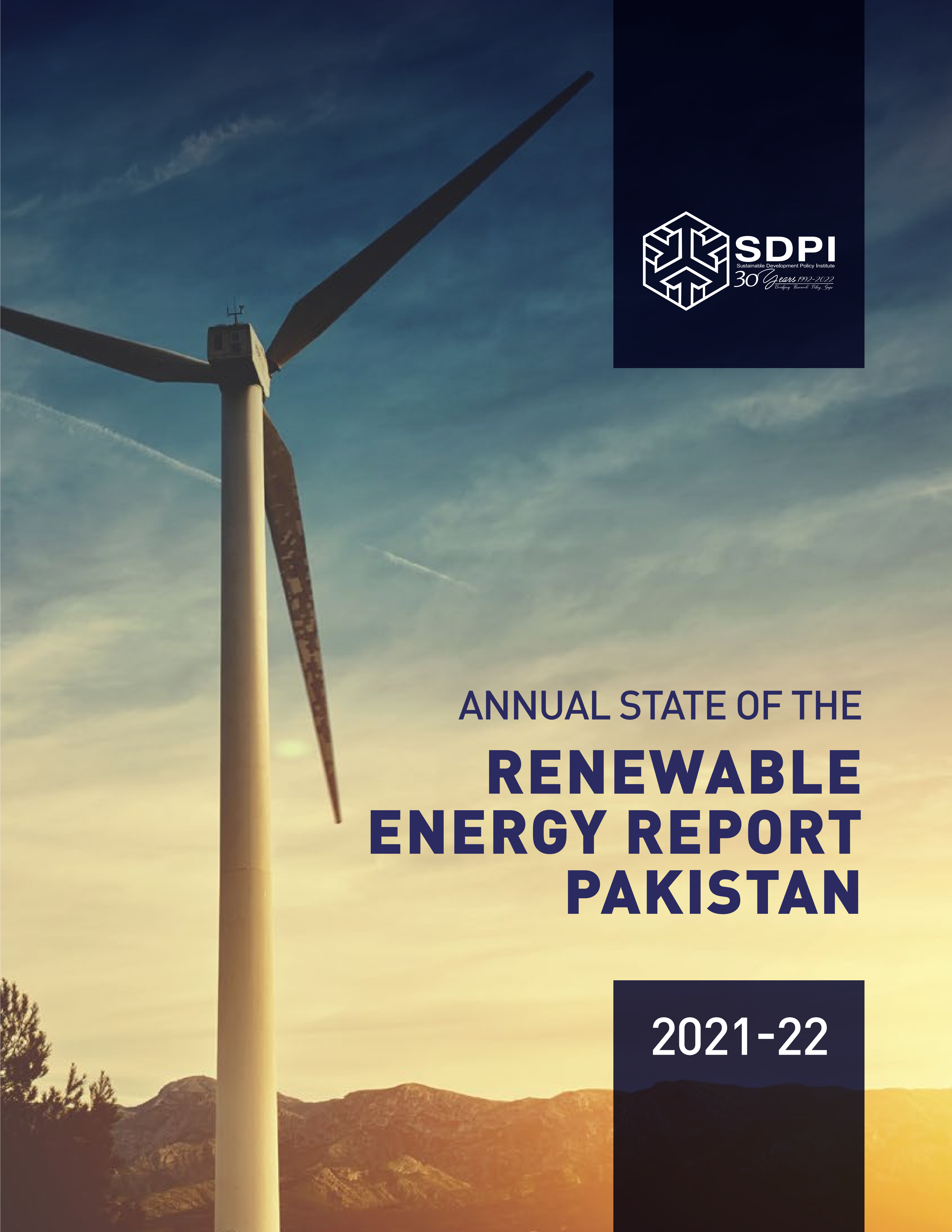

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Sustainable Development Policy Institute
30 Years 1992-2022

ANNUAL STATE OF THE

RENEWABLE ENERGY REPORT PAKISTAN

2021-22

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Table of Contents

List of Boxes

List of Tables

List of Figures

Abbreviations & Acronyms

ADB	Asian Development Bank
AEDB	Alternative Energy Development Board
ARE	Alternative Renewable Energy
BHUs	Basic Health Units
BoP	Bank of Punjab
CCoE	Cabinet Committee on Energy
CDC	Commonwealth Development Corporation
CoP	Conference of Parties
CPEC	China-Pakistan Economic Corridor
CPI	Consumer Price Index
CPPA-G	Central Power Purchasing Agency-Guarantee
CSR	Corporate Social Responsibility
CTBCM	Competitive Trading Bilateral Contract Market
DFI	Development Finance Institutions
DISCOs	Distribution Companies
ECC	Economic Coordination Committee
ESG	Environmental, Social, and Governance
ESMAP	Energy Sector Management Assistance Program
FDI	Foreign Direct Investment
FIT	Feed-in Tariff
FIs	Financial Institutions
FMCGs	Fast-Moving Consumer Goods
FMO	Dutch Entrepreneurial Development Bank
GCC	Green Certificate Company
GCF	Green Climate Fund
GHI	Global Horizontal Irradiance
GHG	Greenhouse Gas
GIZ	German International Development Agency
GLs	Generation Licenses
GoKP	Government of Khyber Pakhtunkhwa
GoP	Government of Pakistan
GST	General Sales Tax
HH	Household
HPPs	Hydel Power Plants
IFC	International Finance Corporation
IGCEP	Indicative Generation Capacity Expansion Plan
IISD	International Institute for Sustainable Development

