harvesting in the construction by-laws be it domestic or commercial construction, and it should be thoroughly regulated in all the settlements. Rooftop harvesting is to be introduced in the by-laws. A uniform policy should be included at the provincial level. The participants focused on the enablers to be water pricing so that people should go for RWH. Rainwater harvesting in Desert areas is the way it is done in the Cholistan desert. Media campaigns are to be channeled to reduce the stress on the groundwater source. Regarding Rainwater Harvesting, participants highlighted the necessity for local development departments to incorporate rainwater harvesting into construction by-laws, emphasizing its importance in both domestic and commercial settings. They stressed the need for thorough regulation across all settlements and proposed the introduction of rooftop harvesting into these by-laws. Furthermore, they suggested the implementation of a uniform policy at the provincial level and underscored the role

of water pricing as an enabler to encourage rainwater harvesting adoption, particularly in areas like the Cholistan desert. Media campaigns were also recommended to alleviate stress on groundwater sources.

B) Chlorination

The participants highlighted the following enabling conditions for Chlorination. The replacement of old water lines /pipes with periodic monitoring of WSS and ensuring that 0.5 ppm should be retained by the water until it reaches the user. Water quality testing is to be ensured with the capacity building of the operation/technical staff. Third-party monitoring of the water supply schemes should be a conditionality. The local department needs to focus on watershed management upstream to control water contaminants.

C) Groundwater Aquifer Recharge through Wastewater (E)

The participants agreed this emerging technology will only be successful in Pakistan only if there is strict **monitoring and quality control** over the groundwater and the water that will be used for recharging the aquifer, as the majority of the people in Pakistan rely on the groundwater for drinking purposes. Stakeholders emphasized the **need to use existing infrastructures**, such as dead wells, for groundwater aquifer recharge through wastewater and advocated for increased funding for this purpose. They stressed the importance of thorough and informed policymaking, underpinned by carefully conducted needs assessments. To enhance economic feasibility and affordability, stakeholders suggested that education and awareness efforts would be crucial, along with generating revenue through water pricing. They highlighted the urgent need for technical capacity building to ensure better implementation of the technology, recommending the development of training modules and manuals by relevant authorities.

Stakeholders pointed out that raising public awareness about the harms of untreated water, associated vectors, and water-borne diseases, along with the country's groundwater stress, would foster population acceptance which subsequently materializes into market and investment opportunities. They also emphasized that social and cultural elements should be integral to the implementation process, suggesting that CSOs and NGOs be involved at the community level to create a conducive environment for the technology's adoption. They recommended using existing infrastructures for groundwater recharge and advocated for increased funding. Suggestions included conducting feasibility studies, using treated wastewater for irrigation and horticulture, increasing public awareness, and initiating training sessions for local leadership to promote technology adoption.

4.1.2. Hydropower

For the Hydropower subsector, a similar approach was seen as it was to the Municipal Solid Waste Sector. The discussion was opened by briefing about the existing and emerging technologies, and questions were asked by the group as per the questionnaire. Further, feedback on the outline for the TRM was also taken from the group.

Stakeholders mentioned that the financial barriers hinder funding for hydropower projects, especially in remote areas where price and cost escalation are common. Government-set tariffs dissuade investment, and determining tariffs based on project cost is necessary. **CPPA's reluctance to purchase electricity** at proposed rates suggests involving institutions like GCF to ensure the bankability of hydropower projects and develop a tariff consensus. **Tectonic activity complicates reservoir storage projects**, and government control over all power generation projects limits private sector flexibility. Non-payment of electricity bills by the population complicates private revenue generation, and subsidized electricity rates cause unmet operational costs. Entities connected to the national grid are profitable, but off-grid projects struggle due to non-recoveries. Additionally, there is no permission to

sell to investors for starting data centers, further hampering revenue opportunities. The geopolitical sensitivity of areas like AJK also hampers investment inflows.

There was a detailed combined discussion on the run-off of the river and micro-hydropower plants as the interventions are very similar.

