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Carbon Asset Inventory of Khyber Pakhtunkhwa's (KP) Renewable Energy Portfolio

2025

Khyber Pakhtunkhwa

DELIVERABLE 2	
Project Name	Study of Pakhtunkhwa Energy Development Organization's (PEDO) Energy Portfolio for Carbon Markets
Report Title	Carbon Asset Inventory of Khyber Pakhtunkhwa's (KP) Renewable Energy Portfolio
Submitted By	Green Growth Consultants (GGC)
Submitted To	Pakhtunkhwa Energy Development Organization (PEDO)

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List of Abbreviations

ACC – Approved Carbon Credits

ADB – Asian Development Bank

BAP – Biodiversity Action Plan

BHUs – Basic Health Units

BMP – Blasting Management Plan

CAGR – Compound Annual Growth Rate

CDM – Clean Development Mechanism

CERs – Certified Emission Reductions

CO2e – Carbon dioxide Equivalent

CORSIA – Carbon Offsetting and Reduction Scheme for International Aviation

CRSS – Center for Research and Security Studies

DC – During Construction

EIAs – Environmental Impact Assessments

EMMtP – Environmental Management and Monitoring Plan

EMP – Environmental Management Plan

ESA – Environmental and Social Assessment

ESG – Environmental, Social, and Governance

ESMP – Environmental and Social Management Plan

ESTP – Environmental and Social Training Plan

FCDO – Foreign, Commonwealth & Development Office (UK)

GCC – Global Carbon Council

GHG – Greenhouse Gas

GS – Gold Standard

GSC – Global Stakeholder Consultation

GW – Gigawatt

GWh – Gigawatt Hours

HPP – Hydropower Project

HRCP – Human Rights Commission of Pakistan

IDP – Internally Displaced Person

IEE – Initial Environmental Examination

I-RECs – International Renewable Energy Certificates

JICA –Japan International Cooperation Agency

KP – Khyber Pakhtunkhwa

kW/m2/d – kilowatt per meter square per day

LOI – Letter of Intent

LPG – Liquefied Petroleum Gas

LRIP – Livelihood Restoration and Improvement Plan

LSC – local stakeholder consultation

LSG – Lower Spat Gah

MMHPP – Micro and Mini Hydropower Project

MRV – Monitoring, Reporting, and Verification

MW – Megawatt

MWh – Megawatt-hour

MWh/m^2 – Megawatt-hour per mete square

NEQS – National Environmental Quality Standards

NGOs – Non-Governmental Organizations

NOx – Nitrogen Oxides

OP – Operational

PAC – Power Acquisition Contract

PC – Post Construction

PEDO – Pakhtunkhwa Energy Development Organization

PET – Pakistan Environmental Trust

PIC – Project Implementation Consultant

PM_{10} – Particulate Matter 10 micrometers or less

PMO – Project Management Office

PPP – Public-Private Partnership

RAP – Resettlement Action Plan

ROD – Rapid Onset Disaster

SDGs – Sustainable Development Goals

SDP – Social Development Plan

SEED – Sustainable Energy for Economic Development

SMP – Social Management Plan

SO2 – Sulphur Dioxide

SOE – Slow Onset Event

SRSP – Sarhad Rural Support Programme

SSESMP – Site-Specific Environmental and Social Management Plan

TMP – Traffic Management Plan

UC – Under Construction

UD – Under Development

UNFCCC – United Nations Framework for Convention on Climate Change

VCS – Verified Carbon Standard

Executive Summary

The £37.5M UK SEED initiative supports economic growth and sustainable energy in KP, Pakistan, with £15M led by Adam Smith International for strategic urban planning to boost investment and efficiency. Within this initiative, The **Carbon Asset Inventory of Khyber Pakhtunkhwa's Renewable Energy Portfolio** delivers a comprehensive technical analysis of the Pakhtunkhwa Energy Development Organization's (PEDO) energy project portfolio, aiming to position its projects for integration into carbon markets and international renewable energy certificates (I-RECs) with an intention to provide a readiness assessment of PEDO projects for participation in such markets. It evaluates PEDO's existing and planned energy projects, focusing on their readiness for certification and alignment with international standards such as Verra, Gold Standard, Global Carbon Council (GCC), and I-RECs. The report also assesses their potential to deliver environmental and social co-benefits, identifies key strengths and challenges, and highlights market eligibility barriers.

In addition, it provides actionable recommendations to enhance project compliance, operational efficiency, and stakeholder engagement, ensuring that PEDO's projects meet the criteria for participation in carbon markets and I-RECs while maximizing their sustainable development impact.

PEDO's project portfolio primarily includes hydropower and solar initiatives, reflecting the rich renewable resource base of Khyber Pakhtunkhwa (KP). KP's energy landscape is marked by a substantial potential of 25 GW for hydropower generation and approximately 0.63 million MW for solar power. Despite this vast resource potential, only a fraction has been harnessed, presenting a significant opportunity for growth. PEDO currently operates 2,632 MW of hydropower and 302 MW of solar power projects, which have the capacity to play a crucial role in Pakistan's renewable energy trajectory. A breakdown of operational, and future hydropower and solar PV capacity is provided hereunder. However, to realize the full potential of these resources, the projects must meet rigorous international standards, which includes achieving eligibility for carbon credits under recognized mechanisms such as Verra, the Gold Standard, and I-RECs.

Category	Source	Total Capacity (MW)
Current Operational Projects	Hydropower	173.72
	Solar Power	14.29
Future Projects	Hydropower	825.388
	Solar Power	38.32
Private Sector Projects (Including 470MW LSG in PPP)	Hydropower	1633.31
	Solar Power	249.5
Grand Total		**2,934.528**

The analysis conducted in this report is carefully structured around a set of key criteria designed to ensure that PEDO's projects meet high standards of eligibility, viability, and operational effectiveness within the carbon markets and International renewable energy certificates (I-RECs) systems. The process followed in assessing the PEDO's projects portfolio for carbon markets, and I-RECs included alignment with prominent carbon standards like Verra, Gold Standard, GCC, and I-RECs to ensure credibility and sustainability for carbon credit issuance and climate finance,

project eligibility against the standards, permanence, technical viability, social and environmental safeguards, and robust **Monitoring, Reporting, and Verification (MRV)** systems to guarantee accurate emissions tracking. Special emphasis is placed on projects with high co-benefits, such as poverty alleviation and energy access, which align with broader sustainability goals and increase carbon market eligibility. The assessment process aligns with international standards, principles, and best practices that require demonstrating project credibility, transparency, and eligibility for carbon credits, facilitating successful entry into carbon markets.

The **Standard Conformance** is a primary criterion in this assessment. Each project included in the PEDO's portfolio is evaluated against the eligibility criteria established by prominent voluntary carbon standards, such as Verra, Gold Standard, and the Global Carbon Council (GCC), along with I-RECs. This involves verifying the project type and compatibility with the target carbon market. This conformance ensures that PEDO's projects align with internationally recognized protocols for carbon credit issuance and I-RECs. Compliance with these standards is critical for securing certification and attracting climate finance, as it signals to investors and stakeholders that the projects are both credible and environmentally sustainable.

The **Project Screening** is undertaken as a selective process that identifies projects deemed eligible for participation in the carbon markets or I-RECs. This screening process is based on an analysis of each project's capacity to meet market requirements and eligibility standards, ensuring that only the most viable projects are put forward for certification and potential investment. This includes determining project eligibility through baseline emissions and additionality assessment. The **permanence and risk assessment** help evaluate potential reversibility risks that could undermine the project's carbon benefits. It also helps evaluate that the project will physically exist throughout the life at its location and emissions reduction benefits as claimed, will remain measurable and verifiable.

Technical Viability is another essential criterion, involving an in-depth assessment of each project's technical foundation. This includes the **social and environmental performance analysis** to observe how the *projects contributed to improving the baseline plus the areas where they fall short considering the requirements of carbon markets*. The carbon markets require that the projects must adhere to the social and environmental safeguards and do not harmfully impact the ecosystem or water resources at project sites. The potential social impacts and community participation processes are crucial for compliance of the projects with sustainability guidelines as per the carbon market standards. Typically, the development of an emission reduction-centric approach is recommended for each project, given its direct relevance to the carbon market, however, the report identifies opportunities within PEDO's portfolio, especially among community-focused micro-hydropower and solar projects, which offer substantial social and environmental benefits beyond emission reductions. These projects can contribute to poverty alleviation, improved health outcomes, and enhanced energy access, aligning with both national and global sustainability goals. Recognizing these opportunities, the report emphasizes the importance of prioritizing projects that demonstrate high potential for co-benefits and additionality, which are critical criteria for carbon credit eligibility.

The robust **MRV** framework is essential to accurately track and report emissions reductions. Effective MRV involves detailed monitoring protocols, periodic reporting, and third-party verification to ensure transparency and accuracy. The co-benefits assessment of the projects helps evaluate the quality of the project and their ability to meet multiple development goals such as energy access and job creation.

The report expands separately on I-RECs informing on their ability to reduce Scope 2 emissions of an entity by providing evidence of renewable electricity generation. Acquiring these certificates are crucial for organizations adhering to global frameworks like **RE100** and **SBTi**, which require alignment between the country of electricity consumption and I-REC generation. This alignment not only ensures the credibility of sustainability claims but also promotes local renewable energy markets by encouraging investment in projects within Pakistan.

It continues to state the eligibility of the complete portfolio for this mechanism given they are producing clean energy in MWh. It informs on the difficulty of selling certificates generated from older projects. While these certificates can contribute to minimizing scope 2 emissions of an entity, the units claimed for I-RECs cannot be claimed for carbon crediting initiatives as that would lead to double counting. It also clarifies on process of issuance of I-RECs in Pakistan through the I-TRACK accredited entity, i.e. Pakistan Environment Trust (PET).

In addition, the report also identifies **Challenges** in complying with the requirements as stated in relevant standards and suggests **Mitigation Options**. Through this lens, it identifies potential hurdles that could impede the projects' success.

A thorough assessment of PEDO's portfolio reveals that while some projects exhibit readiness for carbon crediting and I-RECs, there are challenges related to data availability, regulatory compliance, and operational inefficiencies. Assessing the current operational hydropower in the realm of carbon markets reveals that all the operational projects are ineligible under these markets since on-grid projects are not eligible under Verra, and Gold Standard has 5% capacity cap for RE resource. Reshun is off grid, but it was not developed as per the conformity requirements of carbon market standards making it ineligible for both standards. The operational projects are also ineligible under GCC since more than one year has passed since the start of project operations.

For future operational hydropower, on-grid projects are ineligible for both Verra and Gold Standard, as Verra excludes on-grid projects and Gold Standard has 5% capacity cap for Renewable Energy (RE) resource. However, mujahideen as an off-grid candidate, qualifies for both standards in this category. GCC, on the other hand, provides a window of participation to the all the future operational hydropower projects under its "A" category.

Regarding the off-grid portfolio, 316 MMHPPs and current operational solar projects, particularly those serving off-grid communities, could have established a better alignment with carbon market standards as proving additionality and substantial social co-benefits is comparatively easier. However, these PEDO projects also face eligibility barriers due to a lack of permanency, limited historical data, and insufficient documentation. Whereas the future operational solar projects and 140 MMHPPs serving the remote communities, the projects are eligible as per Verra and Gold Standard and may qualify if they meet strong documentation requirements for additionality, environmental and social safeguards, and MRV.

Private sector future hydropower portfolio is ineligible for Verra and Gold Standard given the aforementioned reason whereas, it is eligible under GCC. Private sector future solar PV portfolio on the other hand is ineligible under Verra as an on-grid candidate, whereas these projects qualify for Gold Standard and GCC as solar PV is currently within the 5% capacity cap for RE resource and GCC include Solar PV as qualifying RE technology. However, these projects require more rigorous documentation, particularly for large-scale initiatives, to demonstrate additionality, community benefits, and minimal environmental impact.

At the same time, the PEDO portfolio assessment reveals that all the projects are eligible to participate and earn I-RECs. However, to claim I-RECs, the projects need to comply with the registration requirements, ownership, documentation and reporting and I-REC issuance requirements as stated in the standard.

Projects lacking sufficient data are excluded from further analysis, while those under construction are given the flexibility to meet data requirements for future prospects, ensuring alignment with relevant carbon market standards. Moreover, some projects are impacted by community-level challenges, such as land disputes and social conflicts, which have delayed implementation timelines and compromised project outcomes. Key projects like the Karora and Jabori hydropower plants have experienced delays due to local conflicts. These projects can enhance their viability for participation in the carbon markets through effective stakeholder engagement, enforcing conflict resolution strategies and demonstrating community participation, environmental and social integrity and co-benefits.

Another challenge noted in the report is the absence of robust Monitoring, Reporting, and Verification (MRV) systems across many projects. MRV systems are essential for tracking greenhouse gas (GHG) emissions reductions and ensuring transparency in environmental and social impact assessments. The current gaps in MRV have impeded PEDO's ability to present accurate data, affecting the credibility and market alignment of its projects. Additionally, several projects located in sensitive ecological zones, such as the Gabral Kalam hydropower project, must adhere to stricter environmental standards to avoid net environmental harm. This is crucial not only for compliance with global environmental benchmarks but also for sustaining the trust of local communities and project stakeholders.

The report advocates for prioritizing projects with substantial emission reduction potential and high social impact. By focusing on initiatives that maximize carbon reduction benefits while also addressing local socioeconomic needs, PEDO can create a portfolio that is both environmentally and socially sustainable. Meaningful engagement with local communities is essential to this strategy, as it enhances project acceptance, mitigates conflict risks, and ensures that project benefits are widely shared. This approach aligns with the principles of equitable climate action, which emphasize the importance of inclusive development in achieving sustainability objectives. A dashboard presenting the key analysis and project details is provided hereunder this summary.

To address the identified challenges, the report recommends several strategic actions. First, implementing robust MRV systems across PEDO's portfolio is essential for compliance with carbon crediting requirements and enhancing market credibility. A comprehensive MRV framework would include emissions tracking, lifecycle impact assessments, and adherence to Environmental, Social, and Governance (ESG) standards. Enhanced MRV capabilities will not only strengthen project data accuracy but also provide a reliable foundation for future project certifications.

Second, the report underscores the need for a concerted effort to improve data collection and transparency. To enhance the eligibility of PEDO's projects for carbon certification, it is essential to improve data transparency related to project generation, environmental impacts, and social outcomes. This will ensure that each project meets the rigorous requirements of certification standards. By addressing data gaps, particularly for older projects that lack historical information, PEDO can better demonstrate the environmental and social benefits of its initiatives and make a stronger case for carbon credits. By establishing clear protocols for data management and reporting, PEDO can improve the market readiness of its projects, attract

climate finance, and foster investor confidence. The availability of reliable data will also enable PEDO to pursue multiple certification standards, expanding the scope for market participation.

PEDO should focus on projects with substantial emission reduction potential and clear additionality. This means prioritizing projects that are not financially or technically feasible without the support of carbon finance. By targeting projects that generate meaningful emissions reductions and demonstrate that they would not proceed without carbon credits, PEDO can strengthen its position in the carbon markets and meet key eligibility criteria. To increase project value and acceptance in the market, PEDO should prioritize projects that deliver significant social and environmental co-benefits, such as poverty alleviation, improved health outcomes, and energy access for communities. Smaller hydropower and community-scale solar projects align most closely with the requirements of standards like Verra, Gold Standard, and GCC, which emphasize community impact and sustainable development. PEDO should prioritize these distributed and community-based projects for certification, as they are more likely to meet eligibility criteria and have the potential to generate high social and environmental returns. Engaging stakeholders and involving local communities in project planning and implementation will further strengthen these benefits, making PEDO's projects more attractive to investors who value sustainable development goals (SDGs).

Moreover, the report includes detailed **Challenge Mitigation Options**. It identifies the critical challenges associated with implementing these projects within the carbon markets and suggests targeted mitigation strategies aimed at overcoming or minimizing these obstacles. By addressing these challenges in advance, PEDO is better positioned to ensure the successful and sustainable execution of its projects, maximizing both environmental impact and market potential. This proactive approach is intended to equip PEDO with practical solutions that can be employed to navigate the complexities of carbon market participation and optimize project outcomes. These outcomes collectively support PEDO's mission to advance renewable energy initiatives within Pakistan while actively participating in global carbon markets.

Climate resilience emerges as another key theme in the report. With a growing frequency of climate-induced events, such as floods and heatwaves, the report stresses the importance of integrating climate-resilient design into PEDO's project planning and execution. Projects located in vulnerable areas should incorporate predictive modeling and geological assessments to mitigate the risks associated with natural disasters. By adopting resilience measures, PEDO can safeguard its projects against climate risks, reduce operational disruptions, and strengthen its contribution to climate adaptation goals. A list of eligible and ineligible projects is as tabulated below:

Project Name	Eligibility				Comments
	Verra	Gold Standard	GCC	I-REC	
Current Operational Large Hydropower Plants					
Malakand III	Not Eligible	Not Eligible	Not Eligible	Eligible	On-Grid Projects not eligible for Verra, Gold Standard has 5% capacity cap for RE resource, Not Eligible under GCC since more than one year has passed since the start of project operations.
Daral Khwar	Not Eligible	Not Eligible	Not Eligible	Eligible	
Pehur	Not Eligible	Not Eligible	Not Eligible	Eligible	

Project Name	Eligibility				Comments
	Verra	Gold Standard	GCC	I-REC	
					As the projects do not qualify for any carbon market, PEDO may immediately take steps for registration of these projects for IRECs
Current Operational Small and Mini Hydropower Plants					
Shishi	Not Eligible	Not Eligible	Not Eligible	Eligible	On-Grid Projects not eligible for Verra, Gold Standard has 5% capacity cap for RE resource, Reshun is off-grid but it was not developed as per the conformity requirements of carbon market standards, Not Eligible under GCC since more than one year has passed since the start of project operations. As the projects do not qualify for any carbon market, PEDO may immediately take steps for registration of these projects for IRECs.
Machai	Not Eligible	Not Eligible	Not Eligible	Eligible	
Reshun	Not Eligible	Not Eligible	Not Eligible	Eligible	
Current Operational Micro Hydropower Plants					
316 MMHPPs	Not Eligible	Not Eligible	Not Eligible	Eligible	Not Eligible under GCC since more than one year has passed since the start of project operations, for other two standards, the requirements cannot be met as these are neither greenfield projects, nor rehabilitation projects. Registration for I-REC can be considered but would be a challenge since projects are handed over to the community and data is not maintained. However, recommendations at Table 18 in this

Project Name	Eligibility				Comments
	Verra	Gold Standard	GCC	I-REC	
					regard may be considered.
Current Operational Solar PV Installations					
Electrification of 100 Villages Through Solar/Alternate Energy Phase-I.	Not Eligible	Not Eligible	Not Eligible	Eligible	Not eligible for any carbon market as these are older Projects Ownership handed over to the community. No evidence of electricity generation data and plant performance details maintained. Rehabilitation of these projects is not under discussion. . Registration for I-REC can be considered but would be a challenge since projects are handed over to the community and data is not maintained. however, recommendations at Table 18 in this regard may be considered.
Electrification of Un-Electrified Villages Solar/Alternate Energy Phase II (I&II).	Not Eligible	Not Eligible	Not Eligible	Eligible	
Solarization of Civil Secretariate.	Not Eligible	Not Eligible	Not Eligible	Eligible	
Solarization of Chief Minister's Secretariat/ Chief Minister's House.	Not Eligible	Not Eligible	Not Eligible	Eligible	
Solar Electrification of 4000 Masajid in Khyber Pakhtunkhwa.	Not Eligible	Not Eligible	Not Eligible	Eligible	
Solar Electrification of 300 Masajid/Worship Places of Non-Muslims in merged Districts of Khyber Pakhtunkhwa.	Not Eligible	Not Eligible	Not Eligible	Eligible	
Solarization of Masajid in District Swat and 440 Masajid in District Peshawar.	Not Eligible	Not Eligible	Not Eligible	Eligible	
Solarization of Masajid in merged Districts of KP (AIP).	Not Eligible	Not Eligible	Not Eligible	Eligible	
Future Operational Large Hydropower Plans					
Gorkin Matiltan	Not Eligible	Not Eligible	Eligible	Eligible	On-Grid Projects not eligible for Verra, Gold Standard has 5% capacity cap for RE resource. GCC and I-REC can be considered for registration. However, recommendations at Table 17, 18 in this
Koto	Not Eligible	Not Eligible	Eligible	Eligible	
Lawi	Not Eligible	Not Eligible	Eligible	Eligible	
Balakot	Not Eligible	Not Eligible	Eligible	Eligible	
Gabral Kalam	Not Eligible	Not Eligible	Eligible	Eligible	
Madyan	Not Eligible	Not Eligible	Eligible	Eligible	
Ranolia	Not Eligible	Not Eligible	Eligible	Eligible	

Project Name	Eligibility				Comments
	Verra	Gold Standard	GCC	I-REC	
					regard may be considered.
Future Operational Small and Mini Hydropower Plans					
Karora	Not Eligible	Not Eligible	Eligible	Eligible	On-Grid Projects not eligible for Verra, Gold Standard has 5% capacity cap for RE resource. GCC and I-REC can be considered for registration n. To improve its viability, the recommendations in Table 17, 18 may be considered.
Jabori	Not Eligible	Not Eligible	Eligible	Eligible	
Chapri Charkhel	Not Eligible	Not Eligible	Eligible	Eligible	
Mujahideen	Eligible	Eligible	Eligible	Eligible	Can be potential carbon market project under all markets including IRECs. To improve its viability, the recommendations in Table 15, 16, 17, 18 may be considered.
Total Future Operational Micro Hydropower Plans					
140MMHPPs	Eligible	Eligible	Eligible	Eligible	Can be potential carbon market project under all markets including IRECs. To improve its viability, the recommendations in Table 15, 16, 17, 18 may be considered.
Total Future Hydropower Plants		825.388			
Future Operational Solar PV Installations					
Solarization of 8000 Schools & 187 BHUs	Eligible	Eligible	Eligible	Eligible	Can be potential carbon market project under Verra, Gold Standard and GCC. These can also register for I-RECs. To improve its viability, the recommendations in Table 15, 16, 17, 18 may be considered.
Solarization of Masajid & Worship Places of Khyber Pakhtunkhwa.	Eligible	Eligible	Eligible	Eligible	
Solarization of 2000 Masajid in Merged Areas (AIP)	Eligible	Eligible	Eligible	Eligible	
Solarization of Schools in Merged areas (AIP)	Eligible	Eligible	Eligible	Eligible	
Solarization of Houses in Various UCs of	Eligible	Eligible	Eligible	Eligible	

Project Name	Eligibility				Comments
	Verra	Gold Standard	GCC	I-REC	
PK- 88 of District Bannu.					
Solarization of Masajid/ Janazgah/ Eid-Gah in various UCs of District Torghar. (DDP)	Eligible	Eligible	Eligible	Eligible	
Future Operational IPP Based Hydropower Plants					
Kalam Asrit HPP	Not Eligible	Not Eligible	Eligible	Eligible	On-Grid Projects not eligible for Verra, Gold Standard has 5% capacity cap for RE resource. GCC and I-REC can be considered for registration. However, recommendations at Table 17, 18 in this regard may be considered.
Asrit Kedam HPP	Not Eligible	Not Eligible	Eligible	Eligible	
Sharmai HPP	Not Eligible	Not Eligible	Eligible	Eligible	
Shigo Kas HPP	Not Eligible	Not Eligible	Eligible	Eligible	
Arkari Gol HPP	Not Eligible	Not Eligible	Eligible	Eligible	
Gabral Utror HPP	Not Eligible	Not Eligible	Eligible	Eligible	
Artistic-1 HPP	Not Eligible	Not Eligible	Eligible	Eligible	
Shalfalam HPP	Not Eligible	Not Eligible	Eligible	Eligible	
Artistic-2 HPP	Not Eligible	Not Eligible	Eligible	Eligible	
Bankhwar HPP	Not Eligible	Not Eligible	Eligible	Eligible	
Nila Da Katha HPP	Not Eligible	Not Eligible	Eligible	Eligible	
Lower Spat Gah	Not Eligible	Not Eligible	Eligible	Eligible	
Future Operational Private Sector Small Hydropower Plants					
Daral Khwar-II HPP	Not Eligible	Not Eligible	Eligible	Eligible	On-Grid Projects not eligible for Verra, Gold Standard has 5% capacity cap for RE resource. GCC and I-REC can be considered for registration. However, recommendations at Table 17, 18 in this regard may be considered.
Balkani HPP	Not Eligible	Not Eligible	Eligible	Eligible	
Future Operational Private Sector Solar PV Powe Plants					
Kulachi, DI Khan	Not Eligible	Eligible	Eligible	Eligible	On-Grid Projects not eligible for Verra. However, these projects qualify for Gold Standard and GCC as solar PV is currently within the 5% capacity cap for RE resource, and GCC include Solar PV as qualifying RE technology. These projects can also register for I-REC. However, recommendations at Table 16, 17, 18 in this regard may be considered.
Kulachi, DI Khan	Not Eligible	Eligible	Eligible	Eligible	
Paharpur, DI Khan	Not Eligible	Eligible	Eligible	Eligible	
Nowshera Solar PV	Not Eligible	Eligible	Eligible	Eligible	
Kohat Solar PV	Not Eligible	Eligible	Eligible	Eligible	

The analysis then examines the emission reduction potential and the expected certificates to be generated by all shortlisted projects. It calculates emission avoidance based on the anticipated generation output of each project, using the emission factors for solar and hydropower. Whereas the I-RECs are calculated based on the anticipated energy generation only. However, not all the projects can be taken forward in carbon markets given some are ineligible for registration and would not be able to generate credits out of this avoidance. This detail is as tabulated below:

Category	Anticipated Generation (GWh)	Tentative Annual Emission Avoidance (tCO2)	Annual I-RECs (MWh)
Current Operational Solar Power	18.97	0	18,967.40
Future Operational Solar Power	50.35	30,161.38	50,352.90
Current Operational Hydropower	963.84	0	963,835.80
Future Operational Hydropower	3,635.66	1,788,742.75	3,635,656.00
Private Sector Hydropower Projects (Including 470MW LSG in PPP)	6,836.48	3,363,547.67	6,836,569.00
Private Sector Solar Power Projects	398.40	238,641.60	398,400.00
Grand Total	**11,903.7**	**5,421,093.4**	**11,903,781.1**
***The baseline emission reduction potential for hydropower projects is taken as 0.492tCO2e/MWh and for solar 0.599tCO2e/MWh for Carbon Credits ** The units claimed for I-RECs cannot be claimed for carbon crediting initiatives as that would lead to double counting.**			

The report concludes with a roadmap for advancing PEDO's energy projects toward market readiness and sustainability. This includes conducting a detailed assessment of shortlisted projects. The report provides a prioritized list of projects as provided hereunder that have passed the screening process. By aligning these projects with global standards, PEDO can position itself as a leader in Pakistan's renewable energy sector, attract investment, and unlock new revenue streams through carbon credits and I-RECs.

KEY FINDINGS AND RECOMMENDATIONS BOX

Key Findings	
Renewable Energy Potential	KP has substantial renewable energy resources (25 GW hydropower, 0.63 million MW solar) with only a fraction currently tapped.
Eligibility Challenges	Limited data availability, operational inefficiencies, and alignment with international MRV standards restrict project eligibility for global carbon credits.
Preventing Double Counting	The project can claim the carbon credits under only one standard. Also, the electricity units claimed for I-RECs cannot be claimed under carbon crediting mechanisms.
Social and Environmental Impact	Current projects face challenges related to climate resilience, stakeholder engagement, and social acceptance, which impact eligibility and long-term sustainability.
Shortlisted Candidates	The assessment concludes that:

	1. The complete PEDO portfolio is eligible for taking forward into I-RECs. However, only operational projects may be taken to IRECS as they are ineligible for Carbon Markets. Amongst them the six operational projects Machai, Malakand-iii, Daral Khuwar, Reshun (subject to availability of data as it is off-grid), Pehur, Shishi are ready to be taken to the IRECs market. The MMHP and solar operational projects which are handed over to the community may not be readily available to take to the IRECs. 2. Regarding Carbon markets, the details of eligible projects against different standards are as follows: **Verra:** Mujahideen 6.95 MW HPP, 140 MMHPPs and Future Operational Solar **Gold:** Mujahideen 6.95 MW HPP, 140 MMHPPs, Future Operational Solar and Future Private Solar Projects **GCC:** All Future Operational Hydropower and All Future Operational Solar Power Projects
Key Recommendations	
Bridge Data Gaps	Improve data transparency on generation, environmental, and social impacts to meet carbon standards.
Strengthen MRV Systems	Implement robust MRV frameworks to enhance compliance and credibility in global markets.
Prioritize Emission Reduction and Additionality	Focus on projects with strong emission reduction outcomes and additionality to boost market eligibility.
Enhance Social and Environmental Co-Benefits	Engage stakeholders and prioritize community benefits to strengthen project acceptance and market value.
Prioritizing projects for carbon markets/I-RECs	List of prioritized energy projects towards market readiness provided for further analysis, focusing on compliance with global standards to enhance investment potential and revenue through carbon credits and I-RECs. Distributed and community based-projects can be focused as these align with the requirements of standards.
Enhance Data and Documentation Practices	PEDO to ensure establishing data collection and documentation practices to ensure compliance with the standards, MRV and ESG requirements.
Capacity Building of PEDO Professionals	Ongoing capacity-building for PEDO's teams through training, knowledge-sharing, and partnerships to navigate carbon crediting and I-REC certification complexities effectively.

The report recommends continuous capacity-building for PEDO's teams to ensure that they are well-equipped to handle the complexities of carbon crediting and I-REC certification processes. Investing in knowledge-sharing initiatives, technical training, and partnerships with international organizations can help PEDO navigate regulatory landscapes, adopt best practices, and maintain compliance with evolving market requirements.

This Report provides PEDO with a strategic pathway to maximize the climate and social impacts of its energy portfolio. By addressing the identified challenges, implementing the recommended measures, and adopting a proactive approach to climate resilience, PEDO can significantly contribute to Pakistan's renewable energy ambitions. This report not only serves as a guide for

enhancing PEDO's project readiness but also underscores the broader role that energy organizations can play in driving sustainable development and climate action.