IPPs	Independent Power Producers
IRENA	International Renewable Energy Agency
ITP	Integrated Transmission Planning
KIIs	Key Informant Interviews
kWh	kilowatt-hour
kWp	kilowatt peak
LES	Local Energy Systems
LoI	Letter of Intent
LoS	Letter of Support
MDBs	Multilateral Development Banks
MFIs	Microfinance Institutions
MHPPs	Micro Hydel Power Plants
MoE	Ministry of Energy
MoF	Ministry of Finance
MPS	Minimum Performance Standards
MSW	Municipal Solid Waste
$MtCO_2eq$	Million Tonnes of Carbon Dioxide equivalent
NCCP	National Climate Change Policy
MTOE	Mega Tonnes of Oil Equivalent
NBFCs	Non-Bank Financial Companies
NDCs	Nationally Determined Contributions
NEECA	National Energy Efficiency and Conservation Authority
NEP	National Electricity Policy
NEPRA	National Electric Power Regulatory Authority
NREL	National Renewable Energy Laboratory
NRSP	National Rural Support Programme
NTDC	National Transmission & Dispatch Company
O&M	Operations & Maintenance
PAEC	Pakistan Atomic Energy Commission
PCGC	Pakistan Credit Guarantee Company
PDF	Project Development Facility
PEDO	Pakhtunkhwa Energy Development Organization
PEPCO	Pakistan Electric Power Company
PMIC	Pakistan Microfinance Investment Company
PMRC	Pakistan Mortgage Refinancing Company
PPAs	Power Purchase Agreements
PPAF	Pakistan Poverty Alleviation Fund
PPIB	Private Power & Infrastructure Board
PPPs	Public-Private Partnerships
PPP	Power Purchase Price
PPSE	Pakistan Private Sector Energy Project

RBF	Result Based Financing
REC	Renewable Energy Certificate
RE	Renewable Energy
REEECCI	Renewable Energy and Energy Efficiency Concepts in Cities and Industry (REEE Scale)
RHCs	Rural Health Centers
ROW	Right-of-Way
RPS	Renewable Portfolio Standards
SAP	Simplified Approval Processes
SBP	State Bank of Pakistan
SECP	Securities and Exchange Commission of Pakistan
SHS	Solar Home System
SHYDO	Sarhad Hydel Development Organization
SMEs	Small and Medium Enterprises
SPPAs	Solar Power Purchase Agreements
TDS	Tariff Differential Subsidies
UoSC	Use-of-System Charges
USAID	United States Agency for International Development
VGF	Viability Gap Funding
WAPDA	Water & Power Development Authority
WBG	World Bank Group
WPMCs	Wind Power Management Companies
WTG	Wind Turbine Generator

Executive Summary

The implementation of an improved institutional framework, policies and global COP26 pledges are set to advance renewable electricity growth. This will be essential for Pakistan as it remains one of the most vulnerable countries to climate change.

Pakistan's energy mix witnessed an offtake of renewables over the past decade. Renewables contribute about 4% of total power sector generation while wind alone contributes more than two-thirds of renewables generation. Energy generated from solar and wind jumped from almost zero in 2011 to 4,320 GWh of electricity units in 2021.

Improvement in competitiveness, ambitious targets, and policy support are propelling Pakistan to achieve new records in renewable power. Relative to existing capacity, solar and wind power are expected to lead the way. Driven by the Competitive Trading Bilateral Contract Market (CTBCM) model and wheeling regulations, the exploration of options for competitive bidding and auctions can pave the way for achieving the Government of Pakistan's (GoP) ambitious renewable power target of 60% by 2030 (including large hydro). Through a combination of economic attractiveness of wind and solar PV, increased ambition at the federal and provincial level, and aid through financial schemes, incentives, and investment potential, Pakistan can continue to accelerate its clean energy transition.

The growth of renewable capacity (wind, solar, and bagasse) is forecasted to accelerate in the next 8 years, with the total generation capacity increasing to 21% i.e. from 2949 MW to 13,686 MW by 2030 (IGCEP, 2022). This accounts for 7,932 MW, 5,005 MW, and 749 MW of solar, wind, and bagasse additions, respectively. The GoP has revised these forecasts based on stronger policy support and ambitious climate targets announced for COP 26, i.e. Alternative Renewable Energy (ARE) Policy (30% share of solar and wind), Indicative Generation Capacity Expansion Plan (IGCEP), National Electricity Policy 2021, and Nationally Determined Contributions (NDCs) (60% capacity share of renewables and hydro by 2030) (GoP, 2021).