A & B) Run off the river plants & Micro and small hydropower plants

AJK has an existing runoff and micro/small hydropower capacity of 969 MW, with potential for more, indicating a favorable environment. The region boasts a total hydropower potential of up to 7,000 MW, with local capabilities for civil works and a need for technological imports. The topography is well-suited for run-of-the-river plants, and regulations and government support are favorable. **AJK PDO sells electricity to the AJK electricity department**, which then distributes it to users, with a capacity of 30 MW sold to other provinces. A private power cell supports private projects through a one-window operation, with the public sector providing data and the private sector investing under the build-operate-transfer model. The technology is needed and well-received by local communities. **Partnerships with Chinese and European technology firms are in place** for technology imports. The main barriers are financial, as installation costs are high, and limited economic opportunities in the region lead to limited local energy usage. Reservoir hydropower projects also exist, with private sector involvement in reservoir, runoff, and micro/small riverine hydropower projects. An example is medium-sized runoff hydropower projects with private sector investment, **totaling 335 MW of private sector-led generation**. Water use charges are generated by these private power plants.

In GB, **~4,500 MW hydropower projects are being developed by the World Bank** and others, along with a separate 40 MW medium riverine hydropower plant. The province offers a conducive environment for hydropower development. In GB, hydropower is crucial, but issues arise with power **availability in winter**, leading to a consideration of reservoir storage systems by the province for power availability. But such solutions are not acceptable given the environmental challenges they offer; methane emissions, **tectonic activity, landslides, cloud bursts, and microclimate changes**, as seen with **the Neelum Jhelum power plant**. Glaciers in GB feed dams downstream in southern provinces. The area has a suitable environment for hydropower and is accepted by the community. The private sector has conducted feasibilities, and inhabitants rely solely on micro and small hydropower plants, leading to unmet demand and the need for further project development.

C) AI Integrated Remote Sensing and GIS for Water Resource Management (E)

This technology is **well suited given monitoring hydropower sources**, especially glaciers, is crucial in Pakistan for understanding flow and depletion levels. Despite efforts to establish early warning systems, donor proposals, such as those submitted to KOICA, have yet to receive responses. The lack of data on glacial recession hinders planning for hydropower projects, emphasizing the need for this information. **Glacial recession modeling and data are essential** to predict and manage sediment load for hydro projects and water resources. **Frequent Glacier Lake Outburst Flood (GLOF)** events in GB and AJK highlight the need for early warning systems, risk mapping, and assessments. Sediment transport causes operational inefficiencies for hydropower infrastructure, and technologies to manage sediment transport, along with checking dams for controlled water flows, are necessary for better management. Furthermore, these technologies are also important considering they may aid in feasibility studies and identification of potential threats to the water sector; fostering better preparedness.

Based on feedback from the stakeholders, **several measures have been suggested** to ensure an optimal and efficient inclusive environment for the noted technology. Stakeholders emphasized the need for **substantial upgrades to the infrastructure**, recommending the **integration of the latest facilities and global technologies** to enhance and upscale operations, ensuring the system's

robustness and efficiency. There is a consensus that while current policies exist, they require better planning and updates, specifically revised hydropower policies and regulations to accommodate new technologies, thus creating a supportive regulatory framework. Stakeholders stress the importance of timely tariff payments to maintain economic feasibility and suggest that ensuring subsidized electricity can enhance affordability and support the widespread adoption of the technology. Capacity development is a recurring theme in stakeholder feedback; they advocated for organized workshops and seminars to improve efficiency and better understanding of the technology across all levels, which is critical for effective implementation and operation. According to stakeholders, there are abundant market and investment opportunities in regions such as AJK and GB, noting the potential for selling electricity to neighboring countries if the infrastructure is developed appropriately, highlighting significant economic opportunities. While the concept is generally well accepted by the public, stakeholders recommend ongoing awareness campaigns to be a useful tool to promote the justifiable use of electricity and increase familiarity with innovative technologies, ensuring continued social and cultural acceptance.

4.1.3. Agriculture

Similarly, for the agriculture water sub-sector, the discussion was focused on the enabling indicators, followed by the project pipeline, and feedback on the outline for TRM. A stakeholder noted that the current infrastructure, policy, and regulatory environment for the technologies are lacking, despite economic feasibility and investment opportunities being in place.