Project Name	Location	Project Capacity (MW)	Grid Detail	Calculated Annual Generation by PEDO (GWh)*	Capacity Factors by PEDO*	Annual Emission Avoidance (tCO2)	Eligibility under Carbon Markets	Annual I-RECs (MWh)	Eligibility Under I-RECs	Comments
Currently Operational Large Scale Hydropower Projects										
Malakand III	Dargai, Malakand	81	On-Grid	549.909	77.5%	270,555.23	Ineligible	549,909	Eligible	On-Grid hydropower projects are ineligible as per Verra while the standards like Gold Standard limit the projects depending upon their share in electricity mix. For GCC, operational projects with a start of operation date exceeding one year are ineligible for participation. As the projects do not qualify for any carbon market, PEDO may immediately take steps for registration of these projects for IRECs
Daral Khwar	Behrain, District Swat	36.6	On-Grid	154	48%	75,768.00	Ineligible	154,000	Eligible	
Pehur	Road No. L-1, Gadoon Amazai, Distt. Swabi, KP.	18	On-Grid	57.7	37%	28,388.40	Ineligible	57,700	Eligible	
Total		135.6	3 x On-Grid	761.609	-	374,711.63	Ineligible	761,609	Eligible	
Currently Operational Medium Scale Hydropower Projects										
Shishi	Shishi, Tehsil Drosh, District Lower Chitral	1.8	On-Grid	4.1	26%	2,017.2	Ineligible	4,100	Eligible	On-Grid hydropower projects are ineligible as per Verra while the standards like Gold Standard limit the projects depending upon their share in electricity mix. For GCC, operational projects with a start of operation date exceeding one year are ineligible for participation. These are older projects. Reshun is off-grid but it was not developed as per the conformity requirements of carbon market standards As the projects do not qualify for any carbon market, PEDO may immediately take steps for registration of these projects for IRECs
Machai	Alo, Mardan	2.6	On-Grid	15.784	69%	7,765.73	Ineligible	15,784	Eligible	
Reshun	Reshun Gol, District Upper Chitral	4.8	Off-Grid	13.45	32%	6,617.4	Ineligible	13,450	Eligible	
Total		9.2	2 x On-Grid, 1 x Off-Grid	33.334	-	16,400.33		33,334		
Currently Operational MMHPPs										

Project Name	Location	Project Capacity (MW)	Grid Detail	Calculated Annual Generation by PEDO (GWh)*	Capacity Factors by PEDO*	Annual Emission Avoidance (tCO2)	Eligibility under Carbon Markets	Annual I-RECs (MWh)	Eligibility Under I-RECs	Comments
316 MMHPPs	Varies	28.92 (Cumulative)	316 x Off-Grid	168.893	67%	83,095.26	Ineligible	168,893	Eligible	These are older projects Ownership handed over to the community Rehabilitation of these projects is not under discussion and hence ineligible for Carbon markets These can be candidate projects for I-RECs, however, registration requirements, ownership, documentation, data management, monitoring and reporting mechanism needs to be in place for claiming IRECs.
Total Operational Hydropower		173.72	5 x On-Grid 317 x Off-Grid	963.836	-	474,207.21		963,836		
Currently Operational Community Scale Solar Power Projects										
Electrification of 100 Villages Through Solar/Alternate Energy Phase-I.	Central & Southern Districts	0.87	Off-Grid	1.155	15%	691.85	Ineligible	1,155	Eligible	These are older projects Ownership handed over to the community Rehabilitation of these projects is not under discussion and hence ineligible for Carbon markets These can be candidate projects for I-RECs, however, registration requirements, ownership, documentation, data management, monitoring and reporting mechanism needs to be in place for claiming IRECs.
Electrification of Un-Electrified Villages Solar/Alternate Energy	District Chitral	0.85	Off-Grid	1.1313	15%	677.65	Ineligible	1,131	Eligible	

Project Name	Location	Project Capacity (MW)	Grid Detail	Calculated Annual Generation by PEDO (GWh)*	Capacity Factors by PEDO*	Annual Emission Avoidance (tCO2)	Eligibility under Carbon Markets	Annual I-RECs (MWh)	Eligibility Under I-RECs	Comments
Phase II (I&II).										
Solarization of Civil Secretariate.	District Peshawar	0.49	On-Grid	0.6515	15%	390.25	Ineligible	652	Eligible	
Solarization of Chief Minister's Secretariat/ Chief Minister's House.	District Peshawar	0.38	On-Grid	0.5044	15%	302.14	Ineligible	504	Eligible	
Solar Electrification of 4000 Masajid in Khyber Pakhtunkhwa.	All Settled Districts	7.38	Off-Grid	9.7869	15%	5,862.35	Ineligible	9,787	Eligible	
Solar Electrification of 300 Masajid/Worship Places of Non-Muslims in merged Districts of Khyber Pakhtunkhwa.	Districts Khyber, Bajaur Mohmand, Kurram, Orakzai NW & SW	0.53	Off-Grid	0.7035	15%	421.4	Ineligible	704	Eligible	
Solarization of Masajid in District Swat and 440 Masajid	District Swat & District Peshawar	2.59	Off-Grid	3.4386	15%	2,057.72	Ineligible	3,439	Eligible	

Project Name	Location	Project Capacity (MW)	Grid Detail	Calculated Annual Generation by PEDO (GWh)*	Capacity Factors by PEDO*	Annual Emission Avoidance (tCO2)	Eligibility under Carbon Markets	Annual I-RECs (MWh)	Eligibility Under I-RECs	Comments
in District Peshawar.										
Solarization of Masajid in merged Districts of KP (AIP).	Districts Khyber, Bajaur Mohmand, Kurram, Orakzai NW, SW FR Lakki, FR Bannu, FR Peshawar, FR Tank, FR DI Khan FR Kohat	1.2	Off-Grid	1.5952	15%	955.52	Ineligible	1,595	Eligible	
Total Operational Solar Power		14.29	6 x Off-Grid 2 x On-Grid	18.966	15%	11,360.87		18,966		
Future Operational Large-Scale Hydropower Projects										
Gorkin Matiltan	Kalam, Tehsil Bahrain, District Swat	84	On-Grid	346	47%	170,232	Eligible (GCC)	346,000	Eligible	On-Grid hydropower projects are ineligible as per Verra, while the standards like Gold Standard limit the projects depending upon their share in electricity mix. However, they are eligible for GCC. To take these projects to the GCC market a comprehensive mechanism to document, monitor and report the impact of the project on ecosystem, local community and co-benefits would need to be put in place. These can also be candidate projects for I-RECs; however, data management,
Koto	Dir (Lower)	40.8	On-Grid	207	58%	101,844.00	Eligible (GCC)	207,000	Eligible	
Lawi	Lower Chitral	69	On-Grid	308	51%	151,536.00	Eligible (GCC)	308,000	Eligible	
Balakot	Tehsil Balakot, District Mansehra	300	On-Grid	1143	43%	562,356	Eligible (GCC)	1,143,000	Eligible	

Project Name	Location	Project Capacity (MW)	Grid Detail	Calculated Annual Generation by PEDO (GWh)*	Capacity Factors by PEDO*	Annual Emission Avoidance (tCO2)	Eligibility under Carbon Markets	Annual I-RECs (MWh)	Eligibility Under I-RECs	Comments
Gabral Kalam	Swat	88	On-Grid	339.19	44%	166,881.48	Eligible (GCC)	339,190	Eligible	monitoring and reporting mechanism needs to be in place for claiming IRECs.
Madyan	Swat	157	On-Grid	770.18	56%	378,928.56	Eligible (GCC)	770,180	Eligible	
Ranolia	Ranolia, Kohistan	17	On-Grid	99.52	67%	48,963.84	Eligible (GCC)	99,520	Eligible	
Total		755.8	7 x On-Grid	3212.89	-	1,580,741.88		3,212,890		
Future Operational Medium-Scale Hydropower Projects										
Karora	Shangla	11.8	On-Grid	71.39	69%	35,123.88	Ineligible	71,390	Eligible	On-Grid hydropower projects are ineligible as per Verra, while the standards like Gold Standard limit the projects depending upon their share in electricity mix. However, they are eligible for GCC. Mujahidin can be potential carbon market projects depending upon the conformance to relevant carbon market standard. A comprehensive ESIA, data management mechanisms and robust MRV is would need to be developed. These can also be candidate projects for I-RECs; however, data management, monitoring and reporting mechanism needs to be in place for claiming IRECs.
Jabori	Mansehra	10.2	On-Grid	71.1	80%	20,661.54	Eligible (GCC)	71,100	Eligible	
Mujahideen	Torghar	6.95	Off-Grid	40.18	66%	19,768.56	Eligible (All)	40,180	Eligible	
Chapri Charkhel	Lower Kurram	13.56	On-Grid	81.96	69%	40,334.32	Eligible (GCC)	81,960	Eligible	
Total		42.51	3 x On-Grid 1 x Off-Grid	264.63	-	130,197.96		264,630	Eligible	
Future Operational MMHPPs										
140 MMHPPs	Varies	27.078	140 x Off-Grid	158.1	67%	77,802.91	Eligible (All)	158,136	Eligible	Can be potential carbon market projects depending upon the conformance to relevant carbon market standard. A comprehensive ESIA, data management mechanisms and robust MRV would need to be developed at the time of execution and

Project Name	Location	Project Capacity (MW)	Grid Detail	Calculated Annual Generation by PEDO (GWh)*	Capacity Factors by PEDO*	Annual Emission Avoidance (tCO2)	Eligibility under Carbon Markets	Annual I-RECs (MWh)	Eligibility Under I-RECs	Comments
										operations. PEDO to ensure projects permanence and risk mitigation during execution and operations. These can also be candidate projects for I-RECs, however, data management, monitoring and reporting mechanisms need to be in place for claiming IRECs.
Total Future Hydropower		825.388	10 x On-Grid 141 x Off-Grid	3,635.656	-	1,788,742.75		3,635,656		
Future Operational Community Scale Solar Power Projects										
Solarization of 8000 Schools & 187 BHUs	All Settled Districts	12	Off-Grid	15.768	15%	9445.032	Eligible (All)	15.768	Eligible	Can be potential carbon market projects depending upon the conformance to relevant carbon market standard. A comprehensive ESIA, data management mechanisms and robust MRV would need to be developed at the time of execution and operations. PEDO to ensure projects permanence and risk mitigation during execution and operations. These can also be candidate projects for I-RECs, however, data management, monitoring and reporting mechanism needs to be in place for claiming IRECs.
Solarization of Masajid & Worship Places of Khyber Pakhtunkhwa.	All Settled Districts	14	Off-Grid	18.396	15%	11,019.2	Eligible (All)	18.396	Eligible	
Solarization of 2000 Masajid in Merged Areas (AIP)	All Merged Districts	6.5	Off-Grid	8.541	15%	5,116.06	Eligible (All)	8,541	Eligible	
Solarization of Schools in Merged areas (AIP)	All Merged Districts	3.55	Off-Grid	4.667	15%	2,794.16	Eligible (All)	4,667	Eligible	
Solarization of Houses in Various UCs	District Bannu	1.8	Off-Grid	2.3652	15%	1,416.75	Eligible (All)	2,365.2	Eligible	

Project Name	Location	Project Capacity (MW)	Grid Detail	Calculated Annual Generation by PEDO (GWh)*	Capacity Factors by PEDO*	Annual Emission Avoidance (tCO2)	Eligibility under Carbon Markets	Annual I-RECs (MWh)	Eligibility Under I-RECs	Comments
of PK- 88 of District Bannu.										
Solarization of Masajid/ Janazgah/ Eid- Gah in various UCs of District Torghar. (DDP)	District Torghar	0.47	Off-Grid	0.61758	15%	370.182	Eligible (All)	618	Eligible	
Total Future Operational Solar		38.32	6 x Off-Grid	50.352	15%	30,161.39		50,352		
Private Sector Large Scale Hydropower Projects										
Kalam Asrit HPP	Swat	238	11x On-Grid.	945.8	45%	465,333.60	Eligible (GCC)	945,800	Eligible	On-Grid hydropower projects are ineligible as per Verra, while the standards like Gold Standard limit the projects depending upon their share in electricity mix. However, they are eligible for GCC. A comprehensive ESIA, data management mechanisms and robust MRV would need to be developed at the time of execution and operations. PEDO to ensure projects permanence and risk mitigation during execution and operations. These can also be candidate projects for I-RECs, however, data management, monitoring and reporting mechanism needs to be in place for claiming IRECs.
Asrit Kedam HPP	Swat	229		944.7	47%	464,792.40	Eligible (GCC)	944,700	Eligible	
Sharmai HPP	Upper Dir	152.12		689	52%	338,988.00	Eligible (GCC)	689,000	Eligible	
Shigo Kas HPP	Lower Dir	102		512	57%	251,904.00	Eligible (GCC)	512,000	Eligible	
Arkari Gol HPP	Chitral	99		372	43%	183,024.00	Eligible (GCC)	372,000	Eligible	
Gabral Utror HPP	Swat	82		310.88	43%	152,952.96	Eligible (GCC)	310,880	Eligible	
Artistic-1 HPP	Upper Dir	62.61		306.57	56%	150,832.44	Eligible (GCC)	306,570	Eligible	
Shalfalam HPP	Upper Dir	60		270.45	51%	133,061.40	Eligible (GCC)	270,450	Eligible	
Artistic-2 HPP	Swat	55.03		211.745	44%	104,178.54	Eligible (GCC)	211,745	Eligible	
Bankhwar HPP	Swat	35		123.68	40%	60,850.56	Eligible (GCC)	123,680	Eligible	
Nila Da Katha HPP	Mansehra	31.3		136.8	50%	67,305.60	Eligible (GCC)	136,800	Eligible	

Project Name	Location	Project Capacity (MW)	Grid Detail	Calculated Annual Generation by PEDO (GWh)*	Capacity Factors by PEDO*	Annual Emission Avoidance (tCO2)	Eligibility under Carbon Markets	Annual I-RECs (MWh)	Eligibility Under I-RECs	Comments
Public Private Partnership (Under Development)										
Lower Spat Gah	Upper Kohistan	470	Grid Connected	1,935.084	47%	952,061.33	Eligible (GCC)	1,935,084	Eligible	On-Grid hydropower projects are ineligible as per Verra, while the standards like Gold Standard limit the projects depending upon their share in electricity mix. However, they are eligible for GCC. A comprehensive ESIA, data management mechanisms and robust MRV would need to be developed at the time of execution and operations. PEDO to ensure projects permanence and risk mitigation during execution and operations. This can also be candidate project for I-RECs, however, data management, monitoring and reporting mechanism needs to be in place for claiming IRECs.
Total		1,616.06	LSG On-Grid	6,758.709	-	3,325,284.83		6,758,709		
Private Sector Medium Scale Hydropower Projects										
Daral Khwar-II HPP	Swat	9.5	2x On-grid.	43.82	53%	19,243.79	Eligible (GCC)	39,113	Eligible	On-Grid hydropower projects are ineligible as per Verra, while the standards like Gold Standard limit the projects depending upon their share in electricity mix. However, they are eligible for GCC. Can be potential carbon market projects depending upon the conformance to relevant carbon market standard. A comprehensive ESIA, data management mechanisms and robust MRV would need to be developed at the time of execution and operations. PEDO to ensure projects permanence and risk mitigation during execution and operations. These can also be candidate projects for I-RECs, however, data management,
Balkani HPP	Shangla	7.75		33.95	50%	15,698.88	Eligible (GCC)	31,908	Eligible	

Project Name	Location	Project Capacity (MW)	Grid Detail	Calculated Annual Generation by PEDO (GWh)*	Capacity Factors by PEDO*	Annual Emission Avoidance (tCO2)	Eligibility under Carbon Markets	Annual I-RECs (MWh)	Eligibility Under I-RECs	Comments
										monitoring and reporting mechanism needs to be in place for claiming IRECs.
Total		17.25		77.77	-	38,262.84		77,770		
Total Private Sector Hydropower		1633.31		6,836.479	-	3,363,547.67		6,836,479		
Private Sector Large Scale Solar Projects										
Kulachi, DI Khan	DI Khan	50	5x on-grid.	79.2	18%	47,440.80	Eligible (Gold and GCC)	79,200	Eligible	Can be potential carbon market projects depending upon the conformance to relevant carbon market standard. A comprehensive ESIA, data management mechanisms and robust MRV would need to be developed at the time of execution and operations. PEDO to ensure projects permanence and risk mitigation during execution and operations. These can also be candidate projects for I-RECs, however, data management, monitoring and reporting mechanism needs to be in place for claiming IRECs.
Kulachi, DI Khan	DI Khan	50		79.8	18%	47,800.20	Eligible (Gold and GCC)	79,800	Eligible	
Paharpur, DI Khan	DI Khan	49.5		79.3	18%	47,500.70	Eligible (Gold and GCC)	79,300	Eligible	
Nowshera Solar PV	Nowshera	50		78.8	18%	47,201.20	Eligible (Gold and GCC)	78,800	Eligible	
Kohat Solar PV	Kohat	50		81.3	19%	48,698.70	Eligible (Gold and GCC)	81,300	Eligible	
Total		249.5		398.4	-	238,641		398,400		
*PEDO to validate										

1 Introduction

1.1 Background and Context

The SEED initiative is a £37.5 million program by the UK's FCDO to boost economic development and sustainable energy in Khyber Pakhtunkhwa (KP), Pakistan. It includes a £15 million component led by Adam Smith International for improved economic and urban planning, aiming to drive investment, enhance public investment efficiency, and deliver significant economic, social, and environmental benefits.

For the initiative mentioned, this report aims to conduct a detailed preliminary study of Pakhtunkhwa Energy Development Organization (PEDO) Energy Portfolio with an intention to provide a readiness assessment of PEDO projects for participation in Carbon and IRECs Markets. The inception report of the subject study outlined the project's methodology and introduced the team responsible for project execution. It also provided an exhaustive list of PEDOs solar and hydropower energy project portfolio in KP to be analyzed for integration into crediting mechanisms.

This report takes forward these projects towards their analysis in pursuance of the goal of market integration. The report shall achieve this by leading baseline data collection supported by project analyses. With this foundation, the projects shall be assessed for compliance with these intended markets. Furthermore, it shall formulate a registry of evaluated projects.

1.2 Objective of Carbon Asset Inventory of KP's Renewable Energy Portfolio

The report aims to conduct a technical analysis of PEDO's solar and hydropower energy projects for their integration into crediting markets. This analysis includes an assessment of the projects' compliance with entry requirements for such mechanisms, identification of potential challenges, and recommendations for enhancing project profiles for eligibility with an intention to provide a readiness assessment of PEDO projects for participation in such markets.

1.3 Establishment of a Baseline

Baselining helps provide a comprehensive understanding of the current state of affairs in a project area, including its socioeconomic profile, climate, geology, etc. This information is crucial for assessing how the project impacted the baseline and how has it contributed to further development. Essentially, it is fundamental to project planning and implementation as it offers a detailed snapshot of the initial conditions, which are crucial for assessing impacts, guiding development, and ensuring effective monitoring and evaluation. Baselining is one of the most pertinent elements because it serves as a reference to guide on how the carbon market project development has helped in improving the baseline.

The Information below indicates the baseline for KP. It denotes the socioeconomic mapping, baseline potential for renewables, and environmental indicators for the province.

1.3.1 Socioeconomic Mapping

Carbon offset projects are not simply about reducing greenhouse gas emissions. They are also about social development and environmental justice. It is therefore pertinent to take into due consideration the indigenous communities that are directly or indirectly impacted by carbon offset projects while upholding their rights as a paramount. This demands a thorough knowledge of the socioeconomic indicators of the province. However, given a history of conflict and violence, including political instability, militancy, terrorism, and sectarianism, understanding and protecting the social situation in KP becomes challenging. These issues have led to widespread insecurity, displacement, and human rights abuses. Several non-governmental organizations (NGOs) such as the Human Rights Commission of Pakistan (HRCP), Da Hawwa Lur, The Bacha Khan Trust, Khudi Pakistan, Sarhad Rural Support Programme (SRSP), and The Center for Research and Security Studies (CRSS) are working to promote peace, development, and good governance in KP.

A 2022 social survey report on KP by the Japan International Cooperation Agency (JICA)[1] and the book “"Indigenous Societies in the Post-colonial World”"[2] highlight the diverse social landscape in KP. The main social communities identified include tribal communities, indigenous people: Kalasha, Afghan refugees, and internally displaced persons (IDPs). A summary of the socioeconomic indicators as per 2023 Important District-wise Socio-economic indicators of KP by P&D department KP are as under:[3]

Agriculture: The data in the report for 2021-22 shows a reported area of KP to be 8.37 million hectares with a cultivated area of 1.824 million hectares. Off this cultivated area, 53.16% is irrigated area.

Education: For the total number for Pakistan, KP shares 14.92% of Primary Schools, 7.22% Middle schools, 7.73% high schools and 7.31%-degree colleges for both sexes. The literacy rate stands 71% for males whereas 35% for females.

Energy: For the year 2021-22, KP generated 19,526GWh of electricity making 12.94% off the total generation and consumed 10,571GWh of electricity making 9.5% off the total consumption.

Health: As of 2022, KP has 296 hospitals with 9,179 doctors, 7,246 nurses and 1,365 lady health visitors. It has 956 dispensaries and 152 MCH centers.

Population: KP has 17,996 thousand males, 17,503 thousand females and 2.325 thousand transgenders. 5,875 thousand people live in urban whereas, 29,677 thousand people live in rural areas having a population density of 349 person/sq.km.

Industries: A summary of industries in KP is as under:

[1] https://openjicareport.jica.go.jp/pdf/12364402.pdf”
[2]https://www.researchgate.net/publication/369076720_Kalasha_People_in_Pakistan_A_Mountain_Indigenous_Tribe's_Struggles_to_Protect_Identity_Culture_Ancestral_Lands_and_Survival”
[3] https://kpbos.gov.pk/search/publication-detail?id=83

Table 1: Industrial outlook of KP. [4]

Description	Unit	Pakistan	KP	% Share
Production and Manufacturing Items 2021-22				
Cement	000 Tons	48,011	15,871	33.1
Cigarettes	Million Nos.	59,695	23,856	40
Cotton Yarn	000 Tons	3,446	59	1.7
Paper	"	310	64	20.6
Sugar	"	7,921	174	2.2
Veg. Ghee	"	1,401	190	13.6
Mineral Production 2021-22				
Barytes	000 Tons	128	3	2.3
Chromite	"	195	31	15.9
Coal	"	9,677	650	6.7
Soap Stone	"	301	301	100
Fire Clay	"	675	30	4.4
Gypsum	"	2,325	907	39
Limestone	"	58,362	18,678	32
Magnesite	"	6	2	25.3
Marble	"	6,626	2,372	35.8
Rocksalt	"	2,716	207	7.6
Silica Sand	"	637	60	9.4

1.3.2 Energy Mix and Baseline Potential for Renewables

The power sector in Pakistan is essential for the country's economic development and for meeting the increasing energy demands of its population and industries. The sector encompasses power generation, transmission, distribution, and supply, each playing a critical role in ensuring reliable electricity.

Generation: Pakistan's power generation mix in 2023 includes a variety of sources: imported coal (11%), local coal (8%), RLNG (26%), gas (6%), RFO (8%), nuclear (8%), hydropower (25%), wind (4%), solar (3%), and bagasse (1%). The country's generation capacity totals 43,298 MW, with thermal power still dominating. However, Pakistan is actively diversifying its energy mix by expanding renewable energy sources, given its significant hydro and renewable energy potential, which are vital for meeting the nation's growing electricity demand.

Transmission and Distribution: Pakistan's transmission network includes 886 km of 660 kV HVDC lines, 8,337 km of 500 kV AC lines, and 11,463 km of 220 kV lines. The extensive distribution network serves approximately 37 million consumers nationwide, illustrating the scale of electricity provision across the country.

Cross-Border Energy Projects: Pakistan imports 100 MW of electricity from Iran under NEPRA's Interim Power Procurement Regulations, 2005. Additionally, Pakistan participates in cross-border projects to bolster its energy security, including the CASA-1000 project, which transmits surplus electricity from Central Asia. Pakistan is also engaged in the TAPI gas pipeline project

[4] https://kpbos.gov.pk/search/publication-detail?id=83

(Turkmenistan-Afghanistan-Pakistan-India) to meet its growing natural gas requirements, reflecting a commitment to regional energy collaboration.

These elements together underscore Pakistan's efforts in energy diversification, network expansion, and cross-border cooperation to achieve a more robust and sustainable power sector.

Table 2: Power Generation Mix of Pakistan 2023
Source (IGCEP-2022)

Category	MW	%age
Imported Coal	4,680	11%
Local Coal	3,300	8%
RLNG	11,052	26%
Gas	2,744	6%
RFO	3,633	8%
Nuclear	3,620	8%
Hydropower	10,847	25%
Wind	1,840	4%
Solar	1,120	3%
Bagasse	362	1%
Cross Boarder	100	0%
Total	**43,298**	**100%**

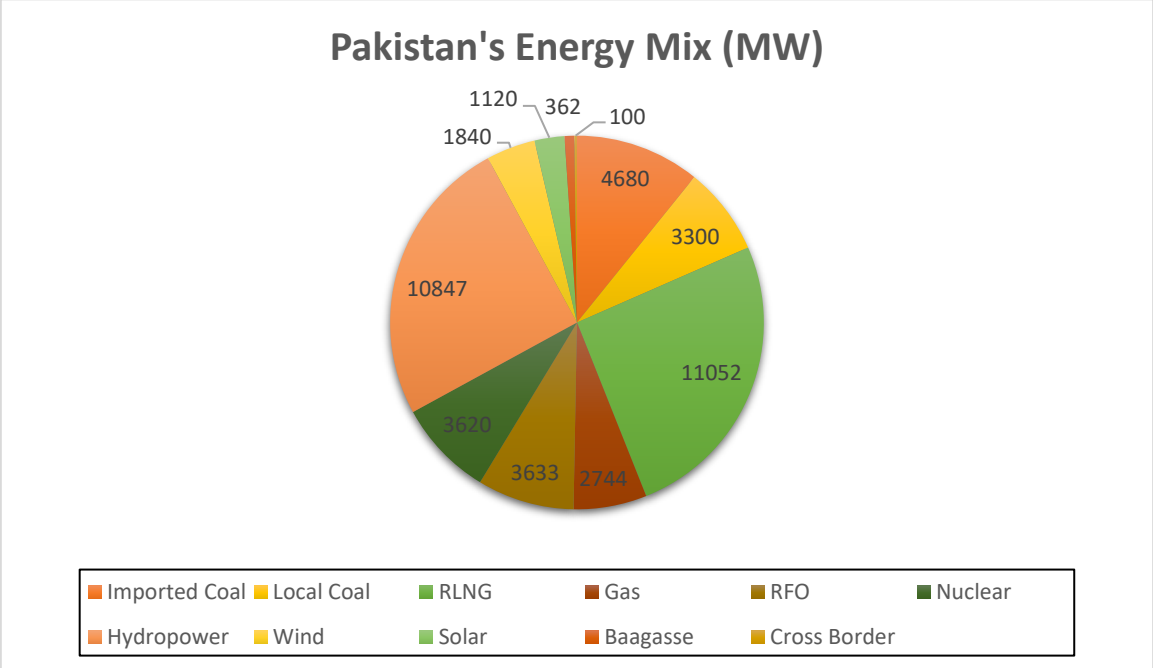


Figure 1: Power Generation Mix of Pakistan 2023
Source (IGCEP-2022)

Pakistan is blessed with a remarkable potential for renewable energy resources including wind, solar, hydro, biomass/biogas/waste-to-energy, geothermal, ocean, tidal and biofuels. However, so far, the wind, solar, hydro, biomass/biogas/waste-to-energy are the only commercial deployed renewable resources. PEDO renewable energy portfolio includes hydro and solar.

The multiple studies indicate the renewable energy potential across the country including a significant potential in KP as portrayed in Figure 2 and Figure 3 for the solar and hydropower

potential in the country. Delving into the research shows that Pakistan has about 60GW hydropower potential off which 25GW is in KP alone making up approximately 42% of the country's share, with harnessing 2632.418MW only in the plans of PEDO thus far [5]. The solar potential on the other hand is estimated to be 2.9 million MW off which 0.6346 million MW[6] can be extracted from KP where PEDO has thus far included harnessing 302.11MW only of this potential. The province has an average solar radiation intensity ranging from 4.0 to 5.5 kWh/m2/day (Figure 2) where Chitral receives the lowest intensity, 2.28kWh/m2/d in December whereas, Mardan records the highest daily solar radiation, 7.88 kWh/m2/d in June. Furthermore, the country boasts 345 GW wind energy potential out of which just 120 GW can be technically exploited. KP does not offer much wind potential out of this share, but the study indicates that Mardan, Malakand, Buner, Shangla, Swabi, and Haripur have the potential to run small wind turbines to generate electricity for communities. Provided not much priority has been given to tapping the wind potential by the government of KP, the scope of this report is limited to hydro and solar power as expanded in section 1.5 for PEDOs energy portfolio.[7]

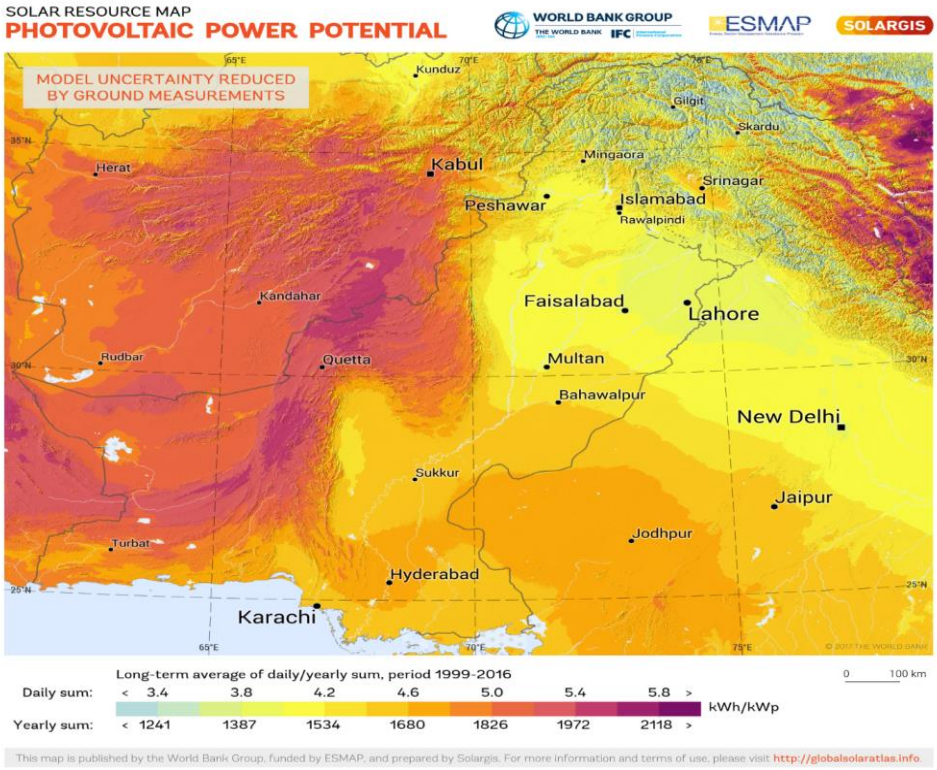


Figure 2: Solar Power Potential in Pakistan.[8]

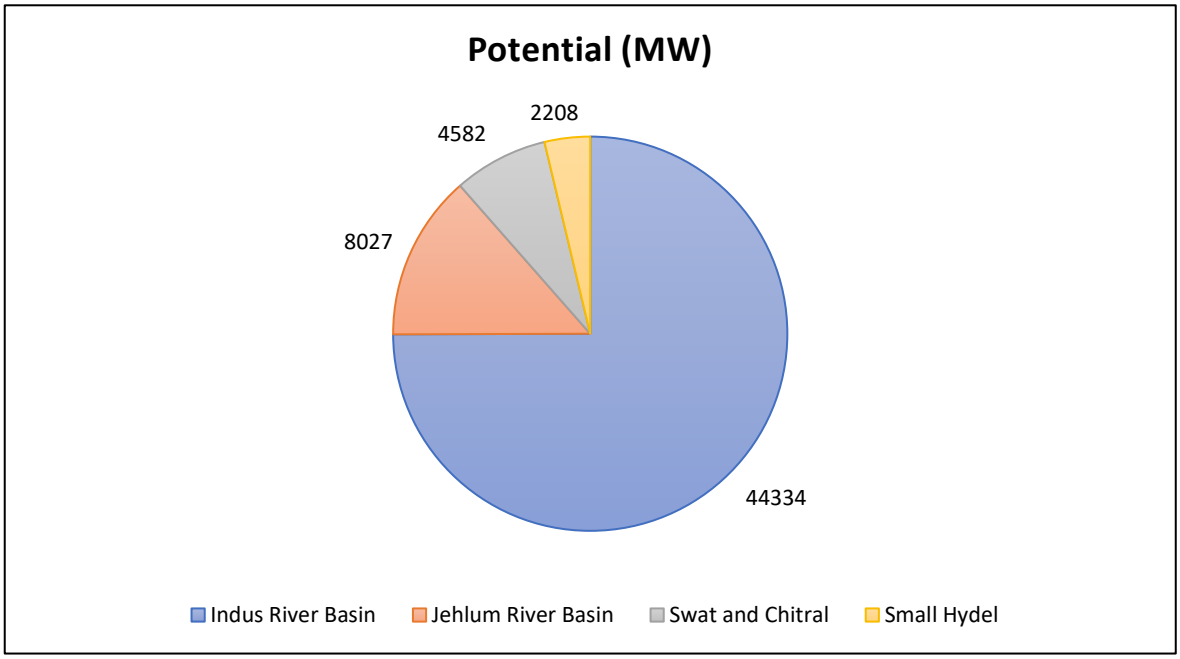
[5] https://pedokp.gov.pk/uploads/downloads/Annual_Report_(2022-2023)_Compressed_File.pdf

[6] https://www.ijew.io/paper/renewable-energy-potential-in-khyber-pakhtunkhwa#:~:text=Average%20daily%20solar%20radiation%20for,falls%20in%20the%20winter%20season (Plus Authors Calculations)

[7] https://www.ijew.io/paper/renewable-energy-potential-in-khyber-pakhtunkhwa"

[8] Energy Sector Management Assistance Program (ESMAP). Global Solar Atlus; ESMAP: Washington, DC, USA, 2018.