In terms of tariff determination of renewables, the current cost of generation from different sources show that renewables are becoming increasingly competitive with conventional fossil fuel-based sources. The current generation mix includes wind and solar with much higher older tariffs of Rs 25.25/kWh and Rs 24.41/kWh and latest plants with tariffs as low as Rs.16.20/kWh and Rs.19.14/kWh (index adjusted). The tariffs determined by NEPRA for wind power plants in the last decade have reduced from Rs.12.77/kWh to Rs.6.39/kWh (NEPRA, 2021).

Methodology of the Report

The development of this report and roadmap followed the following approach:

Current Situation: A review of the current status of renewables, including resource potential and adoption trends and analysis of different renewable energy technologies.

Mapping Future Trajectory: 60% target of renewable energy by 2030, 30% solar & wind, and reducing 50% emissions by 2030 to meet NDCs.

Energy Infrastructure: The model of energy distribution infrastructure in Pakistan with the current situation, future scenarios, perspective on constraints, potential solutions, and associated costs.

Public-Private Sector Investments in the Renewable Energy Sector: This also covered renewable energy financing schemes of different national and international Financial Institutes (IFs), along with potential opportunities to promote renewable energy technologies in Pakistan.

Barriers: Identification of behavioral, economic, and regulatory barriers preventing private sector and investor action with suggested interventions to drive change.

Implementation: The report includes a special chapter that assesses the impact of wind and community-driven micro-hydel power plants on the local community - a perspective of "JUST" Energy Transition.

Stakeholder Engagement: Data collection from credible sources and reports by engaging the public and private sectors for consultations to ensure representation of a broad group of stakeholders.

- Complementing and validating reports through peer-reviewed processes by energy sector experts and coalitions.
- Collecting primary data through qualitative surveys of a representative population of the region.

Based on NDCs, an investment of $101 billion is required by 2030 for Pakistan's clean energy transition. Out of this, $20 billion is required for a 12 GW expansion of the renewable portfolio only (GoP, 2021). As of June 2021, total investments in solar, wind, and bagasse-based power plants (operational and under construction) stand at approximately $786 million, $3,752 million, and $258 million, respectively (NEPRA, 2021).

BOX 1 | Resource Potential of Renewables in Pakistan- Overall Landscape

- **Solar has a large resource potential with average Global Horizontal Irradiance (GHI) being as high as 2,337 kWh/m.2**
- **Utilizing only 0.07% of solar potential can meet the country's energy needs.**

- **Potential of 340 GW (Sindh & Balochistan)**
- **50GW potential in Jhimpir-Gharo (Approximately double the current energy needs)**
- **Off-grid wind-155 WTGs combined capacity of 161 kW and electrification of 1560 houses and 9-coast guard check posts.**
  - 1,000 WTGs in Sindh (by AKF)
  - More than 10 WTGs by PCRET

- **Annual 30 million metric tonnes of MSW and 1 million metric tonnes of animal manure.**

****This makes a case for the enormous potential of off-grid solar based distributed energy in Pakistan. The first solar power distributed energy was tied with the grid through net-metering in 2012. As of September 2020, 5,502 customers of cumulative 94.39 MW have been issued licenses for Net-Metering* (SEC, 2021). *According to recent data, there are 68 solar mini-grids (3-51 kW) deployed in Karak, Laki Marwat and Swabi districts by PPAF* (PPAF, 2021)*; a PV-Wind hybrid power system of 50 kW deployed in Khushab by ADB* (ADB, 2018)*; solarization of 10,762 schools in southern Punjab is benefiting 1.27 million students through the Punjab Energy Department* (PMU, n.d.)*; and solar tube wells (5-25 kW) used for ground water extraction are being deployed in Punjab, Balochistan, Sindh, and Khyber Pakhtunkhwa.*

The overall geotectonic topography of the region suggests the presence of commercially viable geothermal potential across different regions of the country. However, no documented geothermal plant for heating or power production purposes has been installed in Pakistan and the potential of geothermal power remains untapped.

Ongoing challenges & opportunities towards renewable energy uptake in Pakistan

Although the years 2020 and 2021 highlighted the resilience of renewable energy markets during the times of economic turbulence and COVID-19 pandemic, higher commodity prices have bounced back in the wake of the Russia-Ukraine war. In 2021, the rising prices of key raw materials used in the manufacturing of solar and wind turbines and equipment due to supply chain disruption consequently led to a rise in the prices of modules and turbines. China, the biggest market player, increased the prices of wind turbines to 20% higher than previous years. Increasing commodity prices, along with spiraling inflation, meant that countries like Pakistan suffered on account of rising fuel prices, higher Consumer Price Index (CPI) adjusted impacts and base tariff increases. Rising energy prices coupled with rupee depreciation has had a disproportionate impact on the most vulnerable segments of the society.