A) Leaky Dams

Stakeholders suggested **that mini-dams should be constructed for irrigation purposes**. Reducing seepage and conducting rainwater mapping to assess groundwater recharge are essential steps. Leaky dams are particularly needed in regions like KP, Balochistan, and GB, where flooding is an issue. Although no such structures currently exist, they must be developed with the involvement of local communities. This **natural water storage process can be highly effective** in hilly areas when guided by proper mechanisms. There is a significant demand for this technology, and the environment is conducive to its implementation. However, there is no concept of leaky dams or a drainage system in Sindh.

B) Drip Irrigation

Stakeholders recommended implementing enabling conditions, such as **awareness schemes through the MoCC&EC or local governments**, to promote drip irrigation. Data availability supports this initiative. In **Sindh and Punjab, solar subsidies are available to encourage drip irrigation**, and PPPs should be promoted. There are ADP schemes for the solarization of irrigation. However, a lack of funds and backup support deter farmers from adopting this technology. It is essential to provide backup support at the local level. **Agriculture productivity lacks gender sensitivity**, with women being deprived of facilities, **leading to low participation**. Drip irrigation for orchards could involve women and capacity building should be conducted. **Agriculture extension services should be trained** in inclusive development for women. Despite being a good technology, its high-cost limits its widespread use. **Developing the domestic market** could make it more affordable. Feedback from farmers using drip irrigation indicates its potential, but standard specifications need to be automated to achieve higher adoption levels. While drip irrigation is gaining traction in Punjab, it is still used minimally in Sindh.

C) IoT-based Solar Pumps (E)

Stakeholders mentioned potential maintenance issues and the high capital cost of IoT-based solar pumps. Groundwater availability is low, and access is limited, **particularly in Balochistan, where**

groundwater levels have dropped to 500-1000 feet. There is a lack of funds for technology adoption, and regulations for groundwater use are insufficient. Although **Pakistan's Water Policy 2018 exists**, its **implementation is lacking**, with no measures taken by the departments to implement these policies. For instance, in Islamabad, the **CDA can impose fines for excavation beyond 200 feet**, which encourages public compliance. Regulations should also be accompanied by facilitation measures. R&D and demonstrations are needed to attract investment, and incentives should be offered for technology adoption. Regular monitoring of groundwater potential zoning and policy development are crucial. Capacity building for those in power is necessary for technology implementation. International donors can provide financing, and projects are underway to replace diesel with renewable energy. Policies should target sensitive areas.

Further, **stakeholders recommended providing backup support** for running drip irrigation. Although infrastructure exists, there is a lack of service providers due to reliance on imported machinery. Canal leakages should be addressed, and more small-scale drainage infrastructure should be developed. Enabling infrastructure, including easy loans, after-sale services, and technological support, is required. **Policies should be developed for arid regions to adopt drip irrigation** where groundwater is insufficient. Strong regulations and a supportive landscape are needed, including the regularization of groundwater extraction. Government intervention is necessary to develop a regulatory framework and SOPs. Incentives for proper resource utilization should be provided. Promoting PPPs and involving local communities in decision-making and cost-sharing are essential. Farmers' affordability issues could be mitigated by seeking donor agencies. Economic feasibility is not a barrier. Strengthening agriculture extension services and training service providers are crucial. Skills development and technical capacity building must be conducted at the community level, with a focus on enhancing labor productivity and women's involvement. Developing drip irrigation technology locally can reduce costs and create a market. Market and investment opportunities exist and should be tapped in. Raising awareness about the benefits and water-saving aspects of the technology is necessary. Technological acceptance requires education, eco-friendly, and one-window availability solutions should be pursued. Social and cultural acceptability of the technology is also present.

4.1.4. Feedback on Technology Roadmap Outline

Stakeholders emphasized the **need to identify key stakeholders in the water and waste sectors to conduct a thorough needs analysis**. They suggested including experiences from under-developed countries in developing Nationally Determined Contributions (NDCs) and the benefits derived from these efforts. Stakeholders highlighted the importance of identifying implementation mechanisms at both federal and provincial levels, particularly since several ministries, such as agriculture and environment, were dissolved following the 18th amendment. They recommended referencing case studies from agrarian economies as statistical data to provide relevant insights. Additionally, stakeholders noted that macro-level strategies should integrate government initiatives, such as the Green Revolution, to enhance effectiveness. The proposed outline is also attached below (**ANNEX-II**).