Figure 3: Hydropower Potential in Pakistan.[9]



1.3.3 Environmental Indicators

Air Quality Trends: The air quality in KP is observed in real time and shows a range between good and unhealthy for sensitive groups. Currently (13th May, 2024) DI Khan with an AQI of 109 is the most polluted city with Mohmand Agency having the best AQI of 38 in the province.[10]

Water Quality Trends: The water quality in KP is generally good with Gilgit and Ghizer surpassing the baseline but still providing potable water in the province as indicated below:

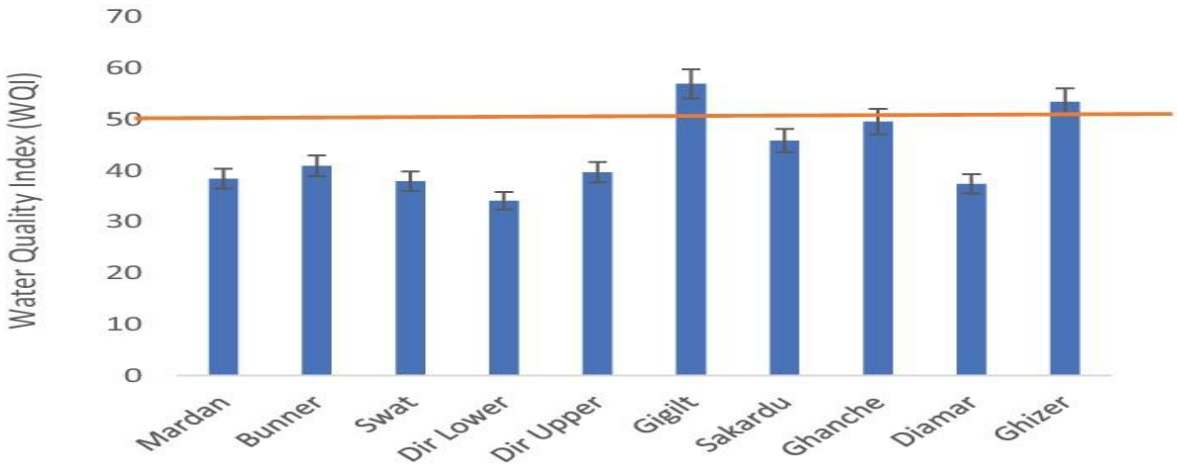


Figure 4: Water Quality Index in KP.[11]

Biodiversity: The biodiversity in the province is as indicated below:[12]

[9] https://www.researchgate.net/publication/268224059_Hydropower_Potential_in_Pakistan
[10] https://www.iqair.com/pakistan/khyber-pakhtunkhwa
[11] https://www.researchgate.net/figure/Water-quality-index-WQI-of-drinking-water-samples-from-KP-and-Northern-areas_fig2_335919991
[12] https://pakistanalmanac.com/khyberpakhtunkhwa-flora-and-fauna/

Table 3: Biodiversity in KP.

FLORA	MEDICINAL PLANTS	FAUNA
Deodar (Cedrus deodara)	Milkweed (Calotropis procera)	Himalayan black bear
Fir (Abies pindrow)	Karir (Capparis deciduas)	Asiatic leopard
Blue pine or kail (Pinus wallichiana)	Kaber (Capparis spinosa)	Mush deer
Chir pine (Pinus roxburghii)	Barri or bata (Periploca aphylla)	Snow leopard
Elm or kaeen (Ulmus wallichiana)	Vena (Rhazya stricta)	Hare
Walnut (Juglans regia)	Sormal poaceae (Saccharum griffithii)	Fox
Oak (Quercus incana)	Dunal (Withania coagulans)	Jackal
Yew (Taxus baccata)	Jharr ber (Zizyphus nummularia,)	Urial
Birch (Betula utilis)	Ger beta (Arabis nova)	Chinkara deer
Chilghoza pine (Pinus gerardiana)	Baker beta (Asparagus capitatus)	Ibex
Spruce (Picea smithiana)	Beta (Blumea lacera)	Wolf
Poplar (Populus ciliata)	Tor soba (Chenopodium murale	Goral
Monotheca or gurgura (Monotheca buxifolia)	Barawa (Cynodon dactylon)	Himalayan palm civet
Vibunum or guch (Vibernum nervosum)	Aspalaghzia (Fagonia cretica)	Kashmir hill fox
Burberis or sumbal (Berberishyberm)	Tatesi gul (Gnaphalium luteo-album)	Red flying squirrel
Pistachios or khanjak (Pistacia mutica)	Zirgul (Inula grantioides Boiss)	Masked civet
Acacia or palosa (Acacia modesta)	Shen beta (Kickxia incana)	Mountain weasel
Sanatha or zarawanai (Dodonea viscose)	Tanoba (Kochia prostrate)	Marco Polo sheep
Bhaiker or arosa (Adhatoda vasica)	Warhora (Lactuca auriculata)	Rhesus macaque
Ber or karkana (Zizyphus mauritiana)	Bathal or tariza (Launea procumbens)	Common leopard
Babul or kikar (Acacia nilotica)	Bur clover (Medicago polymorpha)	Lynx
Olive or zaitoon (Olea furrigenea)	Sponda or Syrian rue (Peganum harmala)	Hog deer
Frash or gaz (Tamarix aphylla)	Isphaghol (Plantago psyllium)	Grey goral
Prosopis or jand (Prosopis spicigera)	Kandiari (Solanum surratens)	Barking deer
Date palm (Phoenix sylvestris)	Needle grass or her beta (Stipa capensis Thunb)	Brown bear
	Kalpora or ger beta (Teucrium stocksianum)	Asiatic jackal
	Kakronda (Blumea lacera)	Monkey

	Tor soba (Chenopodium murale)	Yellow-throated marten
	Bermuda grass or pers (Cynodon dactylon Linn.)	Stripped hyena
	Aspalagzia or virgin's mantle (Fagonia cretica Linn.)	Wild boar
	A type of weed called tetesi gul (Gnaphalium luteo-album Linn.)	Eurasian eagle owl
	Mangoli (Hertia intermedia Boiss.)	Various kinds of pheasants
	Zir gul (Inula grantioides Boiss.)	Black and grey partridges
	Split leaf lettuce or warhora (Lactuca auriculata Wall.)	Chakor
	Batthat or tariza (Launea procumbens Roxb.)	See-see partridge
	Bur clover or karushka (Medicago polymorpha Linn.)	Himalayan snow cock
	Hermal or sponda (Peganum harmala Linn.)	Snow partridge
	Anmamoli or kundiari (Solanum surratens Burm.)	Common crane
	Mediterranean needle grass (Stipa capensis Thunb.)	Demoiselle crane
	Kastori (Teucrium stocksianum Boiss.)	Houbara bustard
	Dakwar guchhi (*morchella elata fr.*)	Falcons
	Sumbal/parsiaushah (adiantum capillus-veneris)- Export Oriented	Various water fowls
		Snakes
		Kraits
		Frogs
		Lizards
		Scorpions
		Spiders
		Butterflies

1.4 Introduction to Crediting Mechanisms

Global crediting mechanisms outline different sectors for which they register credits. Delving into the energy sector, we have four standards that credit renewable energy integration. These include: Verra Standard (VCS), Gold Standard (GS), Global Carbon Council (GCC), and the International Renewable Energy Certificates (I-RECs).

1.4.1 Carbon Crediting

The global carbon credit market has proven to be an effective tool in facilitating emission reduction initiatives. The market revenue for carbon crediting is forecasted to reach US$2 trillion,

with a Compound Annual Growth Rate (CAGR) of 30.5%. Europe is anticipated to lead the market, while the Asia Pacific region is expected to experience the strongest growth until 2030.

Globally, the compliance market has been the primary driver, with the power sector accounting for the largest share of carbon credits, as detailed in Figure 5 below:

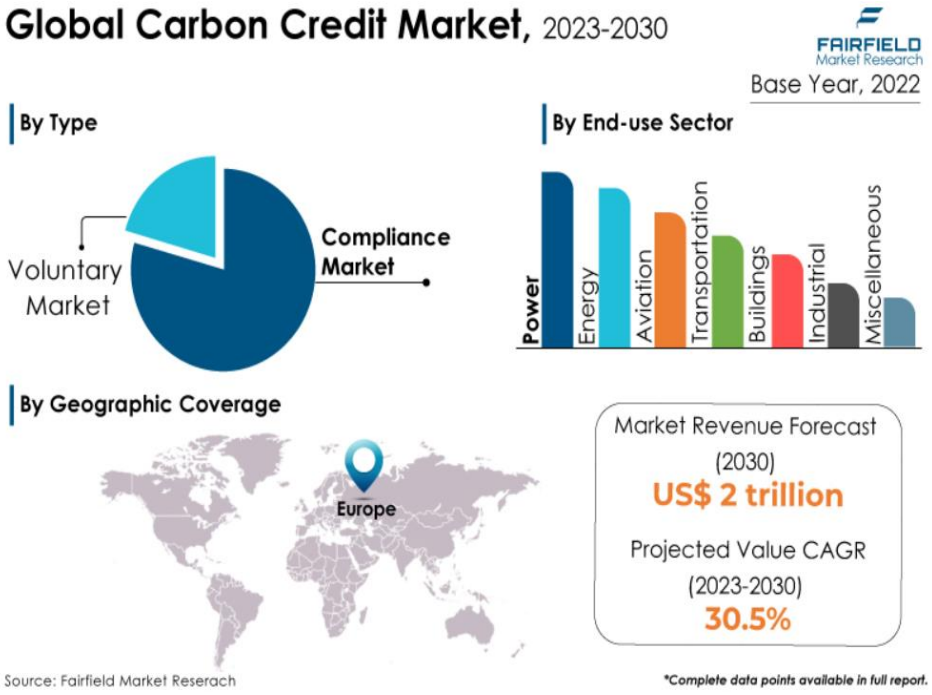


Figure 5: Landscape of Global Carbon Credit Market.[13]

The standards mentioned, including VCS, GS, and GCC, are part of carbon crediting mechanisms and fall under the voluntary carbon market category. These are suited for the PEDO energy portfolio as the compliance market is yet to mature in the country.

The process of registering a clean project with carbon market standards involves several key steps:

- preparing a technical feasibility study,
- environment and social impact study,
- project design document (PDD) outlining emissions reduction potential,
- additionality, and co-benefits;
- conducting stakeholder consultations,
- undergoing third-party validation to ensure compliance with the chosen standard; and finally,
- submitting the project for approval and registration.

The entire process typically takes **12-24 months** from project inception to registration, depending on the complexity of the project and the responsiveness of stakeholders and validators[14].

Additionality in carbon markets requires a project to demonstrate that its greenhouse gas (GHG) reductions would not occur without carbon credit revenues, proving the project overcomes

[13] https://www.fairfieldmarketresearch.com/report/carbon-credit-market
14 https://www.giz.de/de/downloads/giz2023-en-agricultural-carbon-project-development.pdf

financial, technological, or regulatory barriers[15]. For existing projects, establishing additionality is challenging as they often lack evidence that carbon credits are essential for their viability, particularly if they are already operational or financially sustainable. Additionally, demonstrating compliance beyond regulatory requirements or deviation from common practices is complex for pre-commissioned projects. In contrast, new projects have a clearer case for additionality, as their design can explicitly account for carbon credit reliance, making them stronger candidates for carbon market participation[16].

1.4.2 International Renewable Energy Certificates

International Renewable Energy Certificates (I-RECs) represent the attributes of electricity as generated from renewable energy sources. Renewable energy has two parts: the actual electricity and the environmental benefits, like proof that it came from a clean source. These can be separated, so the electricity can go to one buyer, and the benefits, in the form of certificates, can be sold to someone else who wants to support or claim the use of green energy.[17] The market is anticipated to boast a market size of $115.36 billion with a CAGR of 27.19% by 2032 as portrayed in the Figure 6. In reference to Pakistan, the Pakistan Environmental Trust (PET) is the designated and accredited entity for issuance of I-RECs and updating the registry of integrated projects.[18]. At present, it is the only accredited entity within Pakistan for that matter. All projects intending to earn I-RECs are required to register with PET.

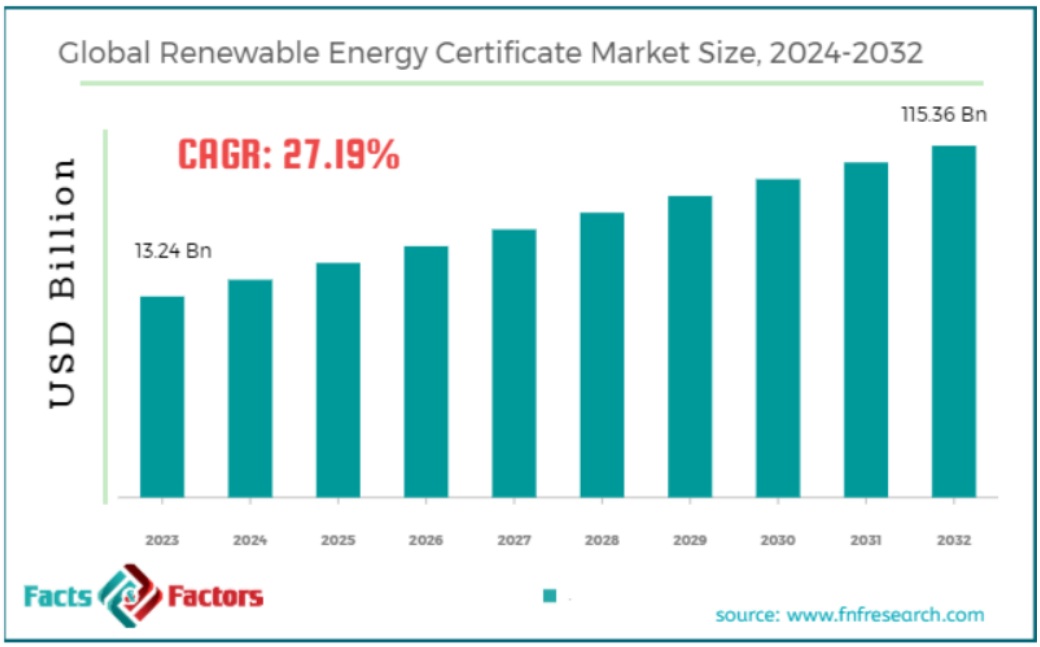


Figure 6: Market Size Expansion of I-RECs.[19]

[15] https://offsetguide.org/high-quality-offsets/additionality/

16 Michaelowa A, Hermwille L, Obergassel W, Butzengeiger S. Additionality revisited: guarding the integrity of market mechanisms under the Paris Agreement. Clim Policy [Internet]. 2019;19(10):1211–24. Available from: http://dx.doi.org/10.1080/14693062.2019.1628695

17 https://www.researchgate.net/publication/237325818_Emerging_Markets_for_Renewable_Energy_Certificates_Opportunities_and_Challenges

18 https://www.trackingstandard.org/pakistan-approved-for-i-rece-issuance/

[19] https://www.fnfresearch.com/renewable-energy-certificate-market-report

1.4.3 Carbon Credits VS I-RECs

Although both carbon credits and I-RECs credit renewable energy integration, the purpose of each instrument is different sharing differing dynamics altogether. The table below expands on how both the instruments contrast each other.

Table 4: Carbon Markets VS I-RECs.[20,21]

CARBON MARKETS	INTERNATIONAL RENEWABLE ENERGY CERTIFICATES (I-RECS)
Focuses primarily on reducing greenhouse gas (GHG) emissions across various sectors	Focuses specifically on tracking and promoting the use of renewable energy.
Objective is to incentivize emission reductions and facilitate the transition to a low-carbon economy.	Objective is to guarantee the origin and attributes of renewable electricity and support renewable energy development.
The Scope can cover a wide range of industries and sectors, including energy, manufacturing, and transportation targeting scope I, II and may also scope III emissions[22].	The Scope is focused specifically on verifying renewable energy generation and consumption, mainly in the electricity sector targeting the scope II emissions.
The unit of trade are Carbon credits, which represent one metric ton of carbon dioxide equivalent (CO_2e) emissions reduced or removed.	The unit of trade are Certificates representing the generation of one megawatt-hour (MWh) of renewable electricity, verifying its source and environmental attributes.
A consumer can claim to have reduced or avoided GHG emissions outside their organization's operations.	A consumer can claim to use renewable electricity from a low or zero emissions source

1.5 Introduction to PEDO's Energy Portfolio

PEDO''s energy portfolio includes a mix of hydropower and solar projects across large-scale (>15MW), medium scale (≤15MW), and mini/micro community projects. This portfolio covers current and future operational projects as well as private sector initiatives, all dedicated to providing clean, reliable energy for the province and the country.

1.5.1 Current Operational Projects

The current operational portfolio consists of projects that have been completed and are in operations. The details of these projects are as hereunder:

[20] https://www.epa.gov/sites/default/files/2018-03/documents/gpp_guide_recs_offsets.pdf#view=fit
[21] https://monsooncarbon.com/the-difference-between-recs-and-carbon-credits/#:~:text=1)%20Different%20Purposes,greenhouse%20gas%20(GHG)%20emissions.
[22] **Scope I Emissions**: Direct emissions from sources owned or controlled by the organization.
Scope II Emissions: Indirect emissions from the generation of purchased energy consumed by the organization.
Scope III Emissions: Indirect emissions from the organization's value chain, including both upstream and downstream activities.

Hydropower

The current operational hydropower portfolio consists of **322 projects in total of cumulative 173.72 MW capacity**. Some pertinent details of all these projects are portrayed in Figure 7 and Table 5 below.

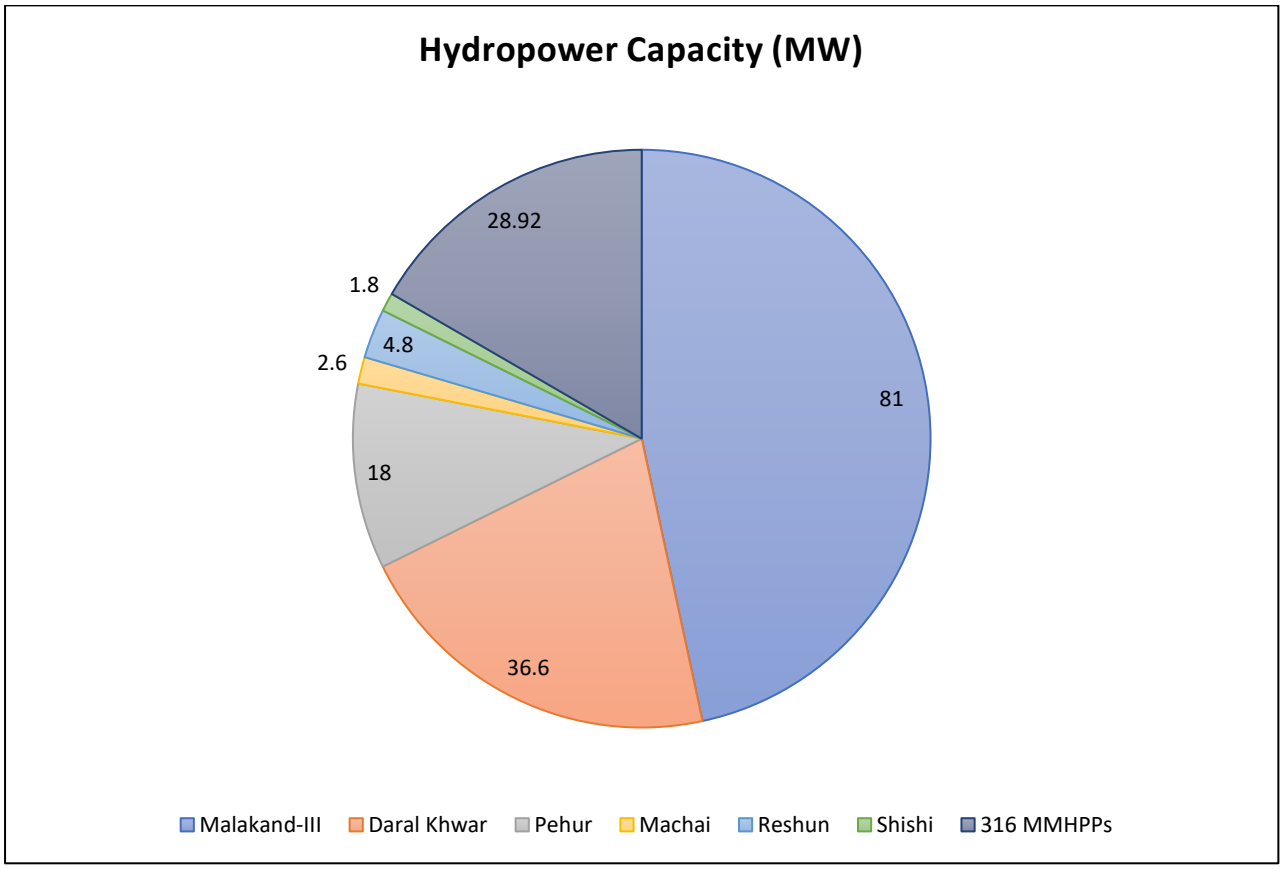


Figure 7: Current Operational Hydropower Capacity

Table 5: Current Operational Hydropower Project Overview

Project Name	Project Capacity	Location/District	Grid Detail	Number of Projects	On/Off-Grid
Malakand-iii	81MW	Dargai, Malakand	132 KV AIS Dargai Grid	X5	On-Grid
Daral Khwar	36.6MW	Behrain, District Swat	Madyan Grid		
Pehur	18MW	Road No. L-1, Gadoon Amazai, Distt. Swabi, KP.	132 KV GSS Gadoon, Amazai		
Shishi	1.8MW	Shishi, Tehsil Drosh, District Lower Chitral	Drosh Grid		
Machai	2.6MW	Alo, Mardan	Katlang Grid		
Reshun	4.8MW	Reshun Gol, District Upper Chitral	Off-Grid	X317	Off-Grid
316 MMHPPs	28.92MW	Abbottabad, Battagram, Buner, Chitral, Dir Lower, Dir Upper, Kohistan, Mansehra, Shangla, Swat, Torgar	Off-Grid		
Total Current Operational Hydro Portfolio		**173.72MW**	X 322 Projects	X5 On-Grid and X317 Off-Grid	

Solar Power

The current operational solar power portfolio extends to **8 projects in total of cumulative 14.29 MW capacity**. A distinct project may expand further into sub-projects, for instance, Solar Electrification of 300 Masajid/Worship Places of Non-Muslims in merged Districts of Khyber Pakhtunkhwa is a project that provides solar power installation to 300 entities. Some pertinent details of all these projects are portrayed in Figure 8 and Table 6 below.

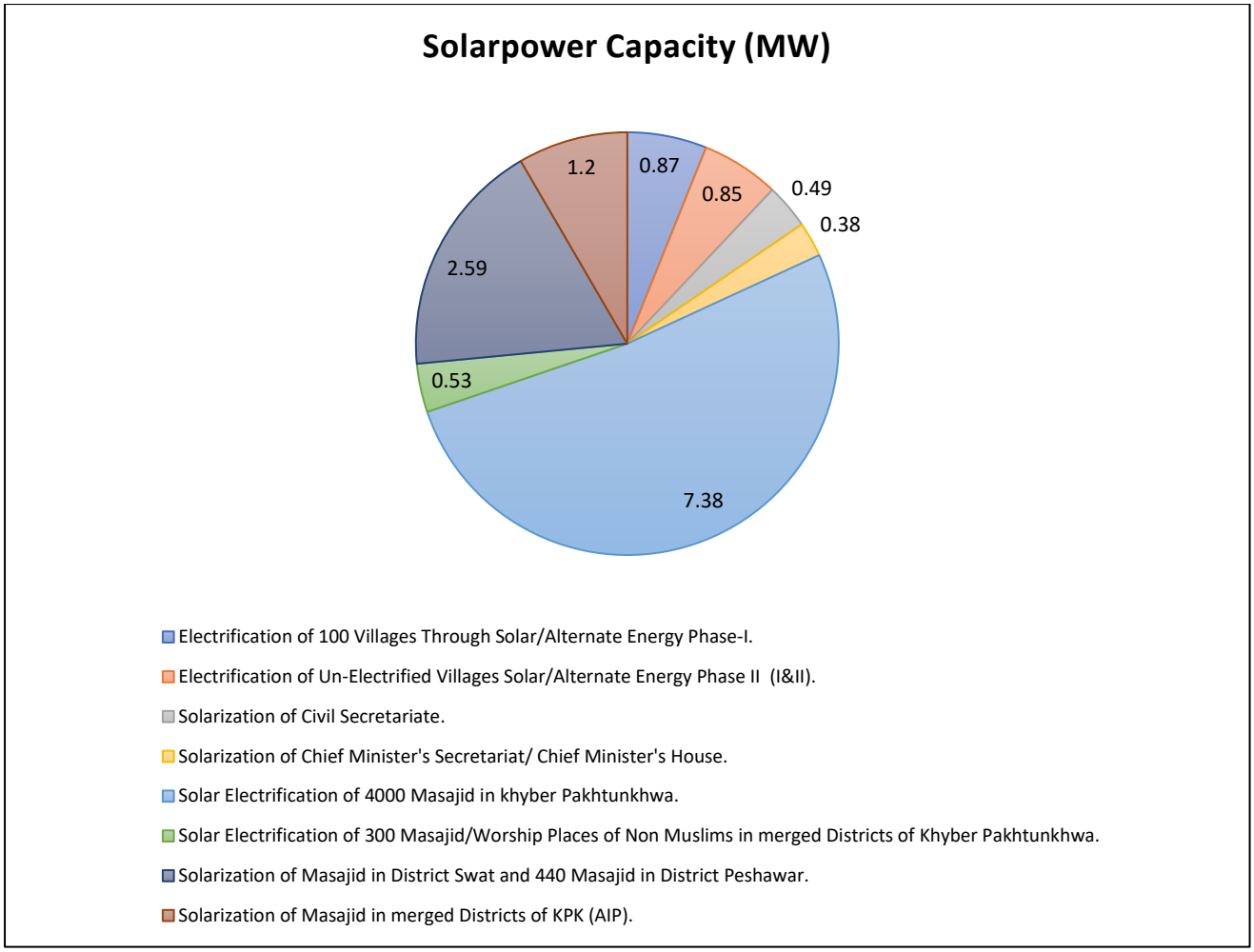


Figure 8: Current Operational Solar Power Capacity

Table 6: Current Operational Solar Power Project Overview

Project Name	Project Capacity	Location/District	Number of Projects	On/Off-Grid
Electrification of 100 Villages Through Solar/Alternate Energy Phase-I.	0.87MW	Central & Southern Districts	X6	Off-Grid
Electrification of Un-Electrified Villages Solar/Alternate Energy Phase II (I&II).	0.85MW	District Chitral		
Solar Electrification of 4000 Masajid in Khyber Pakhtunkhwa.	7.38MW	All Settled Districts		
Solar Electrification of 300 Masajid/Worship Places of Non-Muslims in merged Districts of Khyber Pakhtunkhwa.	0.53MW	Districts Khyber, Bajaur Mohmand, Kurram, Orakzai NW & SW		
Solarization of Masajid in District Swat and 440 Masajid in District Peshawar.	2.59MW	District Swat & District Peshawar		
Solarization of Masajid in merged Districts of KP (AIP).	1.2MW	Districts Khyber, Bajaur Mohmand, Kurram, Orakzai NW, SW FR Lakki, FR Bannu, FR Peshawar, FR Tank, FR DI Khan FR Kohat		
Solarization of Civil Secretariate.	0.49MW	District Peshawar	X2	On-Grid
Solarization of Chief Minister's Secretariat/ Chief Minister's House.	0.38MW	District Peshawar		
Total Current Operational Solar Portfolio	14.29MW		X6 Off-Grid and X2 On-Grid	

1.5.2 Future Operational Projects

The future operational projects consist of all the projects that are either under construction or in development phase. Development phase refers to those projects the on-site construction of which has not started yet and are in their documentation and approvals phase. The details of these projects are as hereunder:

Hydropower

The future operational hydropower portfolio consists of **151 projects in total of cumulative 825.388 MW capacity**. Ranolia is included as future operational projects as it is now being rehabilitated under ADB funding after being flooded in 2022. This list also consists of 3 foreign funded projects in this portfolio. Some pertinent details of all these projects are as portrayed in figure 9 and Table 7 below.