Despite ambitious policy support for renewables in Pakistan, progress has been uneven across the sectors and is mainly directed towards the power sector. Fewer efforts were made to accelerate the renewables' integration in buildings, industry, and transport, even though these sectors are responsible for the largest share of final energy demand and growth as well as CO_2 emissions.

The transition towards a 100% renewable energy system is a low-cost viable option. It will not only help decrease the energy cost but also reduce dependence on imported fossil fuels and increase energy security. Research has identified cost-optimized techno-economic pathways for direct and indirect electrification of power, heat, transport, and desalination sectors so that Pakistan might achieve a 100% renewable energy system by 2050.

The current national grid is overwhelmed with overloading and grid instability, particularly in semi-urban and rural regions. Integrating renewables with lower capacity into the grid requires robust grid infrastructure. This often results in under-utilization of renewable power projects, as the 'must-run' status of renewables is often not followed.

Policy and regulatory uncertainty around renewables, coupled with a lack of coordination mechanisms amongst federal and provincial authorities, leads to slow progress in the transition towards renewables. This is reflected in the uncertainty among investors and developers to rely upon the current procurement regime and the transition to competitive bidding and bilateral trading market in the future. In addition, delays in the regulatory approvals from relevant agencies for the issuance of Letter of Intent (LoI), and Letter of Support (LoS), and delays after the evacuation of infrastructure in terms of commissioning, billing, and invoicing against energy dispatched, further hampers investor appetite to make a credible investment in renewables. In addition, the absence of regulations surrounding innovative clean energy technologies, such as battery storage and hydrogen plants, put forth unnecessary delays and uncertainty for the private sector to introduce or participate in executing these innovative technologies. Land acquisition approval for wind/solar power plants from various authorities is also a tedious and lengthy process, and hence a cause of delay.

Another critical barrier is the lack of adequate financing sources for Pakistan's renewable energy projects, particularly for small-scale projects. This barrier mainly stems from the lack of capacity among financial institutions regarding the reliability and benefits of renewable energy technologies which results in investor reluctance to offer loans or invest funds in these projects and the unavailability of credit enhancement instruments for the accelerated uptake of renewable energy technologies. Policy instruments such as the renewable energy targets, Feed-in-Tariffs (FITs), Solar Power Purchase Agreements (SPPAs), and fiscal incentives require additional supporting instruments such as Renewable Portfolio Standards (RPS) and other financial and fiscal incentives to investors, local equipment providers, and service providers.

There is a need to improve localization of renewable energy supply chain in Pakistan. Solar and wind power remains import dependent, i.e. roughly half the solar equipment and almost all major components of wind turbines are imported. Additionally, the Operations & Maintenance (O&M) for wind farms is also outsourced to international O&M providers and technical experts. This directly impacts the cost of the overall projects, increases probability of global supply chain disruptions, increases import bill impact on the national economy, and is a missed opportunity for employment generation for high skilled jobs. More needs to be done to ensure that Pakistan has a robust localization action plan with clear targets.

One of the key sectors that can help derive demand for - and investment in - renewable energy is the corporate sector along with participation from Development Finance Institutions (DFIs). There is an overwhelming evidence and momentum around the need for deep decarbonization of harder-to-abate industries (including steel, cement, aluminum, chemicals, plastics, metals and mining, aviation, and heavy-duty transport). This requires creating strategic interventions and collaborations on corporate clean procurement to decarbonize all energy inputs, increasing energy efficiency, reducing process emissions, and promoting material circularity. Amongst DFIs, tapping into blended finance is important. Institutions such as Karandaaz, InfraZamin and Pakistan Credit Guarantee Company (PCGC) did not exist in the local landscape before, but can now mobilize support through investment and risk mitigation instruments such as guarantees and blended finance. Targeted public investments through structured finance products, blended finance and diligently working on project readiness support can open access to capital.

Public policy and regulatory support remain fundamental to supporting the transition toward renewable deployment and de-risking investments in the development, commercialization and deployment of new technologies and innovations in the industrial sector. One such tool is the Green Public Procurement Policy tool to stimulate the demand for low carbon solutions and technologies and incentivize or reward businesses and industries who have not only adopted them, but also created a market for these solutions, such as battery technologies and innovative solutions to reduce environmental impacts.

Renewable energy infrastructure needs to be built for a circular economy. Building the renewable energy sector in a way that minimizes extraction of finite resources, limits business risks, and reduces negative climate, biodiversity, and social impacts, necessitates using materials that have already been used. While it is unquestionable that the need to transition towards renewables is critical to meet the climate commitments, it remains imperative to realize that the renewable energy sector is material intensive, as it includes a range of raw materials and resources such as copper, steel, iron, and aluminum. For example, the development of 500-megawatt offshore wind farm requires around 4,400 tonnes of copper. This enormous demand of metals, including rare earth metals, to manufacture infrastructure could lead to both supply and price concerns. In this regard, it is necessary to build a secondary market for materials which could offer financial opportunities for businesses to reuse and recycle existing materials and significantly reduce extraction and production-related Greenhouse Gas (GHG) emissions. A fundamental shift in the architecture of renewable energy infrastructure and industry is required through well-informed policy mechanisms to support business models that include the principles of circular economy.