4.2. Project Pipeline

Domestic: Participants from Sindh reported on a chlorination project in Karachi, supported by the World Bank, titled "Rehabilitation and Reconstruction of Water Supplies" at multiple locations in the city. The Sindh Environmental Protection Agency (EPA) and Karachi Water and Sewerage Board are responsible for its maintenance and operational procedures. The project underwent technical, social, and economic feasibility assessments before execution and is currently running smoothly without facing any challenges.

From the Pakistan Council of Research in Water Resources (PCRWR), participants from Islamabad

Capital Territory (ICT) identified a pipeline project titled "Management of Wastewater through PublicPrivate Partnership" spanning across the country. This initiative aims to manage wastewater through low-cost sustainable solutions, utilizing wastewater quality monitoring for industrial, domestic, and agricultural water treatment. The project proposal has been submitted to the Planning Commission of Pakistan.

Additionally, participants from Khyber Pakhtunkhwa (KPK) highlighted a drinking water project, "Bulk Gravity-Based Water Supply Mansehra," targeting the Mansehra district. This project involves the implementation of slow sand filter treatment plants and chlorination technology. Despite being funded by a Saudi loan, the project is experiencing delays, as identified by the participants from KPK.

Hydropower: A project for an Early Warning System (EWS) and hydrometer systems in AJK has been submitted to KOICA. GLOF 1 was completed, and GLOF 2 is in progress under ADB, which has set up GLOF offices, wherein the representatives visit glaciers to observe the activity. Further steps from KOICA and other donors are awaited. An AJK River protection plan, including check-dams to minimize sedimentation, has been submitted to the Green Climate Fund (GCF) but faces delays due to a lack of financing. Additional plantation is recommended to limit sedimentation. Several hydro projects are identified for development in AJK, and GB has the 7,000 MW Bhonji Dam in planning, awaiting financial assistance. The Attabad Hydropower and Hunza projects are in the pipeline for 18 MW, with various runoff river projects in GB at different stages of planning and development. A strict policy ensuring revenue from electricity bill payments is needed. Installing hydro-meteorological stations is crucial for resource monitoring and management. Upstream mitigation of climate events benefits downstream areas, as supported by GCISC findings.

The following project was mentioned by one of the stakeholders for the **agriculture water** sector.

Name	Dr. Arshad Ashraf
Job Title	Principal Scientific Officer
Department, Province	PARC, Federal
Contact Number	03235017456
Email	Mashr22@yahoo.com
What sub-sector are you filling it for	Agriculture Water
Title of project	Agriculture smart Technologies for rainfed areas
Brief Description	Introduce water-smart and energy-smart technologies in provinces
What technology has been prioritized?	Drip irrigation, Solar power irrigation, wastewater treatment, rain gun irrigation
Status (has it been completely halted? Was it assessed? Etc.)	Progressing
What was the funding source, if any?	JICA, PSDP
What contributed	N/A
Please note the challenges due to which it was not completed/implemented	N/A

Was a technical/economic/social feasibility or any other analysis conducted	N/A
Do you have access to the documents and/or studies for this project?	N/A
Can you provide us with the documents for the listed project?	N/A

5. Conclusion

The discussion on technology adoption in Pakistan highlighted the need for improved frameworks, strategic policies, and coordinated efforts across sectors. Assessments indicated that capacities in infrastructure, policy, economic feasibility, technical skills, market opportunities, and social acceptability are generally fair to satisfactory, requiring significant improvement.

In the domestic sector, rainwater harvesting and chlorination need regulatory integration, infrastructure updates, and public awareness campaigns, while groundwater aquifer recharge through wastewater shows potential but requires strict monitoring. In hydropower, financial barriers, policy constraints, and technical challenges are primary hurdles, though significant opportunities exist for small and micro-hydropower projects, particularly in regions like AJK and GB.

Agricultural technology adoption, including leaky dams, drip irrigation, and IoT-based solar pumps, faces issues like high costs, lack of funds, and insufficient regulatory enforcement. However, there is potential for improvement through local community involvement, capacity building, and policy enhancements. The project pipeline showcases ongoing efforts and underscores the need for further investment, regulatory support, and technological advancement to achieve sustainable water and energy management in Pakistan.