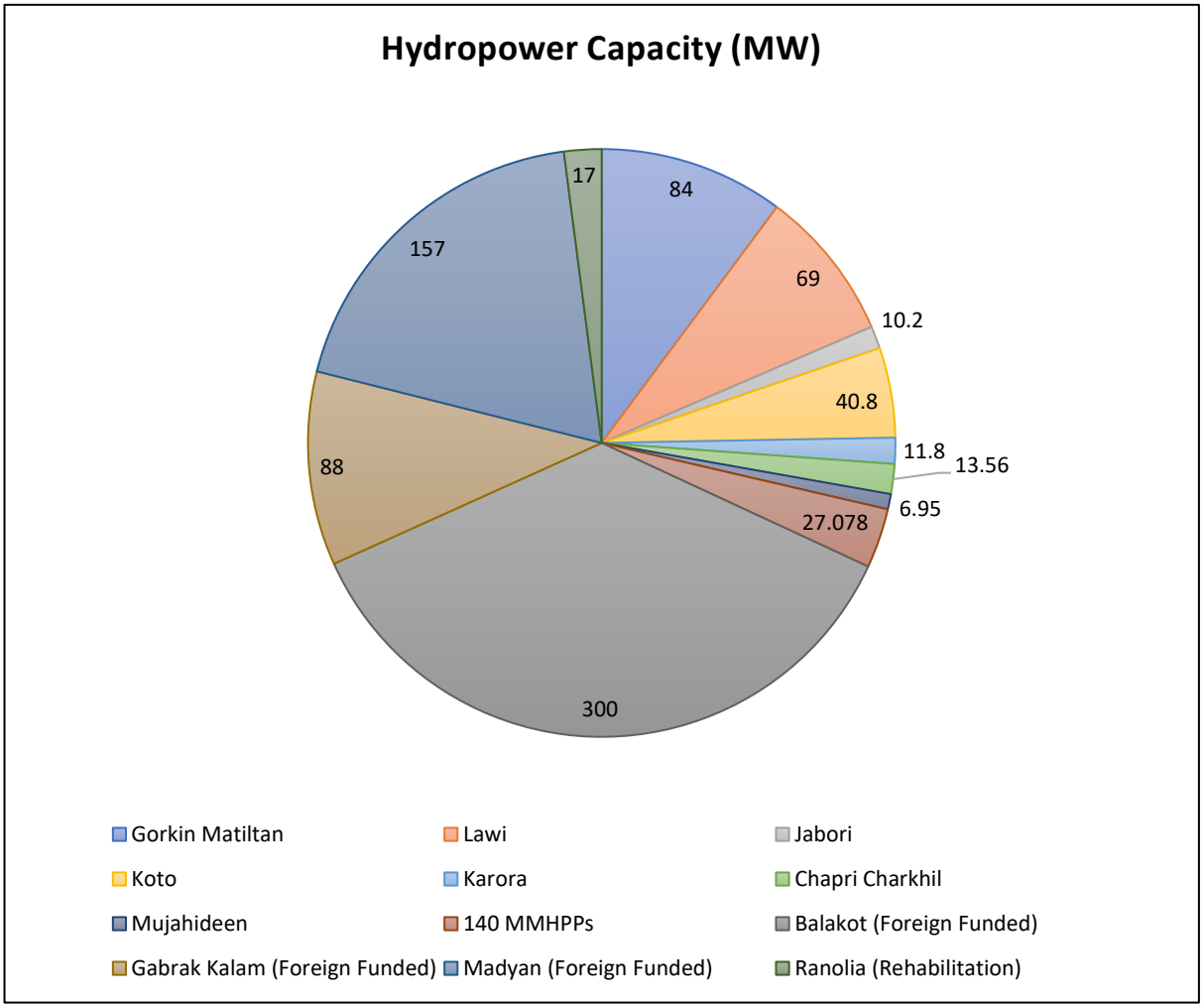


Figure 9: Future Operational Hydropower Capacity

Table 7: Future Operational Hydropower Project Overview

Project Name	Project Capacity	Location/District	Grid Detail	Number of Projects	On/Off-Grid
Gorkin Matiltan	84MW	Kalam, Tehsil Bahrain, District Swat	To be interconnected with Daral Khwar HPP, Bahrain (132 KV Madyan)	X10	On-Grid
Koto	40.8MW	Dir (Lower)	Grid Connected		
Lawi	69MW	Lower Chitral	Grid Connected		
Karora	11.8MW	Shangla	Grid Connected		
Jabori	10.2MW	Mansehra	Grid Connected (132KV Batal GS–- PESCO)		
Chapri Charkhil	13.56MW	Lower Kurram	Grid Connected		
Balakot (Foreign Funded)	300MW	Tehsil Balakot, District Mansehra	Not connected yet. Will be connected as a loop-in-loop-out arrangement at the 500 kV single circuit between Suki Kinari and Maira Grid Station		
Gabral Kalam (Foreign Funded)	88MW	Swat	Will be grid connected		
Madyan (Foreign Funded)	157MW	Swat	Will be grid connected		
Ranolia (Rehabilitation)	17MW	Ranolia, Kohistan	Loop-in Loop-out Dubair-Khan Khwar Line		
Mujahideen	6.95MW	Torghar	Off-grid	X141	Off-Grid
140 MMHPPs	27.078MW	Bannu, Buner, Charsadda, Chitral Upper, Dir, Kohistan, Mardan, Shangla	Off-Grid		
Total Future Operational Hydro Portfolio	825.388 MW		X10 On-Grid and X141 Off-Grid		

Solar Power

The future operational solar power portfolio extends to **6 projects in total of cumulative 38.32 MW capacity**. These projects are similar to current operational projects as they also target the projects which are handed to the community. Some pertinent details of all these projects are portrayed in Figure 10 and Table 8 below.

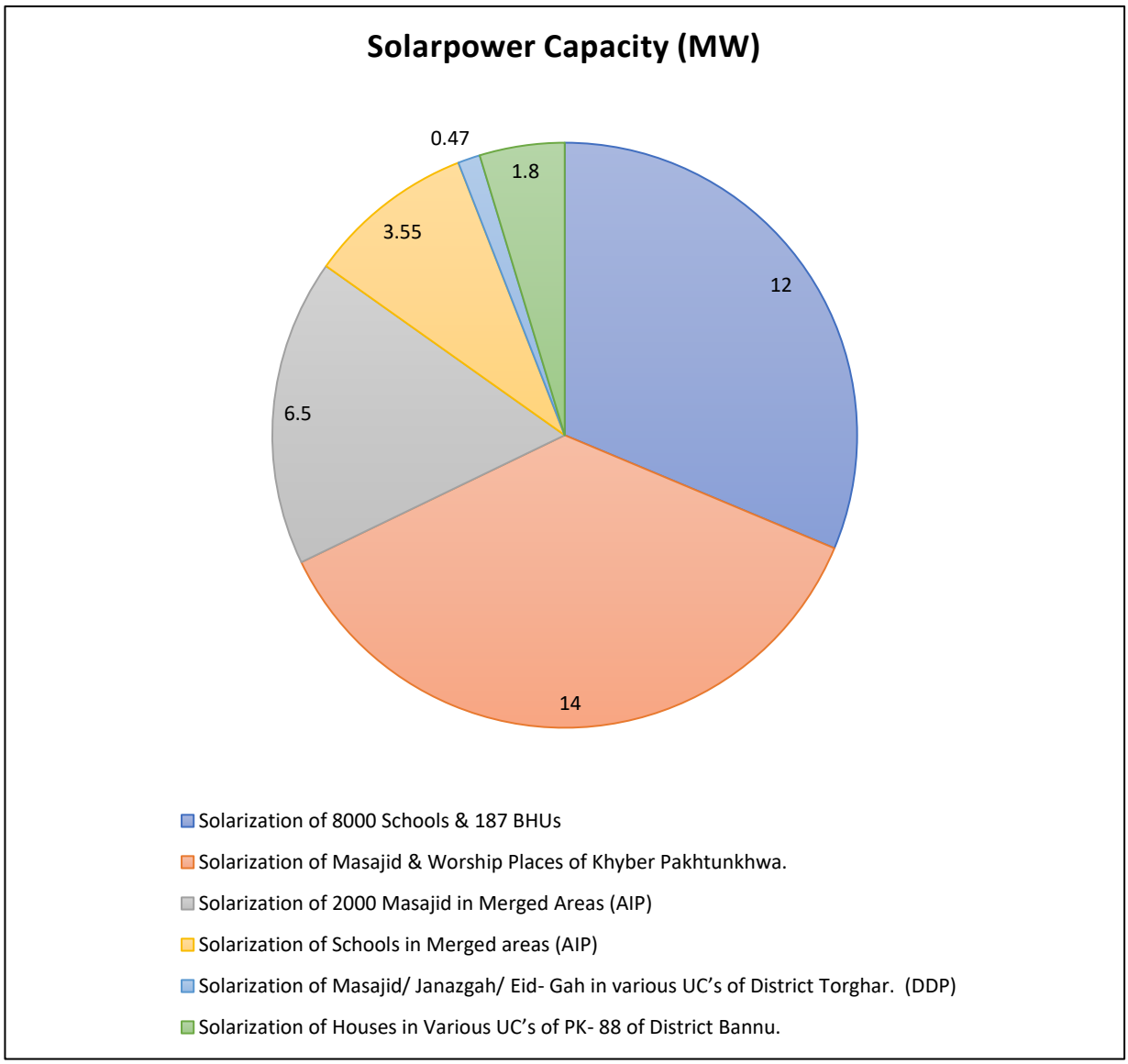


Figure 10: Future Operational Solar Power Capacity

Table 8: Future Operational Solar Power Project Overview

Project Name	Project Capacity	Location/District	Number of Projects	On/Off-Grid
Solarization of 8000 Schools & 187 BHUs	12MW	All Settled Districts	X6	Off-Grid
Solarization of Masajid & Worship Places of Khyber Pakhtunkhwa.	14MW	All Settled Districts		
Solarization of 2000 Masajid in Merged Areas (AIP)	6.5MW	All Merged Districts		
Solarization of Schools in Merged areas (AIP)	3.55MW	All Merged Districts		
Solarization of Houses in Various UCs of PK- 88 of District Bannu.	1.8MW	District Bannu		
Solarization of Masajid/ Janazgah/ Eid- Gah in various UCs of District Torghar. (DDP)	0.47MW	District Torghar		
Total Future Operational Solar Portfolio	**38.32 MW**		**X6 Off-Grid**	

1.5.3 Private Sector Projects

The private sector projects consist of all the projects that are headed by the private sector. As these projects are in early stages of development, data availability is limited for supporting analysis of these projects except Lower Spat Gah (LSG) hydropower project which is operating under the public private partnership (PPP) modality. The details of these projects are as hereunder:

Hydropower

The private sector hydropower portfolio consists of **14 projects in total of cumulative 1633.3 MW capacity**. Some pertinent details of all these projects are portrayed in Figure 11 and Table 9 below.

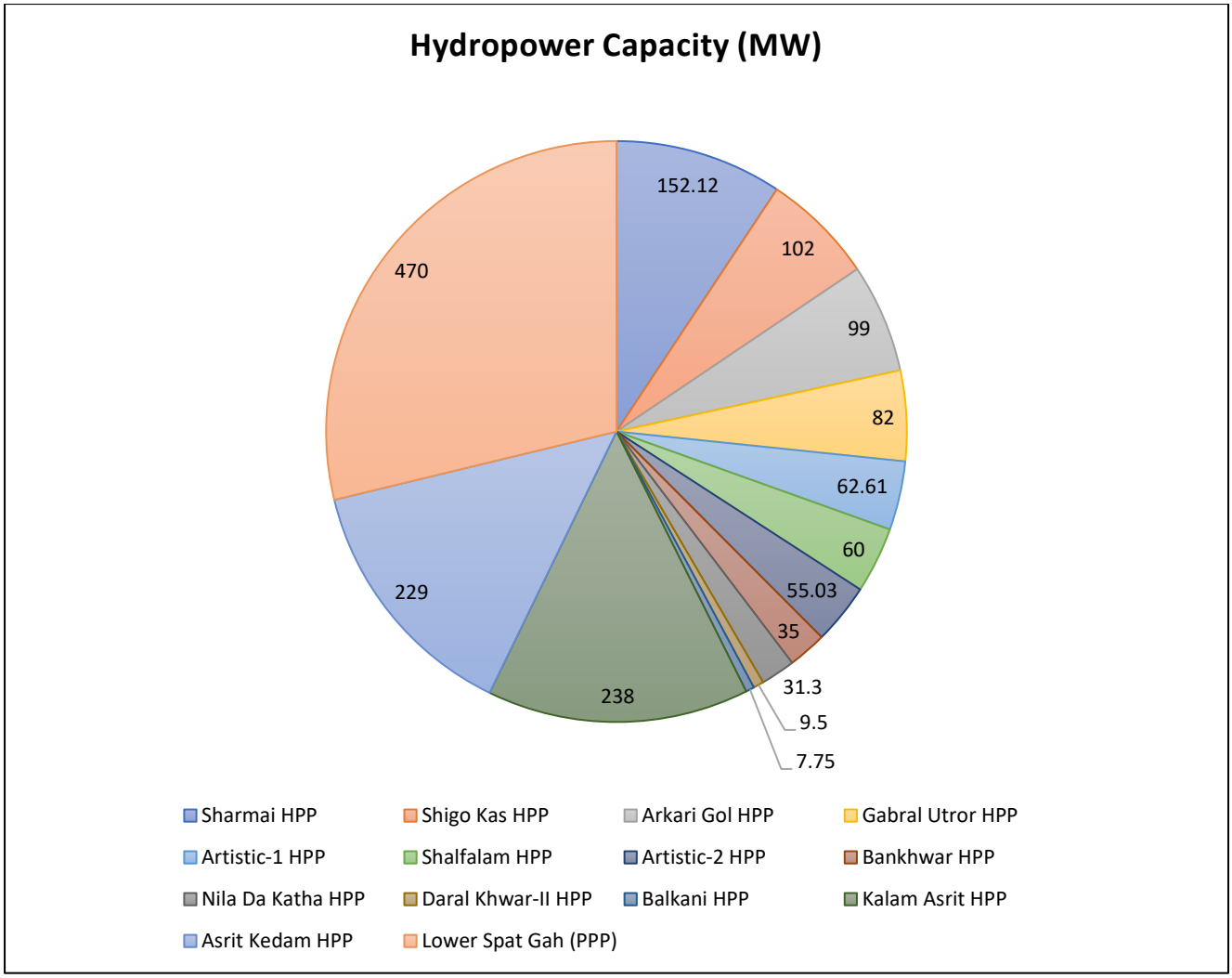


Figure 11: Private Sector Hydropower Capacity

Table 9: Private Sector Hydropower Project Overview

Project Name	Project Capacity	Location/District	Grid Detail
Lower Spat Gah	470MW	Upper Kohistan	Grid Connected
Kalam Asrit	238MW	Swat	
Asrit Kedam	229MW	Swat	
Sharmai	152.12MW	Upper Dir	
Shigo Kas	102MW	Lower Dir	
Arkari Gol	99MW	Chitral	
Gabral Utror	82MW	Swat	
Artistic-1	62.61MW	Upper Dir	
Shalfalam	60MW	Upper Dir	
Artistic-2	55.03MW	Swat	
Bankhwar	35MW	Swat	
Nila Da Katha	31.3MW	Mansehra	
Daral Khwar-II	9.5MW	Swat	
Balkani	7.75MW	Shangla	
Total Future Operational Hydro Portfolio	**1,633.3MW**		

Solar Power

The private sector solar power portfolio extends to **5 projects in total of cumulative 249.5 MW capacity**. These are standalone projects that have been provided with Letter of Intents (LOIs), As these projects are in early stages of development, data availability is limited for supporting analysis. Some pertinent details of all these projects are portrayed in Figure 12 and Table 10 below.

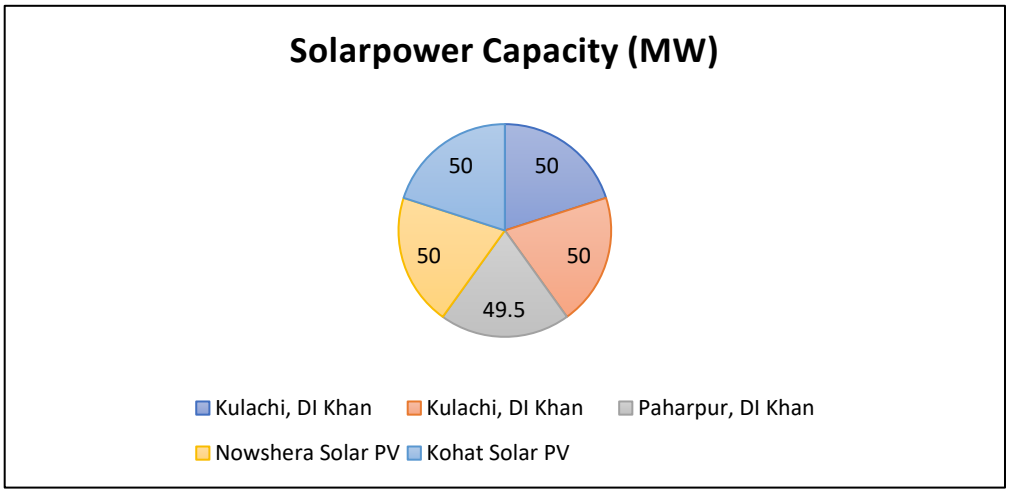


Figure 12: Private Sector Solar Power Capacity

Table 10: Private Sector Solar Power Project Overview

Project Name	Project Capacity	Location/District	Grid Detail
Kulachi, DI Khan	50MW	DI Khan	Grid Connected
Kulachi, DI Khan	50MW	DI Khan	
Paharpur, DI Khan	49.5MW	DI Khan	
Nowshera Solar PV	50MW	Nowshera	
Kohat Solar PV	50MW	Kohat	

2 Project Analyses

This section expands on technical data requirements from PEDO to build on the analysis for gauging the performance of individual projects as per the requirements of crediting mechanisms. It analyzes how they fare for integration and what may be done to enhance the outlook of these particular projects.

2.1 Data Needs Assessment

To conduct a thorough analysis of the PEDO energy portfolio, the following data was solicited from PEDO:

- Generation data from inception to present for installed projects
- Capacity tests and maintenance reports
- IEE/EIA/ESIA for projects with Baseline scenarios
- Quantification of the estimated and actual GHG emissions reductions and removals
- Monitoring reports

A detailed data needs assessment has been conducted in the table 11 below:

Table 11: Data Needs Assessment

	Data Required for Eligibility in Carbon Market					Data Required for Eligibility I-REC	Eligibility Detail		Requirement for Project Registration in Carbon Market Standard					
Commissioned HPP	**Project Capacity**	**Project Source**	**Grid Connectivity**	**Mechanism in place to record generation**	**Commissioning Date**	**Generation Data or Mechanism in place to record generation**	**Eligible (✓) Eligible Subjected to Gen Data Availability (✓*) Ineligible (X)**		**EIA/ESIA**	**Baseline and Emission Quantification as per carbon standards methodology**	**Project Management and Monitoring Plans**	**Conformance reports with social and environmental commitments**	**Proof of Project Additionality**	**Project Maintenance Plans**
Project Name	**Provided (✓) Not Available with PEDO (X) Not Required Since Ineligible for Carbon Market (X*)**						**Any CM**	**IREC**	**Provided (✓) Not Available with PEDO (X) Not Required Since Ineligible for Carbon Market (Area in Grey)**					
Malakand HPP - III	✓	✓	✓	✓	✓	✓	X	✓						
Daral Khwar HPP -I	✓	✓	✓	✓	✓	✓	X	✓						
Pehur HPP	✓	✓	✓	✓	✓	✓	X	✓						
Machai HPP	✓	✓	✓	✓	✓	✓	X	✓						
Reshun HPP	✓	✓	✓	✓	✓	✓	X	✓						
Shishi HPP	✓	✓	✓	✓	✓	✓	X	✓						
Commissioned 316 MMHPPs	✓	✓	✓	X	✓	X	X	✓*						

	Data Required for Eligibility in Carbon Market					Data Required for Eligibility I-REC	Eligibility Detail		Requirement for Project Registration in Carbon Market Standard					
Commissioned HPP	**Project Capacity**	**Project Source**	**Grid Connectivity**	**Mechanism in place to record generation**	**Commissioning Date**	**Generation Data or Mechanism in place to record generation**	**Eligible (✓) Eligible Subjected to Gen Data Availability (✓*) Ineligible (X)**		**EIA/ESIA**	**Baseline and Emission Quantification as per carbon standards methodology**	**Project Management and Monitoring Plans**	**Conformance reports with social and environmental commitments**	**Proof of Project Additionality**	**Project Maintenance Plans**
Project Name	**Provided (✓) Not Available with PEDO (X) Not Required Since Ineligible for Carbon Market (X*)**						**Any CM**	**IREC**	**Provided (✓) Not Available with PEDO (X) Not Required Since Ineligible for Carbon Market (Area in Grey)**					
Commissioned Solar	✓	✓	✓	**X (Except On-Grid)**	✓	**X (Except On-Grid)**	**X**	✓*						
On-going HPP														
Project Name														
Ranolia HPP	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	X	X	X	X
Gorkin Matiltan HPP	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	X	X	X	X
Lawi HPP	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	X	X	X	X
Jabori HPP	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	X	X	X	X

	Data Required for Eligibility in Carbon Market					Data Required for Eligibility I-REC	Eligibility Detail		Requirement for Project Registration in Carbon Market Standard					
Commissioned HPP	**Project Capacity**	**Project Source**	**Grid Connectivity**	**Mechanism in place to record generation**	**Commissioning Date**	**Generation Data or Mechanism in place to record generation**	**Eligible (✓) Eligible Subjected to Gen Data Availability (✓*) Ineligible (X)**		**EIA/ESIA**	**Baseline and Emission Quantification as per carbon standards methodology**	**Project Management and Monitoring Plans**	**Conformance reports with social and environmental commitments**	**Proof of Project Additionality**	**Project Maintenance Plans**
Project Name	**Provided (✓) Not Available with PEDO (X) Not Required Since Ineligible for Carbon Market (X*)**						**Any CM**	**IREC**	**Provided (✓) Not Available with PEDO (X) Not Required Since Ineligible for Carbon Market (Area in Grey)**					
Koto HPP	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	X	X	X	X
Karora HPP	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	X	X	X	X
Chapari Charkhel HPP	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	X	X	X	X
Mujahidin HPP	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	X	X	X	X
Balakot HPP	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	X	X	X	X
Gabral Kalam	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	X	X	X	X
Madyan	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	X	X	X	X
140 On-going MMHPPs	✓	✓	✓	X	✓	X	✓*	✓*	✓	X	X	X	X	X

	Data Required for Eligibility in Carbon Market					Data Required for Eligibility I-REC	Eligibility Detail		Requirement for Project Registration in Carbon Market Standard					
Commissioned HPP	Project Capacity	Project Source	Grid Connectivity	Mechanism in place to record generation	Commissioning Date	Generation Data or Mechanism in place to record generation	Eligible (✓) Eligible Subjected to Gen Data Availability (✓*) Ineligible (X)		EIA/ESIA	Baseline and Emission Quantification as per carbon standards methodology	Project Management and Monitoring Plans	Conformance reports with social and environmental commitments	Proof of Project Additionality	Project Maintenance Plans
Project Name	Provided (✓) Not Available with PEDO (X) Not Required Since Ineligible for Carbon Market (X*)						Any CM	IREC	Provided (✓) Not Available with PEDO (X) Not Required Since Ineligible for Carbon Market (Area in Grey)					
On-going solar	✓	✓	✓	X	✓	X	✓*	✓*	X	X	X	X	X	X
Private Sector														
Private Sector ALL HPP project	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	X	X	X	X
Private Sector ALL Solar project	✓	✓	✓	✓	✓	✓	✓	✓	✓	X	X	X	X	X

	Data Required for Eligibility in Carbon Market					Data Required for Eligibility I-REC	Eligibility Detail	Requirement for Project Registration in Carbon Market Standard					
Commissioned HPP	Project Capacity	Project Source	Grid Connectivity	Mechanism in place to record generation	Commissioning Date	Generation Data or Mechanism in place to record generation	Eligible (✓) Eligible Subjected to Gen Data Availability (✓*) Ineligible (X)	EIA/ESIA	Baseline and Emission Quantification as per carbon standards methodology	Project Management and Monitoring Plans	Conformance reports with social and environmental commitments	Proof of Project Additionality	Project Maintenance Plans
Project Name	Provided (✓) Not Available with PEDO (X) Not Required Since Ineligible for Carbon Market (X*)						Any CM / IREC	Provided (✓) Not Available with PEDO (X) Not Required Since Ineligible for Carbon Market (Area in Grey)					

<u>Eligibility:</u>

> For commissioned HPPs, the EIA/ESIAs are not available with PEDO since these are older projects with these activities not undertaken at that time.

> For 316 commissioned MMHPPs, energy generation data is not available since they have been handed over to the community without PEDO monitoring these projects any further. Whereas, for 140 MMHPPs, recommendation is to monitor energy generations for eligibility given they are an on-going initiative.

> For commissioned Solar, energy generation data is not available for off-grid projects since they have been handed over to the community without PEDO monitoring these projects any further. Whereas, for ongoing solar projects, recommendation is to monitor energy generations for eligibility given they are an on-going initiative

> For I-RECs, it is to be ensured that the monitoring of generation data is in place.

<u>Registration:</u>

> For projects eligible for carbon markets, the data needs highlighted would have to be met in case these projects are to be taken forward for registration. Hence, the gap can be bridged during transaction development of these projects.

PEDO provided GGC with project-specific data and information as indicated in the table above. The shared information included essential parameters such as project name, location, grid connection details, capacity, and electricity generation figures. In addition, PEDO provided Environmental Impact Assessment (EIA) reports for the projects, offering insights into their environmental considerations and compliance measures.

However, for projects found eligible for participation in these markets, further data would be needed, as indicated in the table above. This includes data on emissions reduction baselines and potential MRV (Monitoring, Reporting, and Verification) frameworks for a thorough evaluation of these project's viability and environmental impact. Baseline emissions data are needed to estimate future emissions reductions and calculate the carbon offset potential. MRV frameworks are critical for setting up robust monitoring systems that would allow future compliance with carbon standards. However, this shall be managed during transaction development of the projects found most suitable for market entry.

Challenges Due to Data Gaps

As projects already developed and being developed in routine were focused towards energy generation and not for alignment with carbon markets critical elements that are needed for carbon markets are not included in documents of PEDO. which presents several challenges:

- **Eligibility Assessment for Carbon Markets**: Since baseline and emissions data calculation is crucial for Carbons Markets eligibility it is not possible in its absence to validate emissions reductions, which is essential for certification under standards like Verra, Gold Standard, or GCC. This therefore limits PEDO's ability to access carbon finance.
- **Compliance with Environmental Standard**s: The EIA/ ESIA though available for most projects need to be aligned with the requirements of the Carbon Markets to ensure that projects meet environmental and social safeguards standards, which are often mandatory for international carbon standards and climate finance.
- **Additionality check for carbon market**s: Current operational and pipeline projects were not originally conceived with the intent of entering carbon markets, making it challenging to establish their additionality—whether financial, technical, or legal. This, in turn, hampers their consideration for carbon market mechanisms. To address this issue in future projects, carbon market requirements should be integrated into the project development phase from the outset.
- **Project Performance Evaluatio**n: In case of some projects missing data on derated capacity, maintenance, and actual electricity generation hinders accurate assessment of project's efficiency, reliability, and sustainability.
- **Long-Term Planning and Risk Management**: Absence of feasibility studies and MRV frameworks for future projects impedes long-term strategic planning, as PEDO cannot accurately assess the viability, risks, and potential impact of these projects.

Building on the data received, hydropower and solar projects were analyzed for their eligibility under carbon market standards as detailed in section 2.5. Some projects were found to be deficient in meeting the eligibility criteria set by carbon market standards, primarily due to rules set by the standards and inability to demonstrate additionality, an essential requirement for carbon credits. Additionally, some off-grid projects failed to establish permanence, which is

crucial for ensuring sustained emissions reductions over time. This lack of permanence ultimately disqualified them from being considered for carbon market eligibility.

For under-construction and under-development projects that do appear to meet preliminary eligibility requirements under relevant carbon market standards, PEDO will need to undertake a series of critical actions to qualify for earning carbon credits. These actions include conducting thorough feasibility and environmental impact studies, establishing a centralized data management system, implementing a robust Monitoring, Reporting, and Verification (MRV) framework, and setting up compliance mechanisms. Furthermore, demonstrating co-benefits, such as positive social and environmental impacts, will be essential to enhance the projects' attractiveness to carbon markets and fulfill the standards' requirements.

For projects aiming to claim I-RECs, it is mandatory to record and provide verifiable evidence of electricity generation and its utilization. This requires an established data recording, monitoring, and reporting system to track electricity production and grid feeding accurately. Without such mechanisms in place, these projects would be unable to qualify for I-RECs, as certification requires rigorous documentation of energy generation and usage data.

Addressing the Challenges

To overcome these challenges, particularly for the projects found eligible for carbon markets, PEDO should prioritize the following actions:

1. **Data Collection and Documentation**: Establish a data management system to collect, document, and regularly update critical information for all projects. This includes derated capacity, EIAs/ESIAs, maintenance records, actual electricity generation, and emissions data. A centralized data repository would improve transparency and facilitate easier access to information needed for compliance and reporting.

2. **Conduct Emissions Assessments and Set Baselines:** For both recently operational and future projects that are found eligible for carbon markets, conduct thorough emissions assessments to establish baselines and measure actual emissions reductions. PEDO should engage qualified professionals to measure emissions and develop accurate baseline models, which will support eligibility for carbon credits and ensure transparency.

3. **Implement Comprehensive MRV System**s: Develop and implement MRV frameworks for emissions tracking and project performance monitoring. An MRV system will ensure continuous monitoring of emissions reductions, energy generation, and adherence to ESG (Environmental, Social, and Governance) standards. This system should include third-party verification to enhance credibility.

4. **Perform Feasibility Studies for Future Project**s: For upcoming hydropower and solar projects, conduct feasibility studies to evaluate technical, economic, and environmental viability and additionality. These studies are essential for understanding the potential impact and risks of the projects and for meeting international standards.

5. **Engage with Environmental and Social Consultants:** Collaborate with environmental and social consultants to complete the required EIAs/ESIAs, ensuring projects align with sustainability requirements and are eligible for international certification. This engagement will also facilitate compliance with carbon standards that emphasize social and environmental benefits.

By addressing these data gaps, PEDO can improve the eligibility and attractiveness of its projects for carbon markets and I-RECs, ensuring compliance with international standards and unlocking potential revenue streams from climate finance. This proactive approach will also enhance PEDO's operational efficiency and reputation as a responsible, sustainable energy provider.

Similarly, for projects qualifying under I-RECs, PEDO should implement a robust data management system that continuously monitors and records energy output. This system should include automated data logging devices and periodic reporting protocols to ensure transparency and traceability of energy generation. Engaging third-party verification services could also enhance credibility, helping projects meet the strict I-REC documentation standards.

2.2 PEDO Portfolio Assessment Process for Carbon Markets and IRECs

Figure 13: Steps of Project Analysis

The analysis initiates with energy generation trend assessment done in section 2.3 to gauge how the already established projects compare to their calculated energy generation. This helps understand the on-ground situation and realizing the causes that may have hindered generation output. On these bases, recommendations may be provided for future projects so that they are more prepared and resilient to these effects.

The analysis performed section 2.4 onwards is limited to prevailing standards for screening under the Voluntary Carbon Markets (VCMs) and I-RECs. However, in future if there would be any new market mechanism evolved or introduced or should there be any revision in the requirement of the voluntary carbon market standards, reassessment would be needed.

The assessment of PEDO's energy project portfolio was conducted using a structured approach designed to evaluate eligibility, viability, and operational effectiveness for carbon markets and International renewable energy certificates (I-RECs). This process aligned with established international standards from Verra, Gold Standard, the Global Carbon Council (GCC), and I-REC protocols to ensure project credibility and sustainability. The analysis was carefully built around a set of key criteria, focusing on areas such as standard conformance, project screening, technical viability, social and environmental safeguards, and the presence of robust Monitoring, Reporting, and Verification (MRV) frameworks.