This report identifies three takeaways in the renewable sector to achieve the 2030 policy targets and Nationally Determined Contributions (NDC) commitments:

First, Pakistan needs to make efforts for large investment mobilization. It requires a substantial increase in investments to accelerate renewable energy transition. The recent announcement by the prime minister to install 10,000 MW of solar will alone require an investment of around $5 billion. Further investments are needed in the country's transmission, distribution, and ancillary infrastructure. Total investments would require $101 billion by 2030 and additional $65 billion by 2040 on account of completing the in-progress renewable energy projects, additional hydropower, transmission, and phasing out of coal and replacing with hydropower.

Leveraging blended finance will remain the key area. Institutions such as Karandaaz, InfraZamin and PCGC did not exist in the local landscape before. but can now mobilize support through investment and risk mitigation instruments such as guarantees and de-risking instruments. Second, efforts must be made to tap into climate finance opportunities through the Green Climate Fund (GCF) to access investment flows. Climate funds are available for countries that can procure it competitively, based on robust project feasibilities, technical assessments, and scientific studies. Today, every effort must be made to tap concessional financing for a low carbon future.

Second, a robust policy framework is required for enhanced renewable energy deployment. Extending fiscal support through a robust framework is critical. This may include augmenting the GoP's concessional finance framework with targeted incentives (tax breaks, upfront subsidies, guarantee support, concessional finance, etc.) to ensure that renewable energy deployment gets its due priority. Policies need to be integrated for sustained deployment. There are several policies that work and exist in isolation that can be integrated. Renewable energy deployment, for instance, is related to infrastructure bottlenecks, particularly transmission, and requires a combined policy framework. Other examples include heating and cooling product deployment, battery storage and solar, and off-grid solar products deployment.

Third, Pakistan needs to follow best practices to ensure widespread deployment. These include investments in project readiness efforts by investing in sustained project proposals to convert ideas into technical, financial, and legal feasibilities, working towards the provisions of concessional on-lending products, navigating projects around Public-Private Partnership (PPP) regimes, and ensuring off-grid market initiatives through viability gap funding and subsidy support.

FIGURE 1 | Key Recommended Action Items for Energy Transition

Short-Term (1 Year)

- The Ministry of Energy (MoE) to provide an action plan for the promotion of the renewable sector in its regulatory framework, including a consolidated fiscal framework. The action plan should be prepared in consultation with provinces within a fixed timeframe.
- Operationalize CTBCM for wholesale transactions of greater than 10MW by 1 December 2022.
- Accelerate competitive bidding auctions for the first set of solar and wind energy projects in line with Indicative Generation Capacity Expansion Plan (IGCEP) in 2022.
- Streamline General Sales Tax (GST) and customs duty issues for renewable energy growth.
- Organize intensive capacity building on financial management provisions, CTBCM process changes, subsidies and contract management for renewable energy projects.
- Coordinate action plans to ensure that evacuation plans for wind and solar energy are on track for timely execution.

Medium-Term (2-4 Years)

- Develop a Renewable Energy Certificate (REC) policy for Pakistan. Identify new windows of opportunities in REC markets, such as Green Certificate Comapny (GCC).
- Execute and finalize Private Power & Infrastructure Board (PPIB)-Alternative Energy Development Board (AEDB) merger.
- Develop structured finance products for renewable energy under the concessional financing framework such as using PCGC or InfraZamin through first-loss guarantee structures or junior equity provisions.

- Identify and work on project readiness facilities for GCF transactions to scale up climate finance potential.
- Expand CTBCM to allow participation of consumers of less than 10MW in open access market.
- Devise clear methodology for Use-of-System Charges (UoSC) under wheeling regulations. Encourage bilateral contracting, first at a demonstration level and then scale up.
- Establish policy framework and performance standards for new technologies in renewable energy, in particular battery storage and hybridization projects.
- Develop and launch a net-metering policy, implementation plan and targets.

Long-Term (5-10 Years)

- Expand electricity markets to a retail level with an open access regime for less than 1MW participation.
- Reform current budgetary supported subsidies to project and end user oriented subsidies with evidence-based targetting. Set yearly targets for quantum of subsidies towards fossil fuel versus renewable energy.
- Develop long-term renewables based climate adaptation and mitigation plans. Continue to evaluate renewable energy's impact with a social, environmental and institutional focus.
- Formulate and establish a long-term private finance-led policy for renewable energy and NDCs implementation.
- Establish synergistic frameworks for greater RE expansion in key sectors, such as renewable energy in agriculture (agrivoltaics, solar sharing or vertical farming) or renewable energy in water and sanitation.
- Develop a comprehensive policy for domestic manufacturing of renewable energy products with emphasis on localization targets.