6. Way Forward

Moving forward, the evaluation of technologies will adhere to the scoring criteria established and validated in previous committee meetings. This thorough assessment will prioritize a selection of five technologies, comprising four existing technologies and one emerging technology. The committee will then validate this prioritized list through detailed consultation.

These prioritized technologies will serve as the foundation for developing the Nationally Determined Contributions (NDC) technology roadmap specifically tailored for the waste and water sectors. This roadmap will outline strategic directions and actionable plans to enhance technological implementation in these areas.

Moreover, to support the advancement of these prioritized technologies, detailed ideas and concept notes will be developed. These documents will aim to secure funding for select projects within the water and waste sectors, ensuring the effective deployment and integration of these critical technologies.

ANNEX-I – Participant List

S. No	Name	Institution/Designation	Gender	Sector
1	Ingvild Solvang	GGGI	F	Development
2	Fazal Akbar	AS (D), (LG&RDD), KP	M	GOV
3	Wasi Haider	R.A (GGC)	M	Development
4	Ayesha Bashir	Adaptation Industries Development Expert	F	Development
5	Tahreem Fatima	R.A (P&D), Sindh	F	GOV
6	Leena Aftab	(GGC)	F	Development
7	Syed Tarrar Hussain	AD (EPA, GB)	M	GOV
8	Tahreem Zeeshan	Manager (GGC)	F	Private
9	Muhammad Asad	F&A Officer	M	Private
10	Niazullah Khan	Consultant	M	Development
11	Muhammad khalid Mehmood	JRO, Rwp, LGRD	M	GOV
12	Kumail Abbas	R.O (GGC)	M	Development
13	Hamza Arshad	R.O (GGC)	M	Development
15	Maham Faraz Abbasi	Consultant	F	Development
16	Muhammad Irshad	WASH Advisor	M	Development
17	Allah Warayo Rindh	Additional Director General, Agri Dept. Sindh	M	GOV

18	Naeema Yousaf	Statistical Officer (PBS)	F	GOV
19	Farah Naz	SRO, PCRWR	F	GOV
20	Obaid-ur-Rehman	MoCC	M	GOV
21	Qurat-ul-Ain Ahmad	Head Water, GCISC	F	GOV
22	Madiha Naz	Assistant Director, MoCC	F	GOV
23	Yasir Bashir	Director (Projects) LG&CDD, Punjab	M	GOV
24	Asadullah Saleem	Sector Specialist, POAF	M	GOV
25	Abdul Rehman Iqbal	Assistant Director, (Technical) Sindh EPA	M	GOV
26	Uzair Naqvi	Environmental Geologist, (PDO), AJK	M	GOV
27	Irfan Khan	Technical Advisor (GIZ)	M	Development
28	Dr. Nasir Javed	Waste Specialist/Consultant	M	Development
29	Abdul Rouf Baloch	Secretary, Local Govt. Balochistan	M	GOV
30	Hameedullah	Sector Advisor WASH-WHH	M	Development
31	Engr. Sardar Khalid Gandapur	Executive Engineer, PHE Manshera	M	GOV
32	Michael Bak	Senior Analyst, CARD	M	Development
33	Shahnawaz Arif	Advocacy Coordinator, WHH	M	Development
34	Usama Iqbal	Finance Coordinator, AGHAE	M	Development

35	Umer Zia	WASH officer Program, AGAHE	M	Development
36	M. Sajid Zaman	Consultant (WASH)	M	Development
37	Saima Nazir	DD (R&P), MoCC	F	GOV
38	Eunkyo Choi	M&E Specialist/ GPC, KOICA	F	Development
39	Irfan Wali	AD, LG&RD (GB)	M	GOV
40	Dr. Khalid Farooq	CSO, PBS	M	GOV
41	Kiran Anwaar	Senior Research Officer, PCRWR	F	GOV
42	Syed Shahneel	Coordination Expert	M	Development
43	Ahsan ullah Khan	CDO, PHED Punjab	M	GOV
44	Pervaiz Nasir	WASH Specialist, WaterAid	M	Development
45	Rizwan Ali	Assistant Chief (Env & CC) P&D Board, Punjab	M	GOV
46	Naheed Rajput	National Water Sector Coordinator, PHED HUD Punjab	F	GOV
47	Dr. Sardar Muhammad Rafique Khan	Deputy Director (CC), EPA-AJK	M	GOV
48	M Nawaz	Staff Officer, LG Balochistan	M	GOV
49	Noor-ul-Huda	AD MoCC	F	GOV
50	Ramsha Malik	AD MoCC	F	GOV
51	Engr. Ubaidullah	Research Officer, PHED KPK	M	GOV
52	Dr. Tariq Mahmood	Meteorologist, PMD	M	GOV