Standard Conformance is the first criterion in this assessment, where each project in PEDO's portfolio is evaluated against eligibility standards specific to carbon markets and I-RECs. At this stage, the precise requirement of each standard applicable to Renewable Energy sources for entry into each market are thoroughly analyzed and expanded in section 2.4 to establish the parameters under which projects would be gauged.

On the basis of the criterion established in section 2.4, **Project Screening** is undertaken to selectively identify projects with potential for entry into carbon markets or I-RECs and presented in section 2.5. This screening also includes baseline emission assessments and additionality

evaluation, on the basis of data available and provided by PEDO for assessing each project, essential to confirm that the projects contribute to emissions reductions beyond what would occur in a business-as-usual scenario. Permanence and risk assessment were also considered to ensure that projects would maintain their carbon benefits over time without reversal risks.

Finally, the eligible screened projects were assessed on their **Technical Viability.** This viability focuses on the **Social and Environmental Performance Analysis** essential to understand how PEDO's projects contribute to positive outcomes while adhering to social and environmental safeguards. This analysis reviewed whether projects avoid negative impacts on ecosystems or water resources and evaluated the extent of community participation in planning and execution. Compliance with these safeguards is a fundamental requirement in the carbon market standards, especially in ensuring the projects are aligned with broader sustainability goals. This analysis is complemented by assessing the **MRV Framework** in place to judge the monitoring provisions set by each screened project suggesting the priorities kept in project design, construction and operations. Effective MRV systems are critical for accurately tracking emissions reductions, periodic reporting, and third-party verification, which together ensure transparency and credibility.

2.3 Current Operational Situation of the PEDO Portfolio

Operation Performance Analysis oversees the performance of each project post-operations. The analysis below delves into the energy generation trends of PEDOs energy projects, outlines distinct challenges faced by these projects, and recommends strategies for enhanced project resilience.

2.3.1 Energy Generation Trend Assessment

Assessing the energy production of commissioned projects is crucial for evaluating their compliance with energy generation commitments and their environmental performance. This analysis helps expand clean electricity provision, whether connected to the grid or off-grid, which might otherwise rely on unclean energy alternatives. By avoiding the use of unclean sources, such as coal, emissions are mitigated, making this analysis directly relevant. For instance, consider an annual energy demand of 10 GWh. If this demand were met using coal energy, the associated emissions would be significant. However, if the same demand is met through clean solar power, emission avoidance is achieved through the use of this clean energy source. Furthermore, credit generation directly aligns with the energy produced by the generating entity. The generation it commits for integration into crediting mechanisms is validated by the Validation Verification Bodies (VVBs) for approvals. An assessment of PEDO's energy portfolio with its generation trends is mentioned in Table 12. It is pertinent to mention here that no generation data for operational solar power projects or MMHPPs is provided by PEDO as they are community projects, PEDO has handed them over to the community and reportedly there are no such data recording/management arrangements. Therefore, a comparison of calculated generation with average generation for the remaining operational hydropower projects is presented in Figure 14:

Table 12: Energy Generation Trend of PEDOs operational portfolio[23]

Project Title	Commissioning Date	Type of Technology	Project Capacity (MW)	Design Capacity Factor	Generation Baseline (GWh)	Generation Trends (GWh)						
						2017	2018	2019	2020	2021	2022	2023
Electrification of Un-Electrified Villages Solar/Alternate Energy Phase II (I&II).	10/29/2021	Solar	0.85	15%	1.1313	PEDO has not provided actual annual generation data for these installations indicating that there is no as such generation data recording, management and reporting mechanism exists at these installations.						
100 Villages Through Solar/Alternate Energy Phase- I	1/31/2021	Solar	0.87	15%	1.155							
Solarization of Civil Secretariate	3/10/2020	Solar	0.49	15%	0.6515							
Solarization of Chief Minister's Secretariat/ Chief Minister's House	5/28/2020	Solar	0.38	15%	0.5044							
"Solar Electrificati	6/30/2020	Solar	0.53	15%	0.7035							

[23] As per the generation data provided by PEDO

Project Title	Commissioning Date	Type of Technology	Project Capacity (MW)	Design Capacity Factor	Generation Baseline (GWh)	Generation Trends (GWh)						
						2017	2018	2019	2020	2021	2022	2023
on of 300 Masajid/Worship Places of non-Muslims in merged Districts of Khyber Pakhtunkhwa. "												
Solarization of Masajid in District Swat and 440 Masajid in District Peshawar	1/27/2022	Solar	2.59	15%	3.4386							
Solarization of Mosques & Worship places in merged Districts of KP AIP	5/30/2022	Solar	1.2	15%	1.5952							
Solar Electrification of 4000 Masajid in	6/30/2022	Solar	7.382	15%	9.7869							

Project Title	Commissioning Date	Type of Technology	Project Capacity (MW)	Design Capacity Factor	Generation Baseline (GWh)	Generation Trends (GWh)								
						2017	2018		2019	2020	2021		2022	2023
Khyber Pakhtunkhwa														
Total Current Operational Solar Portfolio			**14.292**	**15%**	**18.966**									
Daral Khwar	14 May, 2019	Hydro	36.6	48%	154				109	157.3	109		136.1	120.45
Machai	18 May, 2020	Hydro	2.6	69%	15.784					4.656	8.63		7.68	7.76
Malakand-iii	30 May, 2008	Hydro	81	77.5%	549.909	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
						468.42	401.47	357.24	425.39	374.15	340.63	311.67	235.1	108.92
Ranolia	21 September, 2021	Hydro	17	67%	99.52						17.51		12.73	0
Reshun	1999	Hydro	4.2	32%%	13.45	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**
						1.18	0	0	0	0	0	0	11.11	10.99
Pehur	01 March, 2010	Hydro	18	37%	57.7	37.533	38.51		47.896	50.582	55.253		43.471	56.571
Shishi	18 Dec, 2009	Hydro	1.8	26%	4.1	3.45	1.07		1.3	2.3	2.34		2.64	2.17

Project Title	Commissioning Date	Type of Technology	Project Capacity (MW)	Design Capacity Factor	Generation Baseline (GWh)	Generation Trends (GWh)						
						2017	2018	2019	2020	2021	2022	2023
316 MMHPPs	2019-22	Hydro	0.15-0.5 (28.92)	67%	168.8928	PEDO has not provided actual annual generation data for these installations indicating that there is no as such generation data recording, management and reporting mechanism exists at these installations.						
Total Current Operational Hydro Portfolio			173.72		997.17							

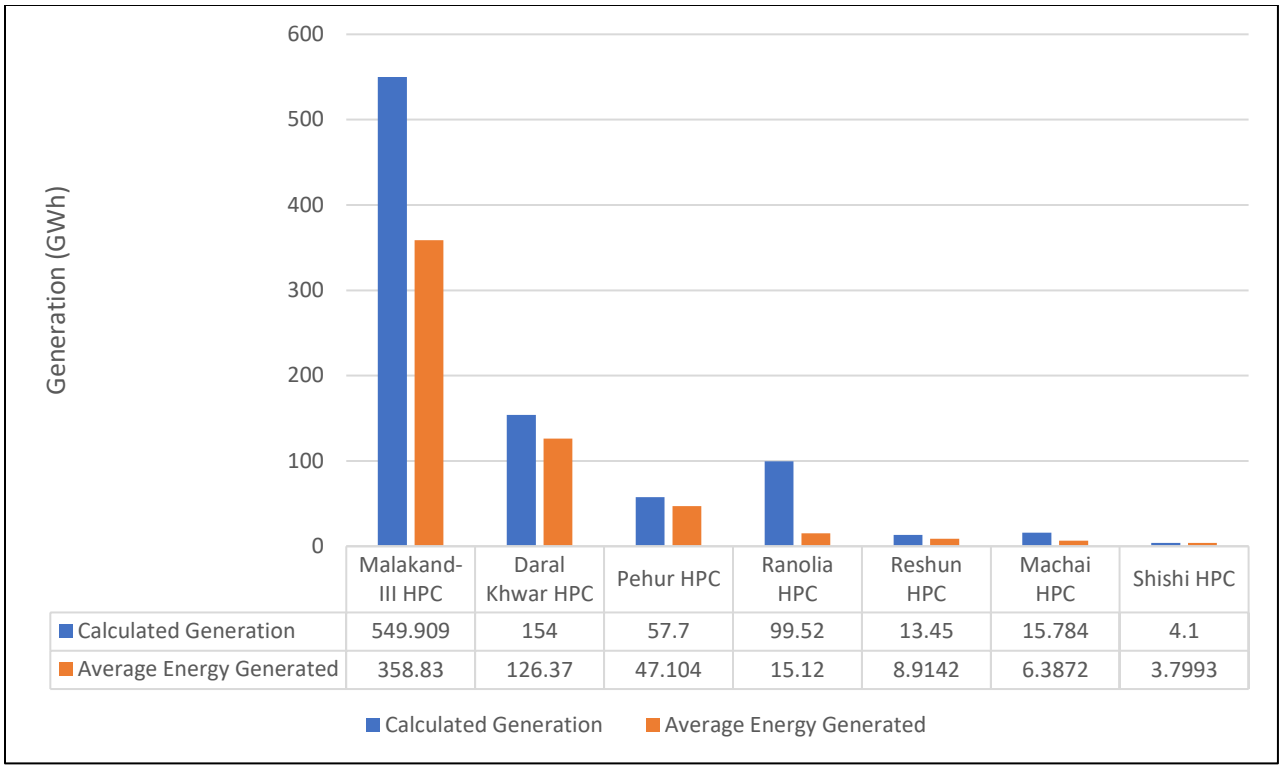


Figure 14: Comparison of Calculated Generation with Average Energy Generation of Projects[24]

The Figure above illustrates that none of the projects consistently achieved their expected generation levels on average. However, performance varied among the projects; for example, Daral Khwar reached approx. 82% of its calculated generation, while, Ranolia achieved only approx. only 15%. The factors contributing to these reduced numbers are examined in section 2.3.2.

2.3.2 Project Operational Challenges and Recommendations

The operational challenges faced by PEDO's projects are multifaceted and significantly impact their ability to achieve design generation capacities. Key issues include natural disasters, financial constraints, and operational inefficiencies. Natural events such as flash floods and heavy rainfall have caused extensive damage to infrastructure, necessitating costly repairs and leading to prolonged operational disruptions. These repairs are often delayed by financial limitations and bureaucratic hurdles, which exacerbate downtime. Additionally, environmental factors like erosion and debris accumulation lead to increased wear and tear on equipment, further reducing efficiency.

Hydropower projects, in particular, face unique challenges related to canal closures, hydrological changes, and seasonal variability, which limit consistent energy production. Changes in hydrology, sometimes due to climate variability, can alter the flow regimes from what was projected in the feasibility stage, leading to discrepancies in design capacity and lower-than-expected generation.

[24] The average energy generation of power plants is calculated by taking average of actual electricity generation based on generation data of each project from the start date of its operations

Inadequate performance monitoring and weaknesses in operations and maintenance further compound these issues, resulting in suboptimal output.

From the discussions, it is ascertained that at the feasibility stage, inadequate understanding of local climate patterns, hydrological conditions and discrepancies in design data would have led to errors in estimating design capacity and capacity factors. Overlooking long-term climate trends during project design and execution means many hydropower plants are not sufficiently resilient to withstand climate-related impacts and are not taking into account the hydrological risks in electricity generation. Without integrating climate change projections, these plants might have remained vulnerable to reduced water availability or altered river flows, which would have directly affected their power generation potential.

Solar projects, especially those located in challenging terrains, encounter distinct difficulties. Topographical complications, logistical challenges, and community barriers hinder the installation and maintenance of solar infrastructure. The remote installations are typically prone to lesser performance as compared to the grid tied power plants. Similarly, generation in installations in urban areas also face generation challenges because of weak operation and maintenance. Additionally, security constraints in remote areas can delay implementation timelines, while grid limitations restrict the penetration of variable renewable energy sources like solar. Because of this, the capacity factors of off-grid solar power applications are typically taken lower than the grid tied installations. From the experience, it is seen that the applications capacity factors of these installations typically range between 14 to 18%. Since PEDO has not maintained generation data from the off-grid applications of solar PV, therefore, PEDO has assumed a conservative capacity factor of 15% in the calculations. This capacity factor number can be assumed for calculations purposes, however, for determining actual capacity factor, a real data recording and monitoring is required.

Since carbon crediting is closely linked to energy generation, reduced output from these challenges directly affects the potential for carbon credits. Addressing these operational inefficiencies and constraints can enhance project viability and maximize the benefits from carbon transactions. Key recommendations include:

- **Incorporating Impacts of Climate Change in Project Design**: Relevant entities including PEDO should take into account impacts of climate change on the hydrology, weather, climate conditions, disasters and other risks while estimating design capacity and design capacity factor.
- **Project Design for Carbon Markets:** The PEDO should take into account the perspective of carbon markets right from the inception, planning and design of the projects, enabling compliance to the relevant provisions, eligibility criteria of the standards, and principals of carbon market mechanisms, proving additionality and permanence and ensuring that the project design results in achieving targeted interventions as required under carbon market standards.
- **Maintaining Long Term Hydrological and Climate Data**: PEDO shall collect, update and maintain long term hydrological and climate data to accurately comprehend their impacts on plant performance during the project life.

- **Improvements in O&M and Data Management**: PEDO must ensure a comprehensive O&M and performance monitoring mechanism, and robust data management and MRV implemented at project sites to avoid mishaps, and ensure better management and performance.
- **Incorporating Climate Resilience into Infrastructure Design**: Ensuring that projects are designed to withstand climate impacts can prevent damage and enhance reliability over time.
- **Building Capacity and Strengthening Maintenance Systems**: Training personnel and investing in robust technological maintenance can improve operational performance and extend equipment life, supporting more consistent energy output.
- **Establishing an Emergency Response Mechanism**: A dedicated emergency response mechanism with clear protocols for rapid response could facilitate prompt repairs and mitigate the effects of natural disasters. Accessing international climate finance may support this initiative.

By addressing these contributing factors such as design capacity miscalculations, climate impacts, and operational inefficiencies PEDO can improve energy production, enhance project resilience, and optimize the benefits from carbon credits.

2.4 Screening Parameters

Every standard sets out their distinct requirements for integration into their crediting mechanisms. These parameters will help in understanding which markets are readily available for PEDOs energy portfolio integration to be taken further for necessary evaluation. The table below expands on the provisions of global standards in terms of their crediting eligibilities:

Table 13: Eligibility Criteria for Standards

STANDARD	PROVISIONS
Verra[25]	• Grid-connected electricity generation activities using hydroelectric and solar PV power plants are excluded from VCS program. Grid-connected means any project whose >50% of total generation is exported to a national or regional grid[26]. • The projects executed for electrification of rural communities using renewable energies (including solar and hydro) can qualify provided these are greenfield projects. Renewable Mini grids of up to 15 MW capacity, and dedicated standalone renewable electricity system for a given consumer i.e. a household; public buildings; and/or small, medium and micro enterprises (SMMEs) are eligible. Electricity uses may include interior lighting, street lighting, refrigeration, or agricultural water pumps. Rehabilitation of non-operational renewable systems that are not generating electricity in their

[25] https://verra.org/wp-content/uploads/2024/04/VCS-Standard-v4.7-FINAL-4.15.24.pdf
[26] https://verra.org/wp-content/uploads/2024/04/VCS-Standard-v4.7-FINAL-4.15.24.pdf

STANDARD	PROVISIONS
	current condition is eligible if substantial investment (over half the cost of a new system) is needed to restore capacity, with proof of non-use for six months or significant rehabilitation costs. Routine and deferred maintenance is not eligible[27]. - In addition to the carbon emissions reduction potential, the standard also requires the projects to demonstrate how these are contributing to SDGs, ensuring stakeholders engagement, and demonstrate that the project must not negatively impact the natural environment or communities[28].
Gold[29]	- For Low Income and Low Middle-Income country like Pakistan, Renewable Energy projects connected to national or a regional electricity grid OR Supplying energy to an identified consumer facility via national/regional grid through a contractual agreement such as wheeling are eligible where the penetration level of the proposed Renewable Energy Technology type is less than 5% of the total grid installed capacity, at the time of the first submission to preliminary review It is mandatory that the project design and planning has met Gold Standard for Global Goals Requirements, including Principles and Requirements, Safeguarding Principles, Stakeholder Consultation and Engagement, Sustainable Development Goals requirements and have developed a compliant Monitoring Plan, duly verified by accredited, approved third party verification body[3031]. - Any Project supplying electricity to a mini-grid, which is not connected to a national or a regional grid is eligible provided the total capacity of the mini-grid does not exceeding 15 MW i.e. the sum of installed capacities of all generators connected to the mini-grid is equal to or less than 15 MW. These projects are exempted from the eligibility requirements and shall follow Gold Standard Community Services Activity Requirements, which requires that the project design and planning has met Gold Standard for Global Goals Requirements, including Principles and Requirements, Safeguarding Principles, Stakeholder Consultation and Engagement, Sustainable Development Goals requirements and have developed a compliant Monitoring Plan, duly verified by accredited, approved third party verification body[3233]. The projects can consist of installation of new microgrid, bringing into operation installed renewable power generation system, which have not been in operation for 6 months or less, however project sponsors need to demonstrate reasons for its stoppage and details of interventions being made to restart the facility[34]

[27] https://cdm.unfccc.int/UserManagement/FileStorage/9N0MH2D8XJL1R5IYC3ZPGK7UBQVSTF
[28] https://verra.org/wp-content/uploads/2024/04/VCS-Standard-v4.7-FINAL-4.15.24.pdf
[29] https://globalgoals.goldstandard.org/202-ar-renewable-energy-activity-requirements/
[30] https://globalgoals.goldstandard.org/standards/201_V1.2_AR_Community-Services-Activity-Requirements.pdf
[31] https://globalgoals.goldstandard.org/101-par-principles-requirements/
[32] https://globalgoals.goldstandard.org/standards/201_V1.2_AR_Community-Services-Activity-Requirements.pdf
[33] https://globalgoals.goldstandard.org/101-par-principles-requirements/
[34] https://globalgoals.goldstandard.org/418-re-suppressed-demand-methodology-micro-scale-electrification-and-energization/

STANDARD	PROVISIONS
Global Carbon Council[35]	Five types of projects (A1, A2, A3, B1 and B2) are eligible under the GCC Program for Renewable Energy, provided they meet the eligibility criteria provided in the Project Standard. **Type A:** These include projects that are not registered under any GHG Program, including the CDM. To submit such type of projects to the GCC Program, the Project Owners shall refer to the Program Process and follow the entire project cycle for registration and issuance of Approved Carbon Credits (ACCs). **Type B:** These projects include all de-registered CDM projects whose Project Owners (or Project Participants as per the CDM Glossary of Terms) wish to register them with the GCC. The start date of the Crediting Period of such GCC projects shall be after 1 Jan 2016 and the same as that stipulated in the registered CDM Project Design Document (as uploaded on the UNFCCC website). Such projects have previously been registered under the CDM, which implies that they have demonstrated compliance with CDM requirements and GCC Rules related to GHG emission reductions (including CDM methodology, global stakeholder consultation (GSC), local stakeholder consultation (LSC), Additionality, and Environmental impacts). For such de-registered CDM projects, ACCs can only be issued by GCC Program after de-registration with the CDM and for the remaining Crediting Period for which CERs have not been issued by the UNFCCC CDM Executive Board, subject to a ceiling of the 10-year crediting period that is allowed under the GCC Program. The project type B is classified into two sub-types (B1 and B2) depending on whether or not the Project Owners wish to apply for additional labels (SDG+, E+ and S+ and the market eligibility flag (e.g., CORSIA)). For submitting such projects to the GCC, the Project Owners shall follow the project cycle, as stipulated in sections 3.1 and 3.2 of the Program Process, for each project type (B1 or B2). Table 14: Project Types Eligible for Registration under the GCC Program.[36]

All projects shall start operations after 1st January 2016				
Description	Type A: Not registered under any GHG Program			Type B: De-registered CDM projects
Project Types	**Type A1**	**Type A2**	**Type A3**	**Type B1 & B2**
Detail	This type includes new futuristic projects,	Prompt-start: Started operations prior to 05072020.[37] Deadline for submitting complete GCC	This type includes projects, not submitted	ACCs can only be issued by GCC Program,

[35] https://www.globalcarboncouncil.com/wp-content/uploads/2024/10/GCC-2.0-Project-Standard_V4.0.pdf

[36] https://www.globalcarboncouncil.com/wp-content/uploads/2024/10/GCC-2.0-Project-Standard_V4.0.pdf

[37] The date of approval of this document by the GCC Steering Committee is 5 July 2020.

STANDARD	PROVISIONS				
		not submitted to any GHG Program, which shall start operations after submission of complete document for GCC registration request	registration requests: 05072022.[38](This is not applicable since the closing date for registration i.e. 05-07-22 has passed)	to any GHG Program, which shall make initial submission to the GCC Program on or after 5 July 2022 and initial submission shall be either prior to the start of operation or within one year from the date of start of project operation.	after CDM de-registration, for the remaining crediting period for which CERs have not been issued, subject to a ceiling of 10 years under GCC Program. (This is not applicable since none of the candidates of PEDOs energy portfolio were registered under CDM)
	The projects must ensure that they have ensured environmental and social no-net harm and contributed to at-least two SDGs with climate action being the mandatory one. The Distributed Power Projects may be comprised of multiple power units, at one or single site or distributed in multiple sites with a maximum capacity of an individual unit of 100 kW. An example of DPPs is residential rooftop solar PVs, which supply electricity to the grid in addition to meeting the domestic electricity demand.				
I-RECs[39]	☐ The stakeholders involved may only register if they follow the provisions in the I-REC code for electricity ☐ Any RE device is eligible provided the information it provides is true and transparent conforming to the requisites of the I-REC code.				

[38] Within 2 years after 5 July 2020, which is the date of approval of this document by the GCC Steering Committee.
[39] https://www.trackingstandard.org/product-code/electricity/

STANDARD	PROVISIONS
	A Registrant must be the Production Facility Owner or duly appointed by the Production Facility Owner. Proof of this status will be required. Such proof may be a copy of the legal ownership or an Owner's Declaration. The registration process may be commenced at any time but cannot be completed before the Production Facility is substantially complete in engineering terms and capable of electricity generation. It is the Registrant's responsibility to satisfy the Issuer that the proposed registration is valid and that the output of the Production Facility is eligible for issuing of I-REC(E)s. The Issuer can request any additional information it deems necessary to verify the eligibility of a submitted Production Facility registration. The Production Facility: o Shall normally be defined as the full or partial collection of generation units that exist within a single unique connection to a public electricity network, which may be a common busbar or substation shared with other generators and consumers; o Shall, where multiple points of connection to a public electricity network exist, be permitted only where evidence of contiguous ownership of electrical or land assets that explicitly relate all generation units within such contiguous ownership is provided; and o Shall be capable of being controlled and dispatched either as a single generating unit or through a common generation control and dispatch system; and o Shall have normally been planned at the time of first construction works as a single generation project and, where capacity increases have occurred, these shall have been directly integrated with any pre-existing generation units inside the contiguous asset boundary; and o May, at the sole discretion of the Issuer, be considered as a single Production Device where multiple generation units have been placed under different ownership as part of a wider integrated project (e.g. a community-funded wind farm). Such cases shall be limited to projects where there is: o Documented contiguous private ownership of electrical or land assets that explicitly relate all generation units within such contiguous private ownership; and o Pre-construction documentation to support that the project was initiated with all generation units explicitly identified for potential development. If the production is being utilized for self-utility, it shall open a self-redemption account to account for the energy units utilized by the utility.

2.5 Project Screening

As per the stated criteria in section 2.4, the projects are screened and shortlisted on the specified requirements of the relevant standards. The status as mentioned for each project means, the operational projects are those which are supplying electricity to the grid, Under Construction projects which are in construction phase, Under Development are those projects which are at feasibility stage and yet to start their construction and Rehabilitation mentioning that project which was commissioned earlier but was flooded and is now being reconstructed. The shortlisted candidates are as mentioned below:

Table 15: Screening of PEDO Energy Portfolio for Eligibility Against Verra Standard

Project Name	Location	Project Capacity (MW)	On-Grid/Off-Grid	Eligibility	Comments
Current Operational Large Hydropower Plants					
Malakand III	Dargai, Malakand	81	On-Grid	Not Eligible	These are old operational projects that are on-grid. Verra does not accept On-grid hydropower.
Daral Khwar	Behrain, District Swat	36.6	On-Grid		
Pehur	Road No. L-1, Gadoon Amazai, Distt. Swabi, KP.	18	On-Grid		
Total Current Operational Large Hydropower Plants		135.6			
Current Operational Small and Mini Hydropower Plants					
Shishi	Shishi, Tehsil Drosh, District Lower Chitral	1.8	On-Grid	Not Eligible	These are old operational projects that are on-grid. Verra does not accept On-grid hydropower. While Reshun is off-grid but it was not developed as per

Project Name	Location	Project Capacity (MW)	On-Grid/Off-Grid	Eligibility	Comments
Machai	Alo, Mardan	2.6	On-Grid		the conformity requirements of carbon market standards.
Reshun	Reshun Gol, District Upper Chitral	4.8	Off-Grid		
Total Current Operational Small and Mini Hydropower Plants		9.2			
Current Operational Micro Hydropower Plants					
316 MMHPPs	Varies	28.92 (Cumulative)	Off-Grid	Not Eligible	These are older operational projects whose rehabilitation is not under discussion. The projects have been handed over to the community and data on these is not readily available.
Total Current Operational Hydropower Plants		**173.72**			
Current Operational Solar PV Installations					
Electrification of 100 Villages Through Solar/Alternate Energy Phase-I.	Central & Southern Districts	0.87	Off-Grid	Not Eligible	These are older operational projects whose rehabilitation is not under discussion. The projects have been handed over to the community and data on these is not readily available.
Electrification of Un-Electrified Villages Solar/Alternate Energy Phase II (I&II).	District Chitral	0.85	Off-Grid		
Solarization of Civil Secretariate.	District Peshawar	0.49	Off-Grid		
Solarization of Chief	District Peshawar	0.38	Off-Grid		

Project Name	Location	Project Capacity (MW)	On-Grid/Off-Grid	Eligibility	Comments
Minister's Secretariat/ Chief Minister's House.					
Solar Electrification of 4000 Masajid in Khyber Pakhtunkhwa.	All Settled Districts	7.38	Off-Grid		
Solar Electrification of 300 Masajid/Worship Places of Non-Muslims in merged Districts of Khyber Pakhtunkhwa.	Districts Khyber, Bajaur Mohmand, Kurram, Orakzai NW & SW	0.53	Off-Grid		
Solarization of Masajid in District Swat and 440 Masajid in District Peshawar.	District Swat & District Peshawar	2.59	Off-Grid		
Solarization of Masajid in merged Districts of KP (AIP).	Districts Khyber, Bajaur Mohmand, Kurram, Orakzai NW, SW FR Lakki, FR Bannu, FR Peshawar, FR Tank, FR DI Khan FR Kohat	1.2	Off-Grid		
Total Operational Solar PV Installations		14.29			
Future Operational Large Hydropower Plans					

Project Name	Location	Project Capacity (MW)	On-Grid/Off-Grid	Eligibility	Comments
Gorkin Matiltan	Kalam, Tehsil Bahrain, District Swat	84	On-Grid	Not Eligible	Verra does not accept On-grid hydropower projects.
Koto	Dir (Lower)	40.8	On-Grid		
Lawi	Lower Chitral	69	On-Grid		
Balakot	Tehsil Balakot, District Mansehra	300	On-Grid		
Gabral Kalam	Swat	88	On-Grid		
Madyan	Swat	157	On-Grid		
Ranolia	Ranolia, Kohistan	17	On-Grid		
Total Future Operational Large Hydropower Plans		755.8			
Future Operational Small and Mini Hydropower Plans					
Karora	Shangla	11.8	On-Grid	Not Eligible	Verra does not accept On-grid hydropower
Jabori	Mansehra	10.2	On-Grid		
Chapri Charkhel	Lower Kurram	13.56	On-Grid		
Mujahideen	Torghar	6.95	Off-Grid	Eligible	Can be potential carbon market project under Verra. To improve its viability, a comprehensive ESIA, assessment related to SDG contribution, community engagement, data management mechanisms and robust Marwood need to be developed at the time of execution and operations.