Table 1: Renewable Energy Policy Assessment Matrix

RE Targets of Pakistan	Actual Achievements	Barriers	Assessment of Policies deployed vis-à-vis Barriers	Best Practices to overcome Barriers	Policy Gaps & Solutions
Renewable energy sources (Small hydro, wind, and solar, bagasse) will account for 30% of the Total generation mix by 2030	RE sources (except large hydro) accounted for around 5% of the total generation mix by July 2022.	Regulatory	Pakistan has already deployed a one-window clearance system, but the licensing system and application are still complicated.	One window operation and simplified licensing system.	Need for policy to simplify the licensing procedure and make regulations for implementation.
		Technological	Mandatory requirement of training of renewable energy plant operators and university/ college students.	Mandatory requirement of training of renewable energy plant operators from local communities and university/ college students.	Regulation for training is still missing and should be made and implemented.
		High upfront costs for renewable energy technologies (Projects)	Fiscal incentives (exempted/reduced CIT and Licensing fees)	Financial and other mandatory support for capacity development of local stakeholders, especially R&D institutions, equipment manufacturers and ESCOs. Moreover, special fiscal incentives to improve the financial performance of renewable energy projects.	Need a policy on additional financial incentives (e.g., investment grants, loan guarantees) and other fiscal incentives (e.g., VAT reduction, accelerated depreciation) for renewable energy projects.
		Financial	SBP provides limited soft loans through the renewable energy Refinance Facility.	A package of financial incentives (soft loans, investment grant, financial subsidy) are provided.	Need a policy in addition to financial incentives (e.g., special investment grants for renewable energy projects, loan guarantees) for renewable energy projects.
		Lack of local competence and human capital	Only limited knowledge creation and limited capacity-building activities are provided.	Support incentives, including financial and fiscal, for capacity development of various stakeholders, especially, equipment manufacturers, training, academic institutions and local stakeholders, R&D institutions, and ESCOs.	Need the policy to support R&D institutions, local equipment manufacturers, related educational institutions and ESCOs.
		Lack of social awareness, acceptance, political and security condition	No policy has been deployed so far.	Awareness campaigns, regarding renewable energy technologies, Need to be started. Legislative cover is required for long tern renewable energy policies.	Need the policy to support awareness campaigns of renewable energy technologies. Pakistan's political, economic and security conditions are also bottlenecks to achieving the targets. Pakistan needs to work on its financial and security situation, involving the investors in the energy sector, offering protection and a higher rate of return on their investments.

Executive Summary

The strategic role of renewable energy cannot be discounted, especially in the context of changing climate and rising inflation. For Pakistan, real incentives exist for an urgent transition towards a renewables-based future.

First, renewable energy can significantly contribute to climate change goals, both under mitigation and adaptation. As a versatile energy resource, renewables can serve a broad range of adaptation/mitigation needs and provide benefits that other resources cannot deliver such as quick installation times, lower tariffs, and environmentally friendly energy. Second, renewables have a real potential to address Pakistan's industrial competitiveness woes. It can allow implementation of energy-intensive solutions – such as textile processing, heavy manufacturing, air conditioning, desalination, and irrigation – with net-zero emissions. Third, distributed renewable energy solutions can help Pakistan create a resilient energy system, especially, for the most vulnerable communities living in off-grid areas. Last, it can help lower tariffs. In times of rising inflation and spiraling commodity costs, renewable energy can provide fuel cost hedging, supplying electricity to a vast majority of the population.

In Pakistan's context, there is a need to do much more. Climate finance provided and mobilized can be significantly increased. Both mitigation and adaptation finance, in their current forms, remain untapped, and renewables-based projects could be a prime candidate for these funding opportunities, especially from newly emerging climate finance architecture. For instance, the GCF has committed to channelize $100 billion of funding per annum, and in 2019 the World Bank announced it would boost its adaptation financing to USD 50 billion by 2025, matching its mitigation funding for the same period.

With rising interest in Environmental, Social, and Governance (ESG) standards and corporate funding for net-zero projects, the emissions mitigation provided by renewable energy technologies can help leverage private finance. In addition, recent progress in green finance, such as use of green bonds, debt for nature swaps, impact bonds and results-based financing framework provide additional streams to leverage financing for renewable energy.