53	Dr. Arshad Ashraf	Principal Scientist, PARC	M	GOV
54	Kamran Khan	Research Officer, EAD	M	GOV
55	Shoukat Ali	I/Tech, EPA Punjab	M	GOV
56	Aqsa Nawaz	Research Assistant, EPA Rawalpindi	F	GOV
57	M Bilal	PM	M	Private
58	Mubarak Ali Sarwar	CEO, AGAHE	M	Development
59	Afsar Khan	Dy. Director, EPA KPK	M	GOV
60	Abdul Qadeer Kakar	Additional Secretary, PHED Balochistan	M	GOV

ANNEX-II – Questionnaire and TRM Outline

Part 1. Enabling Environment and TRM Feedback Enabling

Conditions

- i. Please note the factors and conditions you believe are crucial indicators of a technology’s enabling condition for the water sector, and identified sub-sectors.
- ii. Please rank the technologies’ adoption and implementation potential in terms of its **subsector’s capacities:**
(1-poor, 2-Fair,3-Satisfactory,4-Good,5-Excellent)

	Domestic	Agriculture	Hydropower
Infrastructure			
Policy and regulatory landscape			
Economic feasibility and affordability			
Skills and technical capacity			
Market and investment opportunities			
Social and cultural acceptability			

- iii. In the domestic water sub-sector, please provide your feedback on enabling conditions pertaining to the following technologies:

Rainwater Harvesting	
Chlorination	

- iv. In the agricultural water sub-sector, please provide your feedback on enabling conditions pertaining to the following technologies:

Leaky Dam for water storage	
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Drip irrigation	
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- v. In the hydropower sub-sector, please provide your feedback on enabling conditions pertaining to the following technologies:

Run-off river plants	
Micro and Hydro small power plants	

Emerging Technologies

- i. Please rank the emerging technologies in terms of existing capacities in the sub-sectors that may enable its uptake. (1-poor, 2-Fair,3-Satisfactory,4-Good,5-Excellent)

	Groundwater Aquifer Recharge (Domestic)	Solar Water Pump and Storage Systems (Agriculture)	Remote Sensing and GIS for Water Resource Management (Hydropower)
Infrastructure			
Policy and regulatory landscape			
Economic feasibility and affordability			
Skills and technical capacity			
Market and investment opportunities			
Social and cultural acceptability			

- i. Keeping in mind Pakistan’s enabling environment, which emerging technology do you believe is best suited to be prioritized for Pakistan?
- ii. What measures would you suggest to ensure an optimal and efficient inclusive environment for the noted technology?

Feedback for the Technology Roadmap Map (TRM) Outline

i. Please answer the following in yes/no

Do you believe this outline accurately reflects an inclusive and informed TRM for Pakistan's water/waste sectors?	
The TRM outline is well-organized	
Does this TRM possess a logical flow of information	
The TRM outline includes proposal of interventions to ensure the adoption and implementation of the identified technologies in Pakistan	
I believe my feedback in discussions and surveys will inform the formulation of this TRM	
This TRM reflects an inclusive and gendersensitive assessment of the identified	

ii. Do you have any recommendations and/or additions to the outline?

Part 2. Project Pipeline

The questionnaire table is to be filled out (multiple copies will be provided)

Name	
Job Title	
Department, Province	
Contact Number	
Email	
What sub-sector are you filling it for	
Title of project	
Brief Description	
What technology has been prioritized?	
Status (has it been completely halted? was it assessed? Etc.)	
What was the funding source, if any?	
Please note the challenges due to which it was not completed/implemented	
Was a technical/economic/social feasibility or any other analysis conducted	
Do you have access to the documents and/or studies for this project?	
Can you provide us with the documents for the listed project?	