Project Name	Location	Project Capacity (MW)	On-Grid/Off-Grid	Eligibility	Comments
Total Future Operational Small and Mini Hydropower Plans		42.51			
Total Future Operational Micro Hydropower Plans					
140MMHPPs	Varies	27.078	Off-Grid	Eligible	Can be potential carbon market projects under Verra. To improve its viability, a comprehensive ESIA, assessment related to SDG contribution, community engagement, data management mechanisms and robust MRV would need to be developed at the time of execution and operations. PEDO to ensure projects permanence, operations and risk mitigation during execution and operations.
Total Future Hydropower Plants		825.388			
Future Operational Solar PV Installations					
Solarization of 8000 Schools & 187 BHUs	All Settled Districts	12	Off-Grid	Eligible	Can be potential carbon market projects under Verra. To improve its viability, a comprehensive ESIA, assessment related to SDG contribution, community engagement, data management mechanisms and robust MRV would need to be developed at the time of execution and operations. PEDO to ensure projects permanence and risk mitigation during execution and operations.
Solarization of Masajid & Worship Places of Khyber Pakhtunkhwa.	All Settled Districts	14	Off-Grid		
Solarization of 2000 Masajid in Merged Areas (AIP)	All Merged Districts	6.5	Off-Grid		
Solarization of Schools in Merged areas (AIP)	All Merged Districts	3.55	Off-Grid		
Solarization of Houses in Various UCs of PK- 88 of District Bannu.	District Bannu	1.8	Off-Grid		
Solarization of Masajid/	District Torghar	0.47	Off-Grid		

Project Name	Location	Project Capacity (MW)	On-Grid/Off-Grid	Eligibility	Comments
Janazgah/ Eid-Gah in various UCs of District Torghar. (DDP)					
Total Future Operational Solar PV Installations		38.32			
Future Operational IPP Based Hydropower Plants					
Kalam Asrit HPP	Swat	238	On-Grid	Not Eligible	Verra does not accept On-grid hydropower
Asrit Kedam HPP	Swat	229	On-Grid		
Sharmai HPP	Upper Dir	152.12	On-Grid		
Shigo Kas HPP	Lower Dir	102	On-Grid		
Arkari Gol HPP	Chitral	99	On-Grid		
Gabral Utror HPP	Swat	82	On-Grid		
Artistic-1 HPP	Upper Dir	62.61	On-Grid		
Shalfalam HPP	Upper Dir	60	On-Grid		
Artistic-2 HPP	Swat	55.03	On-Grid		
Bankhwar HPP	Swat	35	On-Grid		
Nila Da Katha HPP	Mansehra	31.3	On-Grid		
Lower Spat Gah	Upper Kohistan	470	On-Grid		
Total		1,616.06			
Future Operational Private Sector Small Hydropower Plants					
Daral Khwar-II HPP	Swat	9.5	On-Grid	Not Eligible	Verra does not accept On-grid hydropower
Balkani HPP	Shangla	7.75	On-Grid		
Total Future Operational Private Sector Small Hydropower Plants		17.25			
Total Private Sector Hydropower including PPP Project		1633.31			
Future Operational Private Sector Solar PV Powe Plants					
Kulachi, DI Khan	DI Khan	50	On-Grid	Not Eligible	On-Grid solar power plants are ineligible to participate in carbon markets under Verra Standard.
Kulachi, DI Khan	DI Khan	50	On-Grid		
Paharpur, DI Khan	DI Khan	49.5	On-Grid		
Nowshera Solar PV	Nowshera	50	On-Grid		

Project Name	Location	Project Capacity (MW)	On-Grid/Off-Grid	Eligibility	Comments
Kohat Solar PV	Kohat	50	On-Grid		
Total Future Operational Private Sector Solar PV Powe Plants		249.5			

Table 16: Screening of PEDO Energy Portfolio for Eligibility Against Gold Standard

Project Name	Location	Project Capacity (MW)	On-Grid/Off-Grid	Eligibility	Comments
Current Operational Large Hydropower Plants					
Malakand III	Dargai, Malakand	81	On-Grid	Not Eligible	On-Grid Hydropower Plants supplying electricity to grid. Hydropower plants are as a whole ineligible under Gold Standard since the share of hydropower in electricity is 25% i.e. more than 5%.
Daral Khwar	Behrain, District Swat	36.6	On-Grid		
Pehur	Road No. L-1, Gadoon Amazai, Distt. Swabi, KP.	18	On-Grid		
Total Current Operational Large Hydropower Plants		135.6			
Current Operational Small and Mini Hydropower Plants					
Shishi	Shishi, Tehsil Drosh, District Lower Chitral	1.8	On-Grid	Not Eligible	On-Grid Hydropower Plants supplying electricity to grid. Hydropower plants are as a whole ineligible under Gold Standard since the share of hydropower in electricity is 25% i.e. more than 5%. Older Projects. Reshun is off-grid but it was not developed as per the conformity requirements of carbon market standards
Machai	Alo, Mardan	2.6	On-Grid		
Reshun	Reshun Gol, District Upper Chitral	4.8	Off-Grid		

Project Name	Location	Project Capacity (MW)	On-Grid/Off-Grid	Eligibility	Comments
Total Current Operational Small and Mini Hydropower Plants		9.2			
Current Operational Micro Hydropower Plants					
316 MMHPPs	Varies	28.92 (Cumulative)	Off-Grid	Not Eligible	These are older operational projects whose rehabilitation is not under discussion. The projects have been handed over to the community and data on these is not readily available.
Total Current Operational Hydropower Plants		**173.72**			
Current Operational Solar PV Installations					
Electrification of 100 Villages Through Solar/Alternate Energy Phase-I.	Central & Southern Districts	0.87	Off-Grid	Not Eligible	These are older operational projects whose rehabilitation is not under discussion. The projects have been handed over to the community and data on these is not readily available.
Electrification of Un-Electrified Villages Solar/Alternate Energy Phase II (I&II).	District Chitral	0.85	Off-Grid		
Solarization of Civil Secretariate.	District Peshawar	0.49	Off-Grid		
Solarization of Chief Minister's Secretariat/ Chief Minister's House.	District Peshawar	0.38	Off-Grid		
Solar Electrification of 4000 Masajid in Khyber Pakhtunkhwa.	All Settled Districts	7.38	Off-Grid		
Solar Electrification	Districts Khyber,	0.53	Off-Grid		

Project Name	Location	Project Capacity (MW)	On-Grid/Off-Grid	Eligibility	Comments
of 300 Masajid/Worship Places of Non-Muslims in merged Districts of Khyber Pakhtunkhwa.	Bajaur Mohmand, Kurram, Orakzai NW & SW				
Solarization of Masajid in District Swat and 440 Masajid in District Peshawar.	District Swat & District Peshawar	2.59	Off-Grid		
Solarization of Masajid in merged Districts of KP (AIP).	Districts Khyber, Bajaur Mohmand, Kurram, Orakzai NW, SW FR Lakki, FR Bannu, FR Peshawar, FR Tank, FR DI Khan FR Kohat	1.2	Off-Grid		
Total Operational Solar PV Installations		14.29			
Future Operational Large Hydropower Plans					
Gorkin Matiltan	Kalam, Tehsil Bahrain, District Swat	84	On-Grid	Not Eligible	On-Grid Hydropower Plants designed to supply electricity to grid. On-grid Hydropower plants are as a whole ineligible under Gold Standard since the share of hydropower in electricity is 25% i.e. more than 5%.
Koto	Dir (Lower)	40.8	On-Grid		
Lawi	Lower Chitral	69	On-Grid		
Balakot	Tehsil Balakot, District Mansehra	300	On-Grid		

Project Name	Location	Project Capacity (MW)	On-Grid/Off-Grid	Eligibility	Comments
Gabral Kalam	Swat	88	On-Grid		
Madyan	Swat	157	On-Grid		
Ranolia	Ranolia, Kohistan	17	On-Grid		
Total PA Harpur Future Operational Large Hydropower Plans		755.8			
Future Operational Small and Mini Hydropower Plans					
Karora	Shangla	11.8	On-Grid	Not Eligible	On-Grid Hydropower Plants designed to supply electricity to grid. Hydropower plants are as a whole ineligible under Gold Standard since the share of hydropower in electricity is 25% i.e. more than 5%. Can be potential carbon market project under Gold Standard if these projects are redesigned to supply electricity to off-grid communities. To improve its viability, a comprehensive technical feasibility, ESIA, assessment related to SDG contribution, community engagement, data management mechanisms and robust MRV would need to be developed at the time of execution and operations.
Jabori	Mansehra	10.2	On-Grid		
Chapri Charkhel	Lower Kurram	13.56	On-Grid		
Mujahideen	Torghar	6.95	Off-Grid	Eligible	Can be potential carbon market project under Gold

Project Name	Location	Project Capacity (MW)	On-Grid/Off-Grid	Eligibility	Comments
					Standard. To improve its viability, a comprehensive ESIA, assessment related to SDG contribution, community engagement, data management mechanisms and robust MRV would need to be developed at the time of execution and operations.
Total Future Operational Small and Mini Hydropower Plans		42.51			
Total Future Operational Micro Hydropower Plans					
140MMHPPs	Varies	27.078	Off-Grid	Eligible	Can be potential carbon market projects under Verra. To improve its viability, a comprehensive ESIA, assessment related to SDG contribution, community engagement, data management mechanisms and robust MRV would need to be developed at the time of execution and operations. PEDO to ensure projects permanence, operations and risk mitigation during execution and operations.
Total Future Hydropower Plants		825.388			
Future Operational Solar PV Installations					
Solarization of 8000 Schools & 187 BHUs	All Settled Districts	12	Off-Grid	Eligible	Can be potential carbon market projects under Verra. To improve its viability, a comprehensive ESIA, assessment related to SDG contribution, community engagement, data management mechanisms and robust MRV would need to be developed at the time of execution and operations. PEDO to ensure projects
Solarization of Masajid & Worship Places of Khyber Pakhtunkhwa.	All Settled Districts	14	Off-Grid		
Solarization of 2000 Masajid in Merged Areas (AIP)	All Merged Districts	6.5	Off-Grid		

Project Name	Location	Project Capacity (MW)	On-Grid/Off-Grid	Eligibility	Comments
Solarization of Schools in Merged areas (AIP)	All Merged Districts	3.55	Off-Grid		permanence and risk mitigation during execution and operations.
Solarization of Houses in Various UCs of PK- 88 of District Bannu.	District Bannu	1.8	Off-Grid		
Solarization of Masajid/ Janazgah/ Eid-Gah in various UCs of District Torghar. (DDP)	District Torghar	0.47	Off-Grid		
Total Future Operational Solar PV Installations		38.32			
Future Operational IPP Based Hydropower Plants					
Kalam Asrit HPP	Swat	238	On-Grid	Not Eligible	On-Grid Hydropower Plants designed to supply electricity to grid. Hydropower plants are as a whole ineligible under Gold Standard since the share of hydropower in electricity is 25% i.e. more than 5%.
Asrit Kedam HPP	Swat	229	On-Grid		
Sharmai HPP	Upper Dir	152.12	On-Grid		
Shigo Kas HPP	Lower Dir	102	On-Grid		
Arkari Gol HPP	Chitral	99	On-Grid		
Gabral Utror HPP	Swat	82	On-Grid		
Artistic-1 HPP	Upper Dir	62.61	On-Grid		
Shalfalam HPP	Upper Dir	60	On-Grid		
Artistic-2 HPP	Swat	55.03	On-Grid		
Bankhwar HPP	Swat	35	On-Grid		
Nila Da Katha HPP	Mansehra	31.3	On-Grid		
Lower Spat Gah (PPP)	Upper Kohistan	470	On-Grid		
Total		1,616.06			
Future Operational Private Sector Small Hydropower Plants					

Project Name	Location	Project Capacity (MW)	On-Grid/Off-Grid	Eligibility	Comments
Daral Khwar-II HPP	Swat	9.5	On-Grid	Not Eligible	On-Grid Hydropower Plants designed to supply electricity to grid. Hydropower plants are as a whole ineligible under Gold Standard since the share of hydropower in electricity is 25% i.e. more than 5%. Can be potential carbon market project under Gold Standard if these are redesigned to supply electricity for off-grid/Mini grids. To improve project viability for this purpose, a comprehensive technical feasibility, ESIA, assessment related to SDG contribution, community engagement, data management mechanisms and robust MRV would need to be developed at the time of execution and operations.
Balkani HPP	Shangla	7.75	On-Grid		
Total Future Operational Private Sector Small Hydropower Plants		17.25			
Total Private Sector Hydropower including PPP Project		1633.31			
Future Operational Private Sector Solar PV Powe Plants					
Kulachi, DI Khan	DI Khan	50	On-Grid	Eligible	Can be potential carbon market projects under Gold Standard since share of solar PV in the national grid is still less than 5% i.e. 3%. However, PEDO needs to engage with NEPRA and NTDC for inclusion of these power plants in the generation planning, or work with private sector to supply electricity from
Kulachi, DI Khan	DI Khan	50	On-Grid		

Project Name	Location	Project Capacity (MW)	On-Grid/Off-Grid	Eligibility	Comments
Paharpur, DI Khan	DI Khan	49.5	On-Grid		these plants in the power market. To improve viability of these projects, PEDO may work with the private sector to undertake comprehensive technical studies, ESIA, assessment related to SDG contribution, community engagement, data management mechanisms and robust MRV. PEDO to ensure projects permanence, operations and risk mitigation during execution and operations.
Nowshera Solar PV	Nowshera	50	On-Grid		
Kohat Solar PV	Kohat	50	On-Grid		
Total Future Operational Private Sector Solar PV Powe Plants		249.5			

Table 17: Screening of PEDO Energy Portfolio for Eligibility Against Global Carbon Council (GCC)

Project Name	Location	Project Capacity (MW)	On-Grid/Off-Grid	Eligibility	Comments
Current Operational Large Hydropower Plants					
Malakand III	Dargai, Malakand	81	On-Grid	Not Eligible	Not Eligible since more than one year has passed since the start of project operations. .
Daral Khwar	Behrain, District Swat	36.6	On-Grid		
Pehur	Road No. L-1, Gadoon Amazai, Distt. Swabi, KP.	18	On-Grid		
Total Current Operational Large Hydropower Plants		135.6			
Current Operational Small and Mini Hydropower Plants					
Shishi	Shishi, Tehsil Drosh, District Lower Chitral	1.8	On-Grid	Not Eligible	Not Eligible since more than one year has passed since the start of project operations.
Machai	Alo, Mardan	2.6	On-Grid		
Reshun	Reshun Gol, District Upper Chitral	4.8	Off-Grid		

Project Name	Location	Project Capacity (MW)	On-Grid/Off-Grid	Eligibility	Comments
Total Current Operational Small and Mini Hydropower Plants		9.2			
Current Operational Micro Hydropower Plants					
316 MMHPPs	Varies	28.92 (Cumulative)	Off-Grid	Not Eligible	Not Eligible since more than one year has passed since the start of project operations. Ownership handed over to the community. No evidence of electricity generation data and plant performance details maintained/.
Total Current Operational Hydropower Plants		**173.72**			
Current Operational Solar PV Installations					
Electrification of 100 Villages Through Solar/Alternate Energy Phase-I.	Central & Southern Districts	0.87	Off-Grid	Not Eligible	Not Eligible since more than one year has passed since the start of project operations. Ownership handed over to the community. No evidence of electricity generation data and plant performance details maintained/. Rehabilitation of these projects is not under discussion.
Electrification of Un-Electrified Villages Solar/Alternate Energy Phase II (I&II).	District Chitral	0.85	Off-Grid		
Solarization of Civil Secretariate.	District Peshawar	0.49	Off-Grid		
Solarization of Chief Minister's Secretariat/ Chief Minister's House.	District Peshawar	0.38	Off-Grid		
Solar Electrification of 4000 Masajid in Khyber Pakhtunkhwa.	All Settled Districts	7.38	Off-Grid		

Project Name	Location	Project Capacity (MW)	On-Grid/Off-Grid	Eligibility	Comments
Solar Electrification of 300 Masajid/Worship Places of Non-Muslims in merged Districts of Khyber Pakhtunkhwa.	Districts Khyber, Bajaur Mohmand, Kurram, Orakzai NW & SW	0.53	Off-Grid		
Solarization of Masajid in District Swat and 440 Masajid in District Peshawar.	District Swat & District Peshawar	2.59	Off-Grid		
Solarization of Masajid in merged Districts of KP (AIP).	Districts Khyber, Bajaur Mohmand, Kurram, Orakzai NW, SW FR Lakki, FR Bannu, FR Peshawar, FR Tank, FR DI Khan FR Kohat	1.2	Off-Grid		
Total Operational Solar PV Installations		14.29			
Future Operational Large Hydropower Plans					
Gorkin Matiltan	Kalam, Tehsil Bahrain, District Swat	84	On-Grid	Eligible	Can be potential carbon market projects under GCC. To improve its viability, a comprehensive ESIA, assessment related to SDG contribution, community engagement, data management mechanisms and robust MRV would need to be developed at the time of execution and operations.
Koto	Dir (Lower)	40.8	On-Grid		
Lawi	Lower Chitral	69	On-Grid		
Balakot	Tehsil Balakot, District Mansehra	300	On-Grid		
Gabral Kalam	Swat	88	On-Grid		
Madyan	Swat	157	On-Grid		

Project Name	Location	Project Capacity (MW)	On-Grid/Off-Grid	Eligibility	Comments
Ranolia	Ranolia, Kohistan	17	On-Grid		
Total Future Operational Large Hydropower Plans		755.8			
Future Operational Small and Mini Hydropower Plans					
Karora	Shangla	11.8	On-Grid	Eligible	Can be potential carbon market projects under GCC. To improve its viability, a comprehensive ESIA, assessment related to SDG contribution, community engagement, data management mechanisms and robust MRV would need to be developed at the time of execution and operations.
Jabori	Mansehra	10.2	On-Grid		
Chapri Charkhel	Lower Kurram	13.56	On-Grid		
Mujahideen	Torghar	6.95	Off-Grid		
Total Future Operational Small and Mini Hydropower Plans		42.51			
Total Future Operational Micro Hydropower Plans					
140MMHPPs	Varies	27.078	Off-Grid	Eligible	Can be potential carbon market projects under Verra. To improve its viability, a comprehensive ESIA, assessment related to SDG contribution, community engagement, data management mechanisms and robust MRV would need to be developed at the time of execution and operations. PEDO to ensure projects permanence, operations and risk mitigation during execution and operations.
Total Future Hydropower Plants		825.388			
Future Operational Solar PV Installations					
Solarization of 8000 Schools & 187 BHUs	All Settled Districts	12	Off-Grid	Eligible	Can be potential carbon market projects under GCC. To improve its viability, a comprehensive ESIA, assessment related
Solarization of Masajid &	All Settled Districts	14	Off-Grid		

Project Name	Location	Project Capacity (MW)	On-Grid/Off-Grid	Eligibility	Comments
Worship Places of Khyber Pakhtunkhwa.					to SDG contribution, no harm to the environment, community engagement, data management mechanisms and robust MRV would need to be developed at the time of execution and operations. PEDO to ensure projects permanence and risk mitigation during execution and operations.
Solarization of 2000 Masajid in Merged Areas (AIP)	All Merged Districts	6.5	Off-Grid		
Solarization of Schools in Merged areas (AIP)	All Merged Districts	3.55	Off-Grid		
Solarization of Houses in Various UCs of PK- 88 of District Bannu.	District Bannu	1.8	Off-Grid		
Solarization of Masajid/ Janazgah/ Eid-Gah in various UCs of District Torghar. (DDP)	District Torghar	0.47	Off-Grid		
Total Future Operational Solar PV Installations		38.32			
Future Operational IPP Based Hydropower Plants					
Kalam Asrit HPP	Swat	238	On-Grid	Eligible	Can be potential carbon market projects under GCC. To improve its viability, a comprehensive ESIA, assessment related to SDG contribution, no harm to the environment, community engagement, data management mechanisms and robust MRV would need to be developed at the time of execution and operations. PEDO to ensure projects permanence and risk mitigation during execution and operations.
Asrit Kedam HPP	Swat	229	On-Grid		
Sharmai HPP	Upper Dir	152.12	On-Grid		
Shigo Kas HPP	Lower Dir	102	On-Grid		
Arkari Gol HPP	Chitral	99	On-Grid		
Gabral Utror HPP	Swat	82	On-Grid		
Artistic-1 HPP	Upper Dir	62.61	On-Grid		
Shalfalam HPP	Upper Dir	60	On-Grid		
Artistic-2 HPP	Swat	55.03	On-Grid		
Bankhwar HPP	Swat	35	On-Grid		
Nila Da Katha HPP	Mansehra	31.3	On-Grid		
Lower Spat Gah	Upper Kohistan	470	On-Grid		
Total		1,616.06			
Future Operational Private Sector Small Hydropower Plants					

Project Name	Location	Project Capacity (MW)	On-Grid/Off-Grid	Eligibility	Comments
Daral Khwar-II HPP	Swat	9.5	On-Grid	Eligible	The Technical feasibility studies, and ESIA/EIAs are not provided. Can be potential carbon market projects under GCC. To improve its viability, a comprehensive ESIA, assessment related to SDG contribution, no harm to the environment, community engagement, data management mechanisms and robust MRV would need to be developed at the time of execution and operations. PEDO to ensure projects permanence and risk mitigation during execution and operations.
Balkani HPP	Shangla	7.75	On-Grid		
Total Future Operational Private Sector Small Hydropower Plants		17.25			
Total Private Sector Hydropower including PPP Project		1633.31			
Future Operational Private Sector Solar PV Powe Plants					
Kulachi, DI Khan	DI Khan	50	On-Grid	Eligible	Can be potential carbon market projects under GCC. However, PEDO needs to engage with NEPRA and NTDC for inclusion of these power plants in the generation planning and support private sector in commissioning of these projects. To improve viability of these projects, PEDO may work with the private sector to undertake comprehensive technical studies, ESIA, assessment related to SDG contribution, community engagement, data
Kulachi, DI Khan	DI Khan	50	On-Grid		
Paharpur, DI Khan	DI Khan	49.5	On-Grid		

Project Name	Location	Project Capacity (MW)	On-Grid/Off-Grid	Eligibility	Comments
Nowshera Solar PV	Nowshera	50	On-Grid		management mechanisms and robust MRV. PEDO to ensure projects permanence, operations and risk mitigation during execution and operations.
Kohat Solar PV	Kohat	50	On-Grid		
Total Future Operational Private Sector Solar PV Powe Plants		249.5			

Table 18: Screening of PEDO Energy Portfolio for Eligibility Against I-RECs

Project Name	Location	Project Capacity (MW)	On-Grid/Off-Grid	Eligibility	Comments
Current Operational Large Hydropower Plants					
Malakand III	Dargai, Malakand	81	On-Grid	Eligible	These projects can be registered for I-RECs. However, the projects need to comply with the registration requirements, ownership, documentation and reporting and I-REC issuance requirements as stated in the standard. Since these are grid connected projects, these are prime candidates for IRECs, subject to availability of data for compliance with IRECs.
Daral Khwar	Behrain, District Swat	36.6	On-Grid		
Pehur	Road No. L-1, Gadoon Amazai, Distt. Swabi, KP.	18	On-Grid		
Total Current Operational Large Hydropower Plants		135.6			
Current Operational Small and Mini Hydropower Plants					
Shishi	Shishi, Tehsil Drosh, District Lower Chitral	1.8	On-Grid	Eligible	These projects can be registered for I-RECs. However, the projects need to comply with the registration requirements, ownership, documentation and reporting and I-REC issuance requirements as stated in the standard.
Machai	Alo, Mardan	2.6	On-Grid		
Reshun	Reshun Gol, District Upper Chitral	4.8	On-Grid		
Total Current Operational Small and Mini Hydropower Plants		9.2			
Current Operational Micro Hydropower Plants					
316 MMHPPs	Varies	28.92 (Cumulative)	Off-Grid	Eligible	These projects can be registered for I-RECs. However, the projects need to comply with the registration requirements, ownership, documentation and reporting and I-REC issuance requirements as stated in the standard. Since PEDO has already transferred the ownership to the communities, the

Project Name	Location	Project Capacity (MW)	On-Grid/Off-Grid	Eligibility	Comments
					management and operations are being managed by the communities themselves, the exact status of operations and performance are unknown, therefore, PEDO would have to take cautious decision in case if it opts to register these projects for I-RECs.
Total Current Operational Hydropower Plants		**173.72**			
Current Operational Solar PV Installations					
Electrification of 100 Villages Through Solar/Alternate Energy Phase-I.	Central & Southern Districts	0.87	Off-Grid	Eligible	These projects can be registered for I-RECs. However, the projects need to comply with the registration requirements, ownership, documentation and reporting and I-REC issuance requirements as stated in the standard. Since PEDO has already transferred the ownership to the communities, the management and operations are being managed by the communities themselves, the exact status of operations and performance are unknown, therefore, PEDO would have to take cautious decision in case if it opts to register these projects for I-RECs.
Electrification of Un-Electrified Villages Solar/Alternate Energy Phase II (I&II).	District Chitral	0.85	Off-Grid		
Solarization of Civil Secretariate.	District Peshawar	0.49	Off-Grid		
Solarization of Chief Minister's Secretariat/ Chief Minister's House.	District Peshawar	0.38	Off-Grid		
Solar Electrification of 4000 Masajid in Khyber Pakhtunkhwa.	All Settled Districts	7.38	Off-Grid		
Solar Electrification of 300 Masajid/Worship Places of Non-Muslims in merged	Districts Khyber, Bajaur Mohmand, Kurram, Orakzai NW & SW	0.53	Off-Grid		

Project Name	Location	Project Capacity (MW)	On-Grid/Off-Grid	Eligibility	Comments
Districts of Khyber Pakhtunkhwa.					
Solarization of Masajid in District Swat and 440 Masajid in District Peshawar.	District Swat & District Peshawar	2.59	Off-Grid		
Solarization of Masajid in merged Districts of KP (AIP).	Districts Khyber, Bajaur Mohmand, Kurram, Orakzai NW, SW FR Lakki, FR Bannu, FR Peshawar, FR Tank, FR DI Khan FR Kohat	1.2	Off-Grid		
Total Operational Solar PV Installations		14.29			
Future Operational Large Hydropower Plans					
Gorkin Matiltan	Kalam, Tehsil Bahrain, District Swat	84	On-Grid	Eligible	These projects can be registered for I-RECs. However, the projects need to comply with the registration requirements, ownership, documentation and reporting and I-REC issuance requirements as stated in the standard.
Koto	Dir (Lower)	40.8	On-Grid		
Lawi	Lower Chitral	69	On-Grid		
Balakot	Tehsil Balakot, District Mansehra	300	On-Grid		
Gabral Kalam	Swat	88	On-Grid		
Madyan	Swat	157	On-Grid		
Ranolia	Ranolia, Kohistan	17	On-Grid		

Project Name	Location	Project Capacity (MW)	On-Grid/Off-Grid	Eligibility	Comments
Total Project Future Operational Large Hydropower Plans		755.8			
Future Operational Small and Mini Hydropower Plans					
Karora	Shangla	11.8	On-Grid	Eligible	These projects can be registered for I-RECs. However, the projects need to comply with the registration requirements, ownership, documentation and reporting and I-REC issuance requirements as stated in the standard.
Jabori	Mansehra	10.2	On-Grid		
Chapri Charkhel	Lower Kurram	13.56	On-Grid		
Mujahideen	Torghar	6.95	Off-Grid		
Total Future Operational Small and Mini Hydropower Plans		42.51			
Total Future Operational Micro Hydropower Plans					
140MMHPPs	Varies	27.078	Off-Grid	Eligible	These projects can be registered for I-RECs. However, the projects need to comply with the registration requirements, ownership, documentation and reporting and I-REC issuance requirements as stated in the standard. Since as per practice, PEDO hands over the ownership, operations and management of such projects to the community, PEDO would have to either re-consider its practice and keep the ownership operations and management or engage with the communities for taking any further decision.
Total Future Hydropower Plants		825.388			
Future Operational Solar PV Installations					
Solarization of 8000 Schools & 187 BHUs	All Settled Districts	12	Off-Grid	Eligible	These projects can be registered for I-RECs. However, the projects need to comply with the registration requirements, ownership, documentation
Solarization of Masajid & Worship	All Settled Districts	14	Off-Grid		

Project Name	Location	Project Capacity (MW)	On-Grid/Off-Grid	Eligibility	Comments
Places of Khyber Pakhtunkhwa.					and reporting and I-REC issuance requirements as stated in the standard. Since as per practice, PEDO hands over the ownership, operations and management of such projects to the community, PEDO would have to either re-consider its practice and keep the ownership operations and management or engage with the communities for taking any further decision.
Solarization of 2000 Masajid in Merged Areas (AIP)	All Merged Districts	6.5	Off-Grid		
Solarization of Schools in Merged areas (AIP)	All Merged Districts	3.55	Off-Grid		
Solarization of Houses in Various UCs of PK- 88 of District Bannu.	District Bannu	1.8	Off-Grid		
Solarization of Masajid/ Janazgah/ Eid-Gah in various UCs of District Torghar. (DDP)	District Torghar	0.47	Off-Grid		
Total Future Operational Solar PV Installations		38.32			
Future Operational IPP Based Hydropower Plants					
Kalam Asrit HPP	Swat	238	On-Grid	Eligible	These projects can be registered for I-RECs. However, the projects need to comply with the registration requirements, ownership, documentation and reporting and I-REC issuance requirements as stated in the standard. PEDO can encourage the project owners to opt for earning I-RECs.
Asrit Kedam HPP	Swat	229	On-Grid		
Sharmai HPP	Upper Dir	152.12	On-Grid		
Shigo Kas HPP	Lower Dir	102	On-Grid		
Arkari Gol HPP	Chitral	99	On-Grid		
Gabral Utror HPP	Swat	82	On-Grid		
Artistic-1 HPP	Upper Dir	62.61	On-Grid		
Shalfalam HPP	Upper Dir	60	On-Grid		
Artistic-2 HPP	Swat	55.03	On-Grid		
Bankhwar HPP	Swat	35	On-Grid		
Nila Da Katha HPP	Mansehra	31.3	On-Grid		
Lower Spat Gah	Upper Kohistan	470	On-Grid		
Total		1,616.06			
Future Operational Private Sector Small Hydropower Plants					

Project Name	Location	Project Capacity (MW)	On-Grid/Off-Grid	Eligibility	Comments
Daral Khwar-II HPP	Swat	9.5	On-Grid	Eligible	These projects can be registered for I-RECs. However, the projects need to comply with the registration requirements, ownership, documentation and reporting and I-REC issuance requirements as stated in the standard. PEDO can encourage the project owners to opt for earning I-RECs.
Balkani HPP	Shangla	7.75	On-Grid		
Total Future Operational Private Sector Small Hydropower Plants		17.25			
Total Private Sector Hydropower including PPP Project		1633.31			
Future Operational Private Sector Solar PV Powe Plants					
Kulachi, DI Khan	DI Khan	50	On-Grid	Eligible	Can be potential These projects can be registered for I-RECs. However, the projects need to comply with the registration requirements, ownership, documentation and reporting and I-REC issuance requirements as stated in the standard. PEDO can encourage the project owners to opt for earning I-RECs.
Kulachi, DI Khan	DI Khan	50	On-Grid		
Paharpur, DI Khan	DI Khan	49.5	On-Grid		
Nowshera Solar PV	Nowshera	50	On-Grid		
Kohat Solar PV	Kohat	50	On-Grid		
Total Future Operational Private Sector Solar PV Powe Plants		249.5			

Table 19 summarizes the eligibility assessment from Tables 15-18, indicating the qualification status of each project against Verra, Gold Standard, GCC and I-REC standards. The analysis shows that the entire portfolio of grid-connected hydropower projects, including both current operational and future operational projects, is not eligible for Verra or Gold standard, however, GCC standard offers flexibility for registering future operational projects.

Within the off-grid hydropower portfolio, the currently operational projects are ineligible for carbon markets. However, future projects, such as the Mujahidin project and the 140 MMHPPs, could be suitable candidates for all Standards. The potential conflict between 316 MMHPPs being ineligible,

whereas 140 MMHPPs being eligible exists because the prior has been constructed and currently in operations, proving additionality, permanence and robust MRV system are going to be the challenges. The latter is currently under construction and has room to overcome the shortcomings and can incorporate the recommendations outlined in this report for effective market participation thereby gaining leverage over the 316 MMHPPs.

In terms of the solar PV portfolio, existing off-grid projects are ineligible for carbon markets due to non-conformity with the standards and the fact that they are not under rehabilitation. Future off-grid solar projects, however, may qualify under Verra, Gold Standard, and GCC given same leverage has been given to these projects as the 140 MMHPPs as per their current status. Private sector solar PV projects show eligibility under Gold Standard and GCC.

While the entire solar and hydropower portfolio could be registered under I-REC, challenges may arise for existing off-grid solar and 316MMHPPs projects as ownership has been transferred and their current status is unknown. The future solar projects and 140 MMHPPs in PEDO's portfolio could also be registered under I-REC, though PEDO may need to reconsider the model for its off-grid solutions.