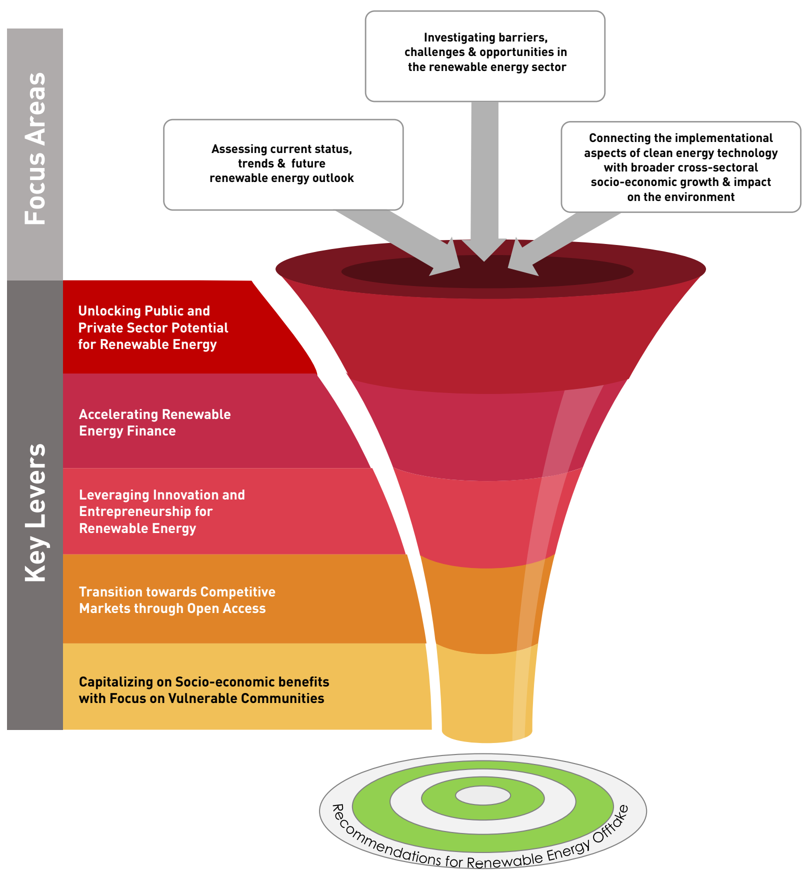
The "Annual State of the Renewable Energy Report Pakistan 2021" (ASRE) is a flagship report by SDPI, focused on developing a pivotal knowledge-based document for all stakeholders relevant to clean energy transition, while also tracking the progress of RE growth and upscale that the country makes on an annual basis.

The project has been executed with all-inclusive and objective approach, to better enable the design and implementation of renewable energy projects in Pakistan and to meet demands from various development contexts. The endeavour focuses on assimilating, assessing and implementing existing information and research for policymaking and development, drawing upon the experiences of all relevant stakeholders engaged through close consultations, aimed at: improving the capacity of policymakers for energy sector to review and assess the current energy use and associated emissions, the renewable energy expansion challenges and trends through the use of a centralized knowledge platform overseeing national and sub-national data, policy information and development scenarios.

The specific objective of this report is to:

Assess the state of renewable energy in Pakistan, while identifying technological, policy, and financial barriers impeding progress towards clean energy transition. The report is also complemented by assessment of impacts of distributive renewable energy on the surrounding local community.

Conceptual & Implementation Framework of Report



Focus Areas

The project seeks to unleash effective and efficient policy and planning for energy transition in Pakistan by addressing critical factors (such as evidence-based research and its harmonization with current energy policy frameworks) keeping in view the social and environmental aspects.

Although there are many underlying issues, three main factors are the focus of this project:

- Assessment of current status, historical trends, and future outlook on the evolving clean energy landscape for comparison with international benchmarks.
- Investigating barriers, challenges, and opportunities within the renewable energy sector. This section pertains to issues around lack of cohesive, aligned, and well-coordinated policies for transitioning to clean energy in Pakistan.
- Connecting the implementation aspects of clean energy technology with broader socio-economic and environmental impacts. This issue is related to how the environmental, social, and economic aspects of renewable energy can be leveraged to enhance infrastructure, human, and social development.

BOX 2 | Key Guiding Questions of Report

What is the status and progress of Pakistan towards Clean Energy Transition? What are the key barriers to the transition and how can they be addressed?

1. **Unlocking Public and Private Sector Potential:** What is the overall potential (utilized and unutilized) for renewable energy in Pakistan? What are the key requirements to unlock the unutilized or underutilized potential?
2. **Accelerating Renewable Energy Finance:** What is the investment landscape of renewable energy in Pakistan, including the public and private sector? How can key financing opportunities (domestic/international) be leveraged to find additional sources of financing for the renewable energy sector?
3. **Leveraging Innovation and Entrepreneurship:** What are the innovative renewable energy technologies with potential to scale in Pakistan, such as battery storage and hydro being used globally?
4. **Transition towards Competitive Markets through Open Access**: How can electricity markets interventions like CTBCM, wheeling, and auctions, be integrated with large renewable energy generators leading to sustainability, affordability, and resilience in the national power sector?

Capitalizing on Socio-Economic Benefits with focus on Vulnerable Communities: What are the key benefits and impacts of renewable energy and how does it compare to conventional thermal power plants in the local context, as well as broader socio-economic growth perspectives?

Focusing on above areas, the report draws conclusions from the national and sub-national policies, planning and activities for achieving equitable and energy transition.