Part 3 - Proposed Outline for NDC Technology Roadmap For Water And Waste Sectors

1. Introduction and Scenario
 - a. Overview of Pakistan's water and waste sectors
 - i. Existing situation of Pakistan's water/waste sectors
 - ii. Impacts of climate change
 - iii. Management/delivery overview
 - iv. Governance, stakeholders and policies

- v. Main challenges/barriers (technical, social, financial, etc.)
- vi. Overview of technology utilization and adoption in waste/water sectors
- b. Problem statement and purpose of the NDC Technology Roadmap for the water and waste sectors
- 2. Vision
 - a. Vision statement
 - b. Objectives
 - c. Rationale and strategic alignment with NDCs/policies/national strategies
- 3. Methodology
 - a. Development process
 - b. Sector prioritization and emerging/existing technology mapping
 - c. Technology assessment and scoring

4. Assessment of Identified technologies

This section will be given in a summarized form, it can be

1) divided by sectors and sub-sectors,

2) it can also be divided by one section for each technology,

3) Few roadmaps went by process chains as well e.g waste management process chain or water service chain,

4) ANOTHER option is division by existing/emerging categories

- a. Introduce short-listed technologies for each sub-sector
- b. Policy and regulatory framework analysis

Item	Suggestions
Policy and regulatory frameworks	<ul style="list-style-type: none"> • Identification and review of existing policy and regulatory landscape • Identify existing strategies and pathways for integrating waste and water technologies
Associated stakeholder identification and roles	<ul style="list-style-type: none"> • Map and identify stakeholders for the water/waste sectors and identified sub-sectors

c. Technical capacity and infrastructure

Item	Suggestions
Infrastructure	<ul style="list-style-type: none"> • Assessment of existing infrastructure in Pakistan for the noted technologies
Technical assistance and capacity building	<ul style="list-style-type: none"> • Identify if training or advisory support exists for technology integration • Analysis of skills in Pakistan for technology utilization

d. Market Readiness and Economic feasibility

Item	Suggestions
a. Competitiveness	<ul style="list-style-type: none"> Market capacity will be assessed through baseline analysis to assess the integration of new technologies. Consumer based surveys will be conducted to ensure if the incorporated technologies are consumer friendly and efficient.
b. Business opportunities and Analysis	<ul style="list-style-type: none"> Business opportunities for exploring business potential and opportunities Feasibility assessment for the technologies to check if the market conditions are favorable
c. Market, industries and infrastructure	<ul style="list-style-type: none"> Identify existing business potential and opportunities Feasibility assessment for the technologies to check if the market conditions are favorable Does a market exist for the identified technologies Explore-sector based approaches

e. Gender and Social Considerations

Item	Suggestions
Inclusive access	<ul style="list-style-type: none"> The potential of the technology to accelerate access for women and vulnerable groups and promote inclusion will be assessed
Impacts	<ul style="list-style-type: none"> The impacts of the technology on women and vulnerable social groups will be assessed

f. Environmental and climate impacts

This section will assess the environment and climate impacts of technologies and their suitability in the context of Pakistan

5) NDC Technology Roadmap for the Water and Waste Sectors Action Plan

- a. Vision and objectives
- b. Alignment with NDCs
- c. Implementation Plan

This plan will include different actions, can be divided in terms of types of actions e.g. policy/regulations, Market, industry, infrastructure, R&D, mobilization of finance, development of a specific strategy/plan, capacity building and provision of technical support

Action Plan (short-term and long-term) and Milestones	Milestones/Targets	Deadline	Identify stakeholders
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<p>Address short-term and longterm actions to introduce and incorporate proposed technologies in the identified sectors. The implementation will be dependent on timed actions and achievable milestones.</p> <ul style="list-style-type: none"> • 5 years as Short-term action (e.g. Technology: engineered landfill for municipal waste. Short-term action: waste segregation (organic, plastic and non-biodegradable waste is segregated) • 5+ years as long-term actions (Long-term Action: waste to energy and Pollution reduction (land, water and air). 	<p>Associated milestones and/or achievements that aligns with the identified actions</p>	<p>Specific yearly deadline for the identified actions and milestones to be achieved.</p>	<p>Identification of stakeholders relevant to the development and implementation of identified actions and milestones</p>
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6) Alignment with NDCs and National Strategies

This will include an alignment of identified actions and milestones with NDC targets it corresponds/contributes to. It will also include a section on contributions to national strategies.

7) Conclusion