It is important to note that some projects are eligible for multiple standards; however, to avoid double counting**, each project can only register under a single standard.**

Table 19: Summary Analysis Indicating Eligibility/Non-Eligibility of PEDO Energy Portfolio against Carbon Markets an I-RECs

Project Name	Eligibility				Comments
	Verra	Gold Standard	GCC	I-REC	
Current Operational Large Hydropower Plants					
Malakand III	Not Eligible	Not Eligible	Not Eligible	Eligible	On-Grid Projects not eligible for Verra, Gold Standard has 5% capacity cap for RE resource, Not Eligible under GCC since more than one year has passed since the start of project operations. As the projects do not qualify for any carbon market, PEDO may immediately take steps for registration of these projects for IRECs
Daral Khwar	Not Eligible	Not Eligible	Not Eligible	Eligible	
Pehur	Not Eligible	Not Eligible	Not Eligible	Eligible	
Current Operational Small and Mini Hydropower Plants					
Shishi	Not Eligible	Not Eligible	Not Eligible	Eligible	On-Grid Projects not eligible for Verra, Gold Standard has 5% capacity cap for RE resource, Reshun is off-grid but it was not developed as per the conformity requirements of carbon market standards, Not Eligible under GCC since more than one year has passed since the start of project operations. As the projects do not qualify for any carbon market, PEDO may immediately take steps for registration of these projects for IRECs
Machai	Not Eligible	Not Eligible	Not Eligible	Eligible	
Reshun	Not Eligible	Not Eligible	Not Eligible	Eligible	
Current Operational Micro Hydropower Plants					
316 MMHPPs	Not Eligible	Not Eligible	Not Eligible	Eligible	Not Eligible under GCC since more than one year has passed since the start of project operations, for other two standards, the requirements cannot be met as these are neither greenfield projects, nor rehabilitation projects. Registration for I-REC can be considered but would be a challenge since projects are handed over to the community and data is not maintained. However, recommendations at Table 18 in this regard may be considered.
Current Operational Solar PV Installations					
Electrification of 100 Villages Through	Not Eligible	Not Eligible	Not Eligible	Eligible	Not eligible for any carbon market as these are older Projects

Project Name	Eligibility				Comments
	Verra	Gold Standard	GCC	I-REC	
Solar/Alternate Energy Phase-I.					Ownership handed over to the community. No evidence of electricity generation data and plant performance details maintained. Rehabilitation of these projects is not under discussion. Registration for I-REC can be considered but would be a challenge since projects are handed over to the community and data is not maintained. However, recommendations at Table 18 in this regard may be considered.
Electrification of Un-Electrified Villages Solar/Alternate Energy Phase II (I&II).	Not Eligible	Not Eligible	Not Eligible	Eligible	
Solarization of Civil Secretariate.	Not Eligible	Not Eligible	Not Eligible	Eligible	
Solarization of Chief Minister's Secretariat/ Chief Minister's House.	Not Eligible	Not Eligible	Not Eligible	Eligible	
Solar Electrification of 4000 Masajid in Khyber Pakhtunkhwa.	Not Eligible	Not Eligible	Not Eligible	Eligible	
Solar Electrification of 300 Masajid/Worship Places of Non-Muslims in merged Districts of Khyber Pakhtunkhwa.	Not Eligible	Not Eligible	Not Eligible	Eligible	
Solarization of Masajid in District Swat and 440 Masajid in District Peshawar.	Not Eligible	Not Eligible	Not Eligible	Eligible	
Solarization of Masajid in merged Districts of KP (AIP).	Not Eligible	Not Eligible	Not Eligible	Eligible	
Future Operational Large Hydropower Plans					
Gorkin Matiltan	Not Eligible	Not Eligible	Eligible	Eligible	On-Grid Projects not eligible for Verra, Gold Standard has 5% capacity cap for RE resource. GCC and I-REC can be considered for registration. However, recommendations at Table 17, 18 in this regard may be considered.
Koto	Not Eligible	Not Eligible	Eligible	Eligible	
Lawi	Not Eligible	Not Eligible	Eligible	Eligible	
Balakot	Not Eligible	Not Eligible	Eligible	Eligible	
Gabral Kalam	Not Eligible	Not Eligible	Eligible	Eligible	
Madyan	Not Eligible	Not Eligible	Eligible	Eligible	
Ranolia	Not Eligible	Not Eligible	Eligible	Eligible	
Future Operational Small and Mini Hydropower Plans					
Karora	Not Eligible	Not Eligible	Eligible	Eligible	On-Grid Projects not eligible for Verra, Gold Standard has 5%

Project Name	Eligibility				Comments
	Verra	Gold Standard	GCC	I-REC	
Jabori	Not Eligible	Not Eligible	Eligible	Eligible	capacity cap for RE resource. GCC and I-REC can be considered for registration. To improve its viability, the recommendations in Table 17, 18 may be considered.
Chapri Charkhel	Not Eligible	Not Eligible	Eligible	Eligible	
Mujahideen	Eligible	Eligible	Eligible	Eligible	Can be potential carbon market project under all markets. To improve its viability, the recommendations in Table 15, 16, 17, 18 may be considered.
Total Future Operational Micro Hydropower Plans					
140MMHPPs	Eligible	Eligible	Eligible	Eligible	Can be potential carbon market project under all markets including IRECs. To improve its viability, the recommendations in Table 15, 16, 17, 18 may be considered.
Total Future Hydropower Plants		825.388			
Future Operational Solar PV Installations					
Solarization of 8000 Schools & 187 BHUs	Eligible	Eligible	Eligible	Eligible	Can be potential carbon market project under Verra, Gold Standard and GCC. These can also register for I-RECs. To improve its viability, the recommendations in Table 15, 16, 17, 18 may be considered.
Solarization of Masajid & Worship Places of Khyber Pakhtunkhwa.	Eligible	Eligible	Eligible	Eligible	
Solarization of 2000 Masajid in Merged Areas (AIP)	Eligible	Eligible	Eligible	Eligible	
Solarization of Schools in Merged areas (AIP)	Eligible	Eligible	Eligible	Eligible	
Solarization of Houses in Various UCs of PK- 88 of District Bannu.	Eligible	Eligible	Eligible	Eligible	
Solarization of Masajid/ Janazgah/ Eid-Gah in various UCs of District Torghar. (DDP)	Eligible	Eligible	Eligible	Eligible	
Future Operational IPP Based Hydropower Plants					
Kalam Asrit HPP	Not Eligible	Not Eligible	Eligible	Eligible	On-Grid Projects not eligible for Verra, Gold Standard has 5% capacity cap for RE resource.
Asrit Kedam HPP	Not Eligible	Not Eligible	Eligible	Eligible	
Sharmai HPP	Not Eligible	Not Eligible	Eligible	Eligible	

Project Name	Eligibility				Comments
	Verra	Gold Standard	GCC	I-REC	
Shigo Kas HPP	Not Eligible	Not Eligible	Eligible	Eligible	GCC and I-REC can be considered for registration. However, recommendations at Table 17, 18 in this regard may be considered.
Arkari Gol HPP	Not Eligible	Not Eligible	Eligible	Eligible	
Gabral Utror HPP	Not Eligible	Not Eligible	Eligible	Eligible	
Artistic-1 HPP	Not Eligible	Not Eligible	Eligible	Eligible	
Shalfalam HPP	Not Eligible	Not Eligible	Eligible	Eligible	
Artistic-2 HPP	Not Eligible	Not Eligible	Eligible	Eligible	
Bankhwar HPP	Not Eligible	Not Eligible	Eligible	Eligible	
Nila Da Katha HPP	Not Eligible	Not Eligible	Eligible	Eligible	
Lower Spat Gah	Not Eligible	Not Eligible	Eligible	Eligible	
Future Operational Private Sector Small Hydropower Plants					
Daral Khwar-II HPP	Not Eligible	Not Eligible	Eligible	Eligible	On-Grid Projects not eligible for Verra, Gold Standard has 5% capacity cap for RE resource. GCC and I-REC can be considered for registration. However, recommendations at Table 17, 18 in this regard may be considered.
Balkani HPP	Not Eligible	Not Eligible	Eligible	Eligible	
Future Operational Private Sector Solar PV Powe Plants					
Kulachi, DI Khan	Not Eligible	Eligible	Eligible	Eligible	On-Grid Projects not eligible for Verra. However, these projects qualify for Gold Standard and GCC as solar PV is currently within the 5% capacity cap for RE resource, and GCC include Solar PV as qualifying RE technology. These projects can also register for I-REC. However, recommendations at Table 16, 17, 18 in this regard may be considered.
Kulachi, DI Khan	Not Eligible	Eligible	Eligible	Eligible	
Paharpur, DI Khan	Not Eligible	Eligible	Eligible	Eligible	
Nowshera Solar PV	Not Eligible	Eligible	Eligible	Eligible	
Kohat Solar PV	Not Eligible	Eligible	Eligible	Eligible	

2.6 Social and Environmental Performance Analysis

The Social and Environmental Performance Analysis evaluates each project's impact on the environment and society for the screened projects for carbon markets. The reason for this analysis being done only for carbon markets is that this is a mandatory requirement for these markets, however, I-RECs only require generation in MWh and conformance to the guidelines outlined in its standard. Furthermore, the analysis is only done for hydropower because the ESIA/EIAs have not been provided for solar projects for their relevant analysis

This analysis is crucial, as it ensures that the project addresses environmental concerns, adheres to social acceptability, and provides co-benefits for sustainable development. Historically, the projects did not delve much into these aspects for carbon markets. As research developed and considerable social and environmental impacts associated with projects emerged, it became mandatory to

comply with these requirements and address them to the best extent. Therefore, a project which is more considerate of these factors earns a better credit value compared to projects not giving much importance to these parameters.

The analysis is as done in Table 20 below:

Table 20: Environmental and Social Analysis of Projects

Project	Project Impact	Mitigation Measures	Monitoring Provisions	Approach to Emissions	Comments
Ranolia 17MW[40]	The project has a minimal negative environmental impact as depicted by the project IEE by ADB.	The Environmental Management plan (EMP) has been drafted and included in the IEE for reducing the potential impacts identified.	Comments on thorough monitoring of the project activities and compliance to IEE and the EMP. It also explores capacitating PEDO for effective environmental management and monitoring.	The project seeks provision of clean energy comparing with fossil alternatives like coal, oil and gas utility for energy production leading to emission reduction.	The Project has been washed out by the floods in 2022. Currently, the project is being rehabilitated with enhanced and updated protection measures. The rehabilitation can further benefit by utilizing updated ESG provisions during rehabilitation focusing more on the social aspects and biodiversity as per the updated global requisites. Keeping emission monitoring pre and post construction as paramount is crucial
Karora 11.8MW[41]	Despite some project activities having effects	The project ESA outlines mitigation measures for	The ESA states that compliance mechanism	Although alternate unclean sources of	Emission reduction should be paramount in the project

[40] https://www.adb.org/sites/default/files/project-documents//34339-023-pak-iee-03.pdf
[41] KARORA HYDROPOWER PROJECT FINAL FEASIBILITY REPORT (VOLUME – II ENVIRONMENTAL AND SOCIAL ASSESSMENT)

	in certain social areas, as depicted in the Environmental and Social Assessment **(ESA)**, the overall social impact rating is low. The benefits of the project and the proposed compensation package outweigh these effects, portraying a commitment to considerate development.	the anticipated project impacts to environmental and social aspects.	would be ensured for monitoring including Compliance Monitoring - to ensure that proposed measures in the EMMtP (Environmental Management and Monitoring Plan) in the ESA are adhered to, and Effects Monitoring - to establish baseline values for environmental parameters such as air quality, water quality and noise levels.	energy are mentioned, but the ESA of the project has not quantified emission reduction potential of the project.	consideration outlining methodologies for anticipated reduction and monitoring mechanisms in place on-site for environmental/social compliance and emission reductions post operations/reduction in grid emission factors. As the project is still in its construction phase, having a vigorous monitoring system, as stated above, and adequate human resources in place, to ensure compliance, would make the project a potential candidate for further evaluation.
Gabral Kalam 88MW[42]	The project ESIA presents significant impacts and challenges to environmental, social and occupational health and safety aspects. These are	The ESIA presents an Environmental and Social Management Plan (ESMP) for pre-construction, construction and operation periods. It outlines the	The ESIA gives due attention to GHG mitigation potential of the project along with monitoring plans during and post construction.	The ESIA calculates the net greenhouse gas emission reductions by the project to be 7.12 million tons when compared to other feasible	Although the emissions reduction potential is included, also including an on-site emission monitoring mechanism will facilitate accounting real emission

[42] Khyber Pakhtunkhwa Hydropower and Renewable Energy Development Program, Gabral Kalam Hydropower Project, Environmental and Social Impact Assessment

	analyzed for 3 stages project sitting, during construction and during operations. The project activities extend to protected forest areas where the need exists to comply with relevant guidelines and standards.	mitigation plans for all the identified impacts supported by Capacity Building and Training for ESMP, Gender Action Plan, Social Development Plan (Draft) and Grievance Redress Mechanisms providing a more nuanced and considerate approach to sustained practices.		options for power generation and transmission, that is Combine Cycle Gas Turbine, considering the total baseline generation emissions for 50 years.	reductions by the project during its lifecycle. The large-scale projects, like this, may present some challenges pertaining to screening processes as specified by different carbon market standards when submitted for further considerations. However, this project is facilitated by a strong environmental and social consideration making it a potential candidate. Since the project activities fall under the protected forest areas, the project sponsors will have to comply with relevant standards to become eligible for consideration into carbon markets.
Madyan 157MW[43]	The project ESIA presents a wide range of environment	The project ESIA presents an Environmental and Social	A monitoring plan has been developed in conjunction	Although the ESIA calculates the net greenhouse	Although the emissions reduction potential is included, also

[43] Environmental and Social Impact Assessment - Madyan Hydropower Project (207MW)

	al and social impacts. The mitigation and enhancement measures outlined in the ESIA for the project are comprehensive and robust, addressing these impacts. By effectively implementing these measures, the project can achieve a high level of sustainability, balancing the need for renewable energy generation with the protection of social and environmental resources. The net impact, therefore, is positive, contributing to sustainable development goals, including clean energy access, social equity, and	Management Plan (ESMP) complemented with a Resettlement Action Plan (RAP), Social Development Plan (SDP) and Livelihood Restoration and Improvement Plan (LRIP) have been prepared in line with the World Bank Operational Policy, Traffic Management Plan (TMP), Blasting Management Plan (BMP) etc. portraying robust considerations towards equitable and sustained development if implemented.	to the ESMP outlining monitoring at construction and operation stage.	gases emissions reduction to be 7.12 million tons when compared to other feasible options for power generation and transmission, but following the same calculations for Gabral Kalam, the updated number may be 28-million-ton reduction for madyan.	including an on-site emission monitoring mechanism will facilitate accounting real emission reductions by the project during its lifecycle. The large-scale projects, like this, may present some challenges pertaining to screening processes as specified by different carbon market standards when submitted for further considerations. However, this project is facilitated by a strong environmental and social consideration making it a potential candidate.

	environmental conservation.				
Balakot 300 MW[44]	The project presents considerable impacts presented by the project during both construction and operation phases. Given a dam would be constructed, the project is anticipated to result in decreased environmental flow release downstream of the dam along with other potential impacts highlighted in the EIA. However, the overall stability in the infrastructure of the project is designed to mitigate potential risks identified along with other mitigation measures included to	The EIA presents Grievance Redress Mechanisms and Environmental Management Plan including Environmental and Social Management System, Stakeholder Engagement, Mitigation and Management Plan and Implementation Plan to minimize the anticipated impacts by the project.	The EIA provides a monitoring plan to manage environmental issues arising from construction works through closely monitoring evidence for implementation of the mitigation measures and environmental compliance; and monitoring changes in the environment during various stages of the Project life cycle with respect to baseline conditions.	The EIA has considered emissions from Wood/Liquefied Petroleum Gas (LPG) burning and traffic. The identification and mitigation include Fugitive and exhaust emissions from transport vehicles, Fugitive dust emissions from blasting, Fugitive dust emissions from quarry areas, Fugitive dust emissions from concrete batching plants, Fugitive dust emissions from aggregate production and handling system, Wind-blown dust from exposed surfaces	While the project identifies emissions and supports mitigation measures, however, quantification of such emissions is not done in the EIA report. The monitoring plan includes tracking environmental compliance during and after construction, however, emission monitoring during the operations phase of the project will be assessed in the operational phase and the EMP is to be furnished after completion of the project. The large-scale projects, like this, may present some challenges pertaining to screening processes as specified by different carbon market standards when submitted

[44] Balakot Hydropower Development Project Environmental Impact Assessment

	curb the impacts to the best extent. Nevertheless, it would be essential to properly monitor the precipitation and flooding patterns to avoid potential impacts.			such as bare land and waste dumping sites and Wind-blown dust from stockpiles of dusty materials such as sand and other minerals	for further considerations. However, this project is facilitated by a strong environmental and social consideration which may make it a potential candidate.
Chapri Charkhel 13.56MW[45]	The assessment of potential impacts of the proposed Chapare-Charkhil weir project indicates that the project will primarily generate minor to moderate environmental impacts. These impacts are expected to be mostly associated with the construction phase and are anticipated to be temporary.	The predicted impacts will be minimized and reduced by implementing the prescribed mitigation measures and will be continually monitored by implementing and updating the Environmental Management Plan (EMP) in the IEE.	Monitoring plan for both the phases, construction and operations, has been separately given in the EMP of the IEE.	The net GHG emissions (project emissions minus baseline emissions) for the transmission line (T/L) are zero. Since the project would be opting for a new transmission line, the emissions from the project and the baseline (alternative) would be similar, resulting in no net change in emissions.	While the project emissions have been considered and found to be net zero, however, the IEE of the project has not quantified emission reduction potential of the project. While monitoring environmental compliance has been outlined in the EMP, in the IEE, a monitoring roadmap for emissions needs to be prepared and implemented for project operations.
Gorkin Matiltan 84MW[46]	As per the feasibility study, the	The project offers a mitigation	The project has a monitoring	The project has calculated an	The large-scale projects, like this, may present some

[45] Chapri Charkhel IEE Report
[46] Matiltan Hydropower Project Feasibility Study

	construction-related impacts of the project are expected to be confined to a 3-year period, whereas the operational phase is projected to last for 50 years. The project will influence the hydrodynamics of the river, including changes in water flow and variations in sedimentation levels, which could affect the natural resource base. The feasibility study provides a comprehensive assessment of the project's impacts, detailing both positive and negative effects in the short and long term, and proposes suitable	plan extending to socio-economic impacts, wildlife protection, fisheries protection, erosion control, disposal evaluated material, pollution mitigation, downstream flow variation, environmental aesthetics, sediment loads, stress effect on river ecology and water supply and drainage.	plan in place for monitoring the water and biological resources.	avoided cost ranging between US$ 20 – 28/ton comparing to fossil powered alternatives.	challenges pertaining to screening processes as specified by different carbon market standards when submitted for further considerations. However, this project is facilitated by a strong environmental and social consideration which may make it a potential candidate. The project acknowledges potential long-term considerations that will require careful attention to manage the impacts effectively, as outlined in the mitigation measures.

	measures to manage these impacts effectively. The project aims to address and balance these effects to ensure sustainable outcomes.				
Lawi 69MW[47]	The project is expected to have notable effects on biodiversity, land resources, and the local community due to construction activities.	The project presents an Environmental Management Plan (EMP) in the EIA which is supported by a Social Management plan (SMP) and an Environmental and Social Training Plan (ESTP) presenting the mitigation measures for the identified impacts and how they can be minimized.	The project is supported by a monitoring plan which outlines the items to be monitored (e.g., water quality), specific parameters (e.g., oil and grease levels), the frequency of monitoring (e.g., bi-annually), the location of monitoring, and the parties responsible for conducting the monitoring during the construction period.	The project outlines the National Environmental Quality Standards (NEQS) to conform to ensure conformance to during the construction activities. As per PC-I of the project, the project will avoid annual releases about 0.147 million ton of CO2 from an equivalent thermal plant which have a corresponding reduction in atmospheric pollution.	The large-scale projects, like this, may present some challenges pertaining to screening processes as specified by different carbon market standards when submitted for further considerations. However, this project is facilitated by a strong environmental and social consideration which may make it a potential candidate. The project includes plans for emission monitoring during the construction phase, but the specific methodology for this is not

[47] Lawi Hydropower EIA Report

					detailed. Additionally, it would be beneficial to consider including a strategy for monitoring emissions during the operational phase.
Lower Spat Gah 470MW[48]	For the significance rating of the impacts a matrix system (quasi-mathematical approach) was used which determines the significance as a product of the quantified characteristics of the impacts. Although the matrix states the significance of the impact on ambient air as «medium» without measures, in a more comprehensive evaluation this has to be	An Environmental Management Plan (EMP) has been prepared which outlines the measures that are required to implement the mitigation measures. Responsibilities have been defined for implementation and for monitoring the implementation. Specialized tools such as Site-Specific Environmental Management Plan will be developed to ensure that all measures are implemented at the project level. It has	Environmental monitoring and reporting plan for the construction and operation phases is provided. Moreover, each supporting plan, RAP, BAP, includes monitoring and documentation requirements; the same is also true of the Site-Specific Environmental and Social Management Plan (SSESMP). Therefore, the monitoring plan shall also contain requirements of these additional	The Project will cause Greenhouse Gas (GHG) emissions. However, the Project has far fewer emissions as compared to other power generation methods such as from the combustion of fossil fuels. Moreover, the reservoirs are small and there is a small amount of biomass, much of which might even be cut and used as fuel wood before impoundment, thus, there will have far fewer emissions as	While the project presents a strong Environmental and Social consideration, the fact cannot be terminated that the project has positive contributions to global warming. Although baseline comparisons with other sources have been discussed, a detailed assessment of expected emissions over the project's life cycle and an on-site emission monitoring mechanism have not yet been provided. The large-scale projects, like this, may present some challenges pertaining to

[48] Lower Spat Gah Hydropower Project Feasibility Study Volume 11: Environmental and Social Impact Assessment

	relativized given the project has positive outcomes. Overall, it can be concluded that with the effective implementation of the defined mitigation measures, the project's environmental and social impacts are manageable and within acceptable levels.	also been supported by Grievance Redress mechanism, Resettlement Action Plan, Social Management Plan and a Biodiversity Action Plan.	plans once they have been developed. Monitoring framework for biodiversity is also presented in the BAP.	compared to HPPs with large reservoirs. The Project will result in the following sources of GHG emissions: a) GHG emissions due to inundation of biomass by the impoundment of the reservoirs. b) GHG emissions during construction.	screening processes as specified by different carbon market standards when submitted for further considerations.
Jabori 10.2MW[49]	Although some components of the project may affect certain environmental areas, the overall environmental impact rating is considered low. The benefits of the project operations, along with the proposed compensation package, are expected	The project presents an Environmental Management Plan (EMP) in the IEE that presents actions towards the mitigation measures highlighted. It also presents an Abbreviated Resettlement Plan (ARP) for entitlements to losses encountered by the project activity.	The project presents an Environmental Monitoring Plan for Effluent from Septic Tank, Water related diseases, Noise, Air Quality and Soil. Hiring of consultants facilitating implementation is commented.	Project outlines monitoring PM_{10}, SO_2, and NOx once every season at major construction sites.	While the project outlines emission monitoring during construction, it does not comment on the methodology for achieving this. The IEE of the project has not quantified emission reduction potential of the project. While the monitoring plan in the IEE includes tracking environmental

[49] Jabori Hydropower Project – IEE Report

	to outweigh the potential effects.				compliance during construction, it does not cover monitoring compliance post-construction and emission monitoring during the project's operational phase to ensure that emissions are effectively managed. It is important to include on-site monitoring of emissions and environmental compliance during operations as well. Although alternative energy options have been explored but, they have only been analyzed on the basis of the source potential, indigenous resource availability, energy access, energy security, project promptness, readiness and technological access.
Mujahideen 6.95MW[50]	The project has been assessed on Environmental and social	An Environmental and Social Management Plan has been	The IEE has a monitoring plan in place along with the ESMP which	The IEE cites that the project is anticipated to improve air	While the IEE includes comments on emission monitoring for

[50] 6.95 MW MUJAHIDIN HYDROPOWER PROJECT DISTRICT TORGHAR, KHYBER PAKHTUNKHWA-IEE

	impacts (construction and operation), Tunnel Risk Assessment, Environmental Flow Assessment and socio-economic benefits. As per the IEE, the project will be environment friendly. Impact Analysis confirms that the Project will cause no significant environmental impacts and very limited land or population relocations. (A risk rating of the project is 'low'. The benefits of the project operation and the compensation package proposed herein outweigh the effects of the project.) The utilization of high efficiency low emission	included in the project outlining contractors' qualifications, mitigation and control measures, Environmental and social codes of practices for construction, constructors ESMP, Institutional arrangements for ESMP implementation, environmental approvals and permits required for project implementation, construction stage site specific management plans, Capacity building and Training and Grievance Redress Mechanisms. This provides measures supported by a roadmap on how these measures would be achieved.	outlines the frequency, location, and responsibility for monitoring various aspects such as environmental impacts, social management, occupational health and safety hazards, water quality, and restoration efforts. The monitoring frequency ranges from quarterly to monthly, depending on the specific impact and its significance. The responsibility for monitoring is assigned to the contractor, Project Implementation Consultant (PIC), and Project Management Office (PMO).	quality nationally and internationally. An oil-fired steam unit, depending on efficiency, would produce approximately 0.7-0.9 tons of carbon dioxide per megawatt-hour (MWh) of energy generated. With a mean annual net energy output of 805.78 GWh, upon connection to the national grid, the project is projected to annually reduce carbon dioxide emissions by 4.83-6.21 tons. Also, the project targets removal of organic materials, trees and shrubs before filling the reservoir to further minimize such effects.	generators and construction machinery during the construction and Operation and Maintenance phase (1 year), it does not address on-ground emission monitoring during the operational phase.

	plant technology are major contributors toward achieving minimal environmental impact with low air emissions, and zero liquids discharges.				
Koto 40.8MW[51]	The project adopts a balanced approach to sustainable energy generation. While some activities at specific sites may have environmental effects, the overall environmental impact rating is considered "low." The project is designed to address environmental and social challenges through the comprehensive mitigation measures outlined in	The feasibility report has an Environmental Management Plan (EMP) in place supported by Resettlement Action Plan (RAP) for entitlements.	The feasibility report outlines a monitoring plan for observing compliance. It outlines two approaches where that are: 1) Compliance Monitoring - to ensure that proposed measures in the EMMP are adhered to, and 2) Effects Monitoring - to establish baseline values for environmental parameters such as air quality, water quality and noise levels.	The feasibility report comments on minimizing emissions to the best extent. During the construction phase of the project, there were zero emissions from all the activities. For instance, activities like using washed aggregate and enclosed cyclone with automatic injection system of material in to the mixing chamber ensured minimizing emissions.	While the feasibility report considers emissions and their mitigation in the construction period, it does not outline post operation emission reductions. The project does not currently include an assessment of the overall impact on emission reductions throughout its lifecycle or a monitoring mechanism for observing on-ground emission reductions. The large-scale projects, like this, may present some challenges

[51] KOTO HYDROPOWER PROJECT FINAL FEASIBILITY REPORT VOLUME – II ENVIRONMENTAL AND SOCIAL ASSESSMENT

	the Feasibility Report.		Given the circumstances of the project, independent environmental monitoring consultant already engaged for the ongoing project shall be asked to conduct the monitoring program		pertaining to screening processes as specified by different carbon market standards when submitted for further considerations.

The analysis above underscored the importance of having detailed monitoring protocols and regular verification to provide trustworthy emissions data as the main point needing strong consideration by the projects.

Moving further, PEDOs commitment to clean energy is explored. Although some of the projects in its energy portfolio have been screened out in the analysis, however, it is notable that hydropower and solar power both lead to emission avoidance and generation of certificates. However, not all the projects can be taken forward in carbon markets given some are ineligible for registration and would not be able to generate credits out of this avoidance.

Hence, for tentative emission avoidance offered by the projects, the methodology for the calculation of emission reduction has been followed as part of this report as per the IPCC guidelines. This provides us with the emission factors to be utilized for calculating emission reduction by both hydropower and solar power projects. A pertinent thing to highlight here is that for emission avoidance during the lifecycle of a project, crediting requirements are delved into for each specific standard as deemed appropriate while developing the project. However, a useful life of 25 years for solar power and 30 years for hydropower may be multiplied by the annual emission avoidance to estimate the life cycle emissions reduction potential.

For I-RECs, the certificates generated would be as per the actual generation from the generating entity. For instance, Ranolia's anticipated generation is 99.52GWh therefore, it would generate 99,520 certificates by achieving this generation. The table 21 below expands on the emissions reduction potential of the screened portfolio and potential certificates from anticipated generation of these projects.

Table 21: Tentative Emission Avoidance and Certificates Generated by PEDOs Energy Projects

Project	Anticipated Generation (GWh)	Tentative Annual Emission Avoidance (tCO2)	Annual I-RECs (MWh)
Current Operational Solar Power			
Electrification of 100 Villages Through Solar/Alternate Energy Phase-I.	1.155	-	1,155
Electrification of Un-Electrified Villages Solar/Alternate Energy Phase II (I&II).	1.1313	-	1,131
Solarization of Civil Secretariate.	0.6515	-	652
Solarization of Chief Minister's Secretariat/ Chief Minister's House.	0.5044	-	504.4
Solar Electrification of 4000 Masajid in Khyber Pakhtunkhwa.	9.7869	-	9,787
Solar Electrification of 300 Masajid/Worship Places of Non-Muslims in merged Districts of Khyber Pakhtunkhwa.	0.7035	-	704
Solarization of Masajid in District Swat and 440 Masajid in District Peshawar.	3.4386	-	3,439
Solarization of Masajid in merged Districts of KP (AIP).	1.5952	-	1,595
Total		-	18,967.40
Future Operational Solar Power			
Solarization of 2000 Masajid in Merged Areas (AIP)	8.541	5,116.06	8541

Project	Anticipated Generation (GWh)	Tentative Annual Emission Avoidance (tCO2)	Annual I-RECs (MWh)
Solarization of Schools in Merged areas (AIP)	4.6647	2,794.16	4664.7
Solarization of Houses in Various UCs of PK- 88 of District Bannu.	2.3652	1,416.75	2,365.2
Solarization of 8000 Schools & 187 BHUs	15.768	9,445.032	15,768
Solarization of Masajid & Worship Places of Khyber Pakhtunkhwa.	18.396	11,019.2	18,396
Solarization of Masajid/ Janazgah/ Eid- Gah in various UCs of District Torghar. (DDP)	0.618	370.182	618
Total		30,161.384	50,352.9
Current Operational Hydropower			
Machai	15.784	-	15,784
Malakand-iii	549.909	-	549,909
Daral Khuwar	154	-	154,000
Reshun	13.45	-	13,450
Pehur	57.7	-	57,700
Shishi	4.1	-	4,100
316 MHHPs	168.8928	-	168,892.8
Total		-	963,835.8
Future Operational Hydropower			
Ranolia	99.52	48,963.84	99,520
Lawi	308	151,536.00	308,000
Koto	207	101,844.00	207,000
Karora	71.39	35,123.88	71,390
Chapri Charkhel	81.96	40,324.32	81,960
Jabori	71.1	34,981.20	71,100
Gorkin Matiltan	346	170,232.00	346,000
Mujahidin	40.18	19,768.56	40,180
Madyan	770.18	378,928.56	770,180
Balakot	1143	562,356.00	1,143,000
Gabral Kalam	339.19	166,881.48	339,190
140 MMHPPs	158.136	77,802.91	158,136

Project	Anticipated Generation (GWh)	Tentative Annual Emission Avoidance (tCO2)	Annual I-RECs (MWh)
Total		1,788,742.75	3,635,656.00
Private Sector Hydropower Projects			
Kalam Asrit HPP	945.8	465,333.60	945,800
Asrit Kedam HPP	944.7	464,792.40	944,700
Sharmai HPP	689	338,988.00	689,000
Shigo Kas HPP	512	251,904.00	512,000
Arkari Gol HPP	372	183,024.00	372,000
Gabral Utror HPP	310.88	152,952.96	310,880
Artistic-1 HPP	306.57	150,832.44	306,570
Shalfalam HPP	270.45	133,061.40	270,540
Artistic-2 HPP	211.745	104,178.54	211,745
Bankhwar HPP	123.68	60,850.56	123,680
Nila Da Katha HPP	136.8	67,305.60	136,800
Daral Khwar-II HPP	43.82	21,559.44	43,820
Balkani HPP	33.95	16,703.40	33,950
	PPP		
Lower Spat Gah	1935.084	952,061.33	1,935,084
Total		3,363,547.67	6,836,569.00
Private Sector Solar Power Projects			
Kulachi, DI Khan	79.2	47,440.80	79,200
Kulachi, DI Khan	79.8	47,800.20	79,800
Paharpur, DI Khan	79.3	47,500.70	79,300
Nowshera Solar PV	78.8	47,201.20	78,800
Kohat Solar PV	81.3	48,698.70	81,300
Total		238,641.6	398,400
Grand Total		5,421,093.404	11,903,781.1

***The baseline emission reduction potential for hydropower projects is taken as 0.492tCO2e/MWh and for solar 0.599tCO2e/MWh for Carbon Credits**
**** The units claimed for I-RECs cannot be claimed for carbon crediting initiatives as that would lead to double counting.**

2.7 I-RECs

International Renewable Energy Certificates (I-RECs) produced by renewable energy projects in Pakistan can play a key role in helping companies reduce their Scope 2 emissions, emissions related to the electricity they use. These certificates act as evidence that a certain amount of electricity has been generated from renewable sources, and they can be sold to companies looking to meet their sustainability commitments. Importantly, I-RECs are not limited to use within Pakistan. They can also

be sold to international companies or traders who need I-RECs from Pakistan to support their clients, particularly those operating within the country.

For companies adhering to global sustainability frameworks like RE100 or the Science Based Targets initiative (SBTi), there is a critical requirement: the renewable energy certificates they purchase must correspond to the country where their electricity is consumed. This means that if a company operates a factory in Pakistan, it cannot simply buy renewable energy certificates from any country and must purchase I-RECs generated within Pakistan. This ensures that the environmental benefits of renewable energy are accurately matched to the specific location of energy consumption.

This alignment between the country of generation and consumption serves two main purposes. First, it helps maintain the credibility of the company's sustainability claims, ensuring they reflect real-world emissions reductions. Second, it supports the growth of local renewable energy markets by encouraging investment in renewable projects within the same region where the energy is used. By purchasing I-RECs from Pakistan for operations in Pakistan, companies are not just meeting their environmental goals, they're also directly contributing to the development of the country's renewable energy sector. This approach underscores the importance of tying sustainability commitments to local impacts, which ultimately benefits both the environment and the local economy.

All the energy portfolio of PEDO can qualify for I-RECs and register the projects with PET, which is the only accredited entity that registers the projects for I-RECs in Pakistan and issues them certificates for their energy generation. However, to become eligible, the projects need to comply with the registration requirements, ownership, documentation and reporting and I-REC issuance requirements as stated in the standard. Furthermore, projects must maintain a reliable system for recording electricity generation and grid feeding data to qualify for issuing I-RECs, as these metrics directly support the projects' eligibility for I-RECs.

A pertinent point here is that a project issuing I-RECs is essentially part of carbon offsets as they directly offset scope 2 emissions. However, the units claimed for I-RECs **cannot** be claimed for carbon crediting initiatives as that would lead to double counting.

3 Carbon Cycle for Project Registration into Carbon Markets

The evaluation criteria for any project conceived to be considered for integration in the voluntary carbon markets (VCMs) follows a carbon cycle comprising of seven stages. These stages are important for any project to be deemed eligible to enter carbon markets. It is pertinent to note that the general hypothesis these projects operate on is proving actual reductions in GHG emissions. This implies using specialized methods and protocols to ensure the accuracy and integrity of the carbon credits. Also, it is important to highlight here that the stages mentioned are a detailed outline for initiating a new project. Any existing project is required to ensure that it already complies with these general requirements to be considered. The seven stages for the carbon cycle are detailed as under[5253]:

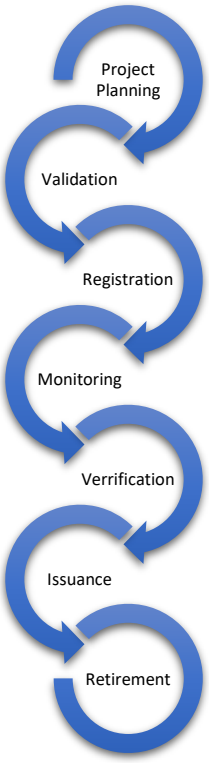


Figure 15: Carbon Cycle for project developers

3.1 Project Planning

Feasibility Assessment: The process initiates with feasibility studies that assess and evaluate the technical, financial, and environmental factors to ascertain the viability of a project. This includes the potential for emissions reductions and the conditions that will apply to the project to be successfully registered. It is very important to analyze the underlying impacts of the project and thorough understanding of the rules set by various carbon standards under consideration.

[52] https://monsooncarbon.com/how-to-earn-carbon-credits-a-quick-guide-for-project-developers/"

[53] https://eos.com/blog/carbon-credits/

Project Design and Financing: Project developers must create an implementation plan for their project, including costs and procedures. They will also acquire and manage the finances associated, pondering on both the start-up and continuing costs.

Draft a Project Design Document and Initial Submission: A Project Design Document (PDD) is a detailed report that outlines a project's activities, methods, emissions baseline, expected project emissions, environmental and social safeguards, and anticipated benefits. It also includes a monitoring plan. Submission of this document is very important and often carries strict deadlines. Most standards allow revision of the document after initial submission. Projects typically initiate prior to the formal completion of Project Design Document, but stakeholder consultation usually begins early in the process.

3.2 Validation

After the Project Design Document is completed, the project undergoes a validation process to verify that the claims made in the document are valid and meet the requirements for the project.

Validation is important to ensure that the carbon credits generated by the project are legitimate. It involves two main external parties: the carbon standard the project is aiming to register with, such as Verra (Verified Carbon Standard), Winrock (American Carbon Registry), and the Gold Standard Foundation, and an accredited third-party auditor called the validation/verification body (VVB), such as Earthood Services Private Limited (ESPL), Bureau Veritas Certification, TÜV NORD CERT GmbH etc.

Accredited VVBs carefully review the Project Design Document to ensure it complies with carbon credit standards and scientific methodologies. They also inspect the monitoring plan, including the metrics used to monitor the project.

This thorough validation process boosts the project's credibility by confirming its adherence to the established norms in the carbon crediting system.

3.3 Registration

Once validated, the project documents shall be submitted to the carbon standard for necessary approval. These documents include comprehensive plans detailing the ways their venture would reduce their greenhouse gas footprint. This paperwork should provide the carbon credit project’s goals, location, and technologies.

Successful registration signifies compliance with the standard’s requirements, gaining official approval for the project to proceed.

3.4 Monitoring

Once the project begins, or sometimes even earlier, the developer must monitor it closely. A strong system for data collection should be developed and approved earlier. It's crucial to implement this system, as failing to do so could hinder progress in later stages of the project.

3.5 Verification

After some time, the project's outcomes will need to be verified. This process tests the claims made in the project's monitoring report, including the number of carbon credits being claimed.

During this stage, independent verification by VVBs validates the accuracy and reliability of the monitoring data. This process ensures that the project is achieving the expected emissions reductions or removals, which adds credibility to its claimed environmental impact.

The verifier's findings and feedback are detailed in a comprehensive verification report. This report is forwarded to the relevant carbon credit body to prove the eligibility.

3.6 Issuance

Once the monitoring report and documentation are verified, they are submitted to the chosen carbon credit standard for review. The project developers then receive official acknowledgment, and the verified number of credits are issued according to these reductions and are ready for market trading.

3.7 Retirement

Ownership of carbon credits is tracked until they are retired by an entity, for instance a large company offsetting their emissions. Once retired, these credits cannot be transferred, traded, or sold.

This step is vital to prevent double counting and maintain the integrity of the carbon credit market.

The process from Stage 5 to 7 is repeated to verify and issue new carbon credits, while retiring any that are no longer available.

3.8 Timelines and Fee Structures by Standards

For projects being considered in each standard Verra, Gold, GCC and I-REC, the following tentative timeline and fees for project integration remain intact. However, it is important to note that the timeline mentioned is tentative and may subject to change depending on circumstances.

3.8.1 Verra

Registration Timeline[54]

After project documents submission, the standard takes 30 days for public comments and 1 year or more for validation. Once validated, the standard registers the project which may take time as per project size. This shows that a typical registration with the standard may tentatively take up to 1 year and 4 months which may subject to change on case-to-case basis.

Fee Structure[55]

Verra charges fees at different stages of project registration and carbon credit issuance. To start, opening an account costs $500, with an additional $500 per year for maintenance. Listing a project in the pipeline costs $1,000, and submitting it for registration review costs $2,500. Once credits (VCUs) are issued, there's a fee of $0.20 per VCU. If a project wants to develop or modify a methodology, costs range from $1,500 to $13,000, depending on complexity. Verra also offers a small rebate per VCU issued, scaling down as more credits are generated. Lastly, validation bodies pay an annual fee between $5,000 and $9,000, depending on the number of programs they verify.

[54] https://verra.org/programs/verified-carbon-standard/
[55] https://stg.verra.org/wp-content/uploads/2023/03/Program-Fee-Schedule-v4.3-FINAL.pdf

3.8.2 Gold

Gold Registration Timeline[56]

After project documents submission, it takes about a month to register account. After that the standard takes 3 months (*including working days only*) for public comments and 1 year or more for validation. Once validated, the standard registers the project which may take time as per project size. This shows that a typical registration with the standard may tentatively take up to 1 year and 6 months which may subject to change on case-to-case basis.

Gold Standard Fees[57]

Gold Standard charges various fees for project certification and credit issuance. Opening a registry account costs $1,000 per year, and reactivating a suspended account costs $2,500. Certification fees depend on project type, with a preliminary review fee charged by a third-party (SustainCERT). The design review fee starts at $0.15 per credit, while the issuance fee varies from $0.05 to $0.30 per credit, depending on project type and issuance model (cash or share of proceeds). Projects renewing their crediting period pay similar fees. Microscale projects have additional validation fees, ranging from $5,000 for standalone projects to $2,500 per additional VPA. Gold Standard also charges methodology approval fees (case-specific), conversion fees for transitioning credits, and VVB approval fees ranging from $2,500 to $4,600 per entity. Additional fees apply for deviations, training, and certification updates.

3.8.3 GCC

GCC Registration Timeline[58]

After project documents submission, the following activities apply: initial submission and completeness check (5 days), a 15-day Global Stakeholder Consultation, and third-party verification before submission for registration. The GCC Operations Team reviews within 10 days, and if aligned with the verifier's recommendation, the project is automatically registered unless the Steering Committee objects within 10 days; otherwise, a review extends the decision timeline. After final approval (3 days), projects move to IHS Markit.

For ACR issuance, projects must complete a monitoring period, submit data for a 5-day completeness check, undergo third-party verification, and be reviewed within 10 days before automatic issuance, unless the Steering Committee intervenes within another 10 days. The final issuance decision is posted publicly within 3 days, after which credits become tradable on IHS Markit. Delays can occur due to stakeholder feedback, non-conformities, or Steering Committee reviews, making the total process variable but generally spanning over a month for each major phase.

Therefore, if everything goes smooth, Project Registration would take ~43 days, ACR Issuance: ~38 days and total adding to 2.5 to 3 months minimum.

[56] https://globalgoals.goldstandard.org/standards/101_V1.2_PAR_Principles-Requirements.pdf

[57] https://globalgoals.goldstandard.org/standards/GS-fee-schedule-2023.pdf

[58] https://www.globalcarboncouncil.com/wp-content/uploads/2021/10/GCC-Program-Processes.pdf

GCC Standard Fees[59]

GCC charges various fees for project registration, credit issuance, and trading. Opening a GCC Projects Portal account is free, but registering a project costs $3,000. To participate in the IHS Markit Registry (S&P Global), project owners and buyers must pay a $1,000 account opening fee (valid for one year) and an annual maintenance fee of $1,000 per account.

Issuance fees vary by project type and volume, starting at $0.12–$0.15 per ACC for the first 1 million ACCs and decreasing to $0.03–$0.04 per ACC for issuances above 10 million ACCs. These fees can be paid before issuance or before the transfer of ACCs. Additionally, transferring or retiring ACCs incurs a $0.04 per ACC fee, payable before execution.

For projects seeking additional certification labels (such as Social or Environmental Safeguard Labels or SDG labels), a fee of $0.02 per ACC per label applies, or $0.06 per ACC if all three labels are issued.

Verification bodies seeking GCC approval under UNFCCC/ISO Track must pay $2,000 per two-year approval, while those under the MOU Track pay directly to their accreditation body.

3.8.4 IRECs Through Pakistan Environmental Trust (PET)

PET Timeline

Based on industry practice, a tentative timeline for registering a device with the IRECs standard is 6-months provided everything goes smooth.

PET Fee Schedule for IRECs[60]

Registrant Application Fee = $0 (Free)

<u>One-Time Device Registration Fee:</u>

Capacity>50 MW = $2,000

Capacity 3MW – 50MW = $1,000

Capacity <3MW = $500

Capacity <1MW = $100

Device Renewal Fee (After 5 Years Validity) = 40% of the original registration fee

<u>Issuance Fee:</u>

Issuance Fee (Per MWh) = $0.025

Issuance Fee for Self-Consumption (Per MWh) = $0.035

[59] https://www.globalcarboncouncil.com/wp-content/uploads/2023/05/GCC-Fee-Schedule.pdf
[60] https://www.trackingstandard.org/wp-content/uploads/Fee-structure-2025_v1.3.pdf

4 Recommendations

The following recommendations are suggested for all the projects shortlisted for effective integration and further considerations.

4.1 General Recommendations

- Thorough consideration needs to be given to the emission reduction potential the project holds throughout its lifecycle, supported by global mechanisms for project development to ensure effective integration.
- The social needs of the affected community should be the paramount consideration to ensure that project activities and development, including land acquisition, are well-received by stakeholders. This should be supported by robust project co-benefits and community engagement plans to further induce acceptability.
- Provision of co-benefits is an essential part of carbon market integration, and the projects should give them the due attention in that regard.
- A robust monitoring mechanism is required to provide updates on how the project will achieve transparent and accurate disclosure of data and information.
- Climate resilience is paramount, considering the country is annually hit by floods. Projects should incorporate predictive modeling techniques in their designs to ensure adaptability to future climate-induced disasters, including Slow Onset Events (SOE) or Rapid Onset Disasters (ROD).
- Thorough geological surveys utilizing modern technologies are vital to gain a clear understanding of the project's geological area, aiding in rational decision-making.
- Developing local capacity is essential to ensure that technological needs can be met through indigenous resources.
- All existing PC-1s of projects that are not yet operational should be amended to include the impact of carbon emission avoidance after they become operational. This will showcase additionality in the project and make it eligible for carbon markets. Similarly, all future PC-1s of hydel or solar projects should include this additionality.

4.2 Specific Recommendations

- To ensure the successful advancement of projects eligible for the Voluntary Carbon Market (VCM), PEDO should establish a comprehensive monitoring, reporting, and verification frameworks to ensure compliance with carbon crediting requirements and enhance data accuracy for future certifications. This framework should provide the required data and documents and monitor and report the impact of the project on the ecosystem, local community, and co-benefits.
- Address data gaps, especially in older and community-focused projects, by setting clear data management protocols to boost market readiness and attract climate finance.
- Incorporate predictive modeling and resilience strategies in projects, especially in vulnerable areas, to mitigate climate risks and support adaptation goals.

- Efforts should be put in place to integrate updated Environmental, Social, and Governance (ESG) provisions. Enhanced focus on biodiversity and social measures will align projects with current global standards, strengthening their eligibility for carbon markets.
- Where applicable, establishing comprehensive emission monitoring systems for both construction and operational phases is recommended to improve accuracy in emissions tracking. Projects already incorporating emissions reduction measures may benefit from additional methodologies to quantify and monitor reductions, particularly in post-construction phases.
- For projects with Environmental Management Plans (EMPs) primarily focused on the construction phase, expanding these to include operational emissions monitoring and compliance tracking can strengthen adherence to environmental standards. Additionally, while alternative energy sources and project impact assessments have been addressed in some cases, lifecycle emissions monitoring and on-site strategies can provide a clearer long-term environmental outlook where relevant.
- Conduct further assessments of prioritized projects, aligning them with global standards to unlock investment potential and revenue from carbon credits and I-RECs.
- The Solar Portfolio and MMHPPs are strong candidates due to their community involvement, contributions to poverty alleviation, health, and economic growth, directly supporting the SDGs. Providing data on their compliance with social and environmental criteria, their existence along with assurance of a robust monitoring system for emission reductions, will further strengthen their case.

4.3 Recommendations for PEDO

Moving forward for participation in the crediting markets, PEDO would have to take the following executive decisions:

4.3.1 Carbon Markets

- Implement a unified digital platform for real-time tracking of project data, including emissions, electricity generation, and maintenance records, ensuring data integrity and accessibility.
- Commission expert assessments to establish scientifically robust emissions baselines, aligning with carbon market eligibility criteria and international best practices.
- Develop and institutionalize a Monitoring, Reporting, and Verification (MRV) system to ensure compliance with carbon market standards and enhance the credibility of emissions reductions.
- Undertake a comprehensive evaluation of the technical, economic, and environmental viability of PEDO's energy projects to determine their suitability for carbon market participation.
- Align PEDO's projects with the sustainability criteria of recognized carbon market standards, ensuring adherence to environmental and social safeguards.

4.3.2 I-RECs

- The six projects Machai, Malakand-iii, Daral Khuwar, Reshun, Pehur, Shishi, which are only eligible for IRECs markets, should be registered for IRECs immediately after obtaining approval from the relevant authority.

- Implement a unified digital platform for real-time tracking of project data, including electricity generation and maintenance records, ensuring data integrity and accessibility.
- Integrate digital solutions for automated data collection and verification, ensuring full traceability and compliance with I-REC requirements.

4.4 Capacity Building Recommendations for PEDO

PEDO shall make the necessary arrangements for technical assistance and grant support to facilitate the following capacity-building activities:

- Conduct introductory training on carbon markets and I-RECs, covering key terminologies, compliance structures, and market participation through seminars and lectures.
- Provide interactive sessions on national and international regulatory requirements, contracts, and certification processes for carbon credits and I-RECs.
- Train PEDO staff on data collection, emissions monitoring, additionality assessment, and working with VVBs to improve project eligibility and reporting.
- Equip PEDO with skills for engaging buyers, pitching projects, and navigating trading platforms for carbon credits and I-RECs.
- Enhance PEDO's financial capacity in budgeting, certification costs, revenue estimation, and handling sales of carbon credits and I-RECs.
- Implement post-training evaluations, upload training materials on PEDO's website, and schedule additional in-person training as needed based on market dynamics.
- PEDO should strengthen its internal capacity to engage in carbon markets by implementing a structured training program on carbon pricing, MRV systems, and climate finance in collaboration with international experts and institutions. The option of retaining an in-house consultant/consulting firm can also be explored. In parallel, PEDO should explore globally available standardized training opportunities, participate in knowledge-sharing platforms, and engage experienced carbon market consultants or firms to receive tailored technical support and practical exposure to international best practices.

5 Conclusion and Way Forward

The Carbon Asset Inventory of KP's Renewable Energy Portfolio highlights the critical role of renewable energy projects in achieving emission reduction targets and contributing to sustainable development. Through a comprehensive evaluation of project performance, challenges, and alignment strategies with high-level standards like Verra, the analysis provides valuable insights and actionable recommendations.

Moving forward, the projects are shortlisted by their eligibility/ineligibility expanded in table 22. The standard-wise project bifurcation, as illustrated in Table 23 below, may be further considered for each carbon standard when taking the projects forward. These projects may be assessed in greater depth based on their credit-generating potential, evaluating additionality and the integrity of credits offered, in alignment with procedures outlined in distinct standards. This process will also include a stakeholder engagement strategy to facilitate the crediting process. Finally, the projects will undergo a financial viability assessment, followed by a risk assessment and mitigation strategy.

Table 22: Summary Analysis Indicating Eligibility/Non-Eligibility of PEDO Energy Portfolio against Carbon Markets an I-RECs

Project Name	Eligibility				Comments
	Verra	Gold Standard	GCC	I-REC	
Current Operational Large Hydropower Plants					
Malakand III	Not Eligible	Not Eligible	Not Eligible	Eligible	On-Grid Projects not eligible for Verra, Gold Standard has 5% capacity cap for RE resource, Not Eligible under GCC since more than one year has passed since the start of project operations. As the projects do not qualify for any carbon market, PEDO may immediately take steps for registration of these projects for IRECs.
Daral Khwar	Not Eligible	Not Eligible	Not Eligible	Eligible	
Pehur	Not Eligible	Not Eligible	Not Eligible	Eligible	
Current Operational Small and Mini Hydropower Plants					
Shishi	Not Eligible	Not Eligible	Not Eligible	Eligible	On-Grid Projects not eligible for Verra, Gold Standard has 5% capacity cap for RE resource, Reshun is off-grid but it was not developed as per the conformity requirements of carbon market standards, Not Eligible under GCC since more than one year has passed since the start of project operations. As the projects do not qualify for
Machai	Not Eligible	Not Eligible	Not Eligible	Eligible	
Reshun	Not Eligible	Not Eligible	Not Eligible	Eligible	

Project Name	Eligibility				Comments
	Verra	Gold Standard	GCC	I-REC	
					any carbon market, PEDO may immediately take steps for registration of these projects for IRECs
Current Operational Micro Hydropower Plants					
316 MMHPPs	Not Eligible	Not Eligible	Not Eligible	Eligible	Not Eligible under GCC since more than one year has passed since the start of project operations, for other two standards, the requirements cannot be met as these are neither greenfield projects, nor rehabilitation projects. Registration for I-REC can be considered but would be a challenge since projects are handed over to the community and data is not maintained. However, recommendations at Table 18 in this regard may be considered.
Current Operational Solar PV Installations					
Electrification of 100 Villages Through Solar/Alternate Energy Phase-I.	Not Eligible	Not Eligible	Not Eligible	Eligible	Not eligible for any carbon market as these are older Projects Ownership handed over to the community. No evidence of electricity generation data and plant performance details maintained/provided. Rehabilitation of these projects is not under discussion. I-REC can be considered but would be a challenge since projects are handed over to the community and data is not maintained. However, recommendations at Table 18 in this regard may be considered.
Electrification of Un-Electrified Villages Solar/Alternate Energy Phase II (I&II).	Not Eligible	Not Eligible	Not Eligible	Eligible	
Solarization of Civil Secretariate.	Not Eligible	Not Eligible	Not Eligible	Eligible	
Solarization of Chief Minister's Secretariat/ Chief Minister's House.	Not Eligible	Not Eligible	Not Eligible	Eligible	
Solar Electrification of 4000 Masajid in Khyber Pakhtunkhwa.	Not Eligible	Not Eligible	Not Eligible	Eligible	
Solar Electrification of 300 Masajid/Worship Places of Non-Muslims in merged Districts	Not Eligible	Not Eligible	Not Eligible	Eligible	

Project Name	Eligibility				Comments
	Verra	Gold Standard	GCC	I-REC	
of Khyber Pakhtunkhwa.					
Solarization of Masajid in District Swat and 440 Masajid in District Peshawar.	Not Eligible	Not Eligible	Not Eligible	Eligible	
Solarization of Masajid in merged Districts of KP (AIP).	Not Eligible	Not Eligible	Not Eligible	Eligible	
Future Operational Large Hydropower Plans					
Gorkin Matiltan	Not Eligible	Not Eligible	Eligible	Eligible	On-Grid Projects not eligible for Verra, Gold Standard has 5% capacity cap for RE resource. GCC and I-REC can be considered for registration. However, recommendations at Table 17, 18 in this regard may be considered.
Koto	Not Eligible	Not Eligible	Eligible	Eligible	
Lawi	Not Eligible	Not Eligible	Eligible	Eligible	
Balakot	Not Eligible	Not Eligible	Eligible	Eligible	
Gabral Kalam	Not Eligible	Not Eligible	Eligible	Eligible	
Madyan	Not Eligible	Not Eligible	Eligible	Eligible	
Ranolia	Not Eligible	Not Eligible	Eligible	Eligible	
Future Operational Small and Mini Hydropower Plans					
Karora	Not Eligible	Not Eligible	Eligible	Eligible	On-Grid Projects not eligible for Verra, Gold Standard has 5% capacity cap for RE resource. GCC and I-REC can be considered for registration. To improve its viability, the recommendations in Table 17, 18 may be considered.
Jabori	Not Eligible	Not Eligible	Eligible	Eligible	
Chapri Charkhel	Not Eligible	Not Eligible	Eligible	Eligible	
Mujahideen	Eligible	Eligible	Eligible	Eligible	Can be potential carbon market project under all markets including IRECs. To improve its viability, the recommendations in Table 15, 16, 17, 18 may be considered.
Total Future Operational Micro Hydropower Plans					
140MMHPPs	Eligible	Eligible	Eligible	Eligible	Can be potential carbon market project under all markets including IRECs. To improve its viability, the recommendations in Table 15, 16, 17, 18 may be considered.
Total Future Hydropower Plants		825.388			
Future Operational Solar PV Installations					
Solarization of 8000 Schools & 187 BHUs	Eligible	Eligible	Eligible	Eligible	Can be potential carbon market project under Verra, Gold Standard and GCC.

Project Name	Eligibility				Comments
	Verra	Gold Standard	GCC	I-REC	
Solarization of Masajid & Worship Places of Khyber Pakhtunkhwa.	Eligible	Eligible	Eligible	Eligible	These can also register for I-RECs. To improve its viability, the recommendations in Table 15, 16, 17, 18 may be considered.
Solarization of 2000 Masajid in Merged Areas (AIP)	Eligible	Eligible	Eligible	Eligible	
Solarization of Schools in Merged areas (AIP)	Eligible	Eligible	Eligible	Eligible	
Solarization of Houses in Various UCs of PK- 88 of District Bannu.	Eligible	Eligible	Eligible	Eligible	
Solarization of Masajid/ Janazgah/ Eid-Gah in various UCs of District Torghar. (DDP)	Eligible	Eligible	Eligible	Eligible	
Future Operational IPP Based Hydropower Plants					
Kalam Asrit HPP	Not Eligible	Not Eligible	Eligible	Eligible	On-Grid Projects not eligible for Verra, Gold Standard has 5% capacity cap for RE resource. GCC and I-REC can be considered for registration. However, recommendations at Table 17, 18 in this regard may be considered.
Asrit Kedam HPP	Not Eligible	Not Eligible	Eligible	Eligible	
Sharmai HPP	Not Eligible	Not Eligible	Eligible	Eligible	
Shigo Kas HPP	Not Eligible	Not Eligible	Eligible	Eligible	
Arkari Gol HPP	Not Eligible	Not Eligible	Eligible	Eligible	
Gabral Utror HPP	Not Eligible	Not Eligible	Eligible	Eligible	
Artistic-1 HPP	Not Eligible	Not Eligible	Eligible	Eligible	
Shalfalam HPP	Not Eligible	Not Eligible	Eligible	Eligible	
Artistic-2 HPP	Not Eligible	Not Eligible	Eligible	Eligible	
Bankhwar HPP	Not Eligible	Not Eligible	Eligible	Eligible	
Nila Da Katha HPP	Not Eligible	Not Eligible	Eligible	Eligible	
Lower Spat Gah	Not Eligible	Not Eligible	Eligible	Eligible	
Future Operational Private Sector Small Hydropower Plants					
Daral Khwar-II HPP	Not Eligible	Not Eligible	Eligible	Eligible	On-Grid Projects not eligible for Verra, Gold Standard has 5% capacity cap for RE resource. GCC and I-REC can be considered for registration. However, recommendations at Table 17, 18 in this regard may be considered.
Balkani HPP	Not Eligible	Not Eligible	Eligible	Eligible	
Future Operational Private Sector Solar PV Powe Plants					
Kulachi, DI Khan	Not Eligible	Eligible	Eligible	Eligible	On-Grid Projects not eligible for Verra. However, these projects qualify for Gold
Kulachi, DI Khan	Not Eligible	Eligible	Eligible	Eligible	

Project Name	Eligibility				Comments
	Verra	Gold Standard	GCC	I-REC	
Paharpur, DI Khan	Not Eligible	Eligible	Eligible	Eligible	Standard and GCC as solar PV is currently within the 5% capacity cap for RE resource, and GCC include Solar PV as qualifying RE technology. These projects can also register for I-REC. However, recommendations at Table 16, 17, 18 in this regard may be considered.
Nowshera Solar PV	Not Eligible	Eligible	Eligible	Eligible	
Kohat Solar PV	Not Eligible	Eligible	Eligible	Eligible	

Table 23: Summary of Project Moving Forward

Standard	Projects for Further Consideration	
	On-Grid	Off-Grid
Verra	-	☐ Mujahideen 6.95MW ☐ 140 MMHPPs ☐ Future Operational Solar
Gold	☐ Future Private Sector Solar Projects	☐ Future Operational Solar Projects ☐ 140 MMHPPs ☐ Mujahideen 6.95 MW
GCC	☐ Ranolia 17 MW ☐ Lawi 69 MW ☐ Koto 40.8 MW ☐ Karora 11.8 MW ☐ Chapri Charkhel 13.56 MW ☐ Jabori 10.2 MW ☐ Gorkin Matiltan 84 MW ☐ Madyan 157 MW ☐ Balakot 300 MW ☐ Gabral Kalam 88 MW ☐ Future Private Sector Hydropower Portfolio ☐ Future Private Sector Solar Projects	☐ Future Operational Solar Projects ☐ 140 MMHPPs ☐ Mujahideen 6.95 MW
IRECs	☐ Machai, Malakand-iii, Daral Khuwar, Pehur, Shishi are ready for IRECs market	☐ Reshun
	While the complete portfolio is eligible for IRECs, only those projects that are ineligible for Carbon Markets should be considered. The above-mentioned six operational projects, ineligible for other Carbon Markets, are ready to be taken to the IRECs quickly after necessary approvals from relevant forums.	

In a nutshell, as displayed in table 23, Mujahideen HPP, 140 MMHPPs and Future Operational solar, all as off grid candidates, can be taken forward for Verra for further considerations. For Gold, Mujahideen HPP, 140 MMHPPs and Future Operational Solar projects can be taken forward as off grid, whereas, private solar projects can be taken forward as on-grid candidates for further scrutiny. Finally, under GCC, future operational solar projects, 140 MMHPPs and Mujahideen HPP as off-grid candidates whereas, complete future operational hydropower projects, private sector hydropower projects and private solar projects being on-grid candidates can be taken forward for further evaluation.

The report elaborates on I-RECs, confirming that PEDO's entire portfolio is eligible for this mechanism since it generates clean energy in MWh. It notes challenges in selling certificates from older projects but highlights that these certificates can help reduce an entity's scope 2 emissions. However, units claimed for I-RECs cannot be used for carbon crediting to prevent double counting. Hence, projects that are ineligible for Carbon markets should be considered for IRECs. Amongst them the six projects Machai, Malakand-iii, Daral Khuwar, Reshun, Pehur, Shishi are ready to be taken to the IRECs market. The report also clarifies the role of PET as the accredited I-REC issuance body in this process.

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