Five Key Levers

The report is developed under a clear logical framework to rationalize the objectives through five levers which include:

1. Unlocking public and private sector potential for renewable energy
2. Accelerating renewable energy finance
3. Leveraging innovation and entrepreneurship for renewable energy
4. Transition towards competitive markets through open access
5. Capitalizing on the socio-economic benefits on vulnerable communities

The framework is set to contemplate with public and private sector stakeholders through well-coordinated consultations on challenges across each level. The lessons learned are then framed into recommendations to strengthen and institutionalize evidence-based policymaking for energy transition. The guiding questions for this report are framed under each level to i) derive knowledge-based evidence using scientific tools and assessments, and ii) make a call to action for the stakeholders based on an integrated roadmap for clean energy transition.

Approach and Methodology

The report presents the finding using data collected through primary as well as secondary data sources, including surveys (for section III) and consultations with public and private sector stakeholders. Following collaborative process was applied in producing this report:

- Data collection from credible sources and reports by engaging public and private sector for consultations to ensure representation of broad group of stakeholders.
- Complementing and validating report through peer reviewed process by energy sector experts and coalitions.
- Collecting primary data through qualitative surveys of representative population of the region.

The following approach has been used in developing this report and roadmap.

Methodology	Deliverables (Outcomes)
Review of status of renewables, resource potential, adoption trends and analysis for different renewable energy technologies.	Current Landscape (Increased capacity of renewable energy actors including policymakers and private sector to assess renewable energy integration trends)
Evaluation of future forecasts for renewable energy integration - 60% aspiration of renewable energy by 2030, 30% solar & wind, and reducing 50% emissions by 2030 to meet NDCs.	Future Trajectory (Increased capacity of public and private sector renewable energy actors to forecast realistic future projections and identify opportunity areas for interventions)
Exploration of renewable energy financing schemes of different national and international FIs.	Public and Private Sector Investments in Renewables (Central repository for updated financing schemes along with potential opportunities to promote renewable energy technologies in Pakistan)
Identification of behavioral, economic, and regulatory barriers preventing private sector and investor action and suggesting interventions to drive change.	Barriers in Clean Energy Transition (Lead to data driven and well-informed policymaking for energy transition)
Development of case studies of renewable energy projects, in this case, impact of wind and community driven micro-hydel “JUST” energy transition power plants on local communities.	Renewable Energy Implementation (Supporting energy transition through social development lens by sharing impacts of renewable energy and lessons learnt for sector development)
Formulation of policy perspectives on future renewable energy options and pathways for meeting Pakistan’s renewable energy targets and their impact assessment.	Transition Roadmap (Providing policy recommendations, including incentive schemes in the form of institutional, policy, and financial support)

Section I

Status of Renewable Energy

National Renewable Energy Overview

Pakistan's energy mix primarily includes natural gas, oil, hydropower, coal, and nuclear energy. Solar, wind, and biomass, although, are being integrated into the energy mix, currently they have a limited share in energy production (Table 3).

Out of the total primary energy supply of 80.62 MTOE, 24.12 MTOE goes to transformation and transmission losses. 11% of the total supplies are in the form of electricity, with renewables making up 0.5% of the overall primary energy supply (Figure 2) (HDIP, 2020).

Total Primary Energy Supply	Conversion Losses	Final Energy Consumption	Energy Consumption by Electricity Sector
80.62 MTOE	**30%**	**52.17 MTOE**	**8.83 MTOE**

Figure 2: Pakistan Energy Supply & Consumption Outlook

In Pakistan, the power sector has an installed capacity of 39,772 MW with a maximum dependable capacity of 27,819 MW as of FY2021; the dependable capacity falls short of 434 MW in meeting the peak demand of 28,253 MW. In FY2021, the total electricity generation was 129,719 GWh, of which about 60% was generated using fossil fuels followed by hydro and nuclear having a share of 25% and 7% respectively. Renewable energy only accounted for 4% (Figure 3) (NEPRA, 2021). The country is yet to fully tap its abundant potential of renewable resources and much needs to be done to realize full potential.

Table 3: Renewable Energy Capacity Additions (2016-2021)

Source	2021 Capacity (MW)	2016 Capacity (MW)	% Change
Thermal Power	25,098	16,619	51%
Hydroelectric	9,915	7,116	39%
Wind	1,248	306	308%
Solar	530	300	77%
Bagasse	369	146	153%
Nuclear	2,612	787	232%
TOTAL	39,772	25,274	51%

Pakistan commissioned its first wind power plant in 2012 that is located in Jhimpir, Sindh (FFCEL, n.d.). Progress towards the integration of renewables has been steady, especially over the past five years, whereby 1,395 MW of renewable energy power plants were commissioned. As of 30 June 2021, the share of installed capacity of renewable-based power plants (wind, solar, and bagasse) was 5% (2,147 MW) whereas hydro accounted for 25% (9,915 MW), collectively generating 32.15% (41,699 GWh) of total electricity (Figure 3) (NEPRA, 2021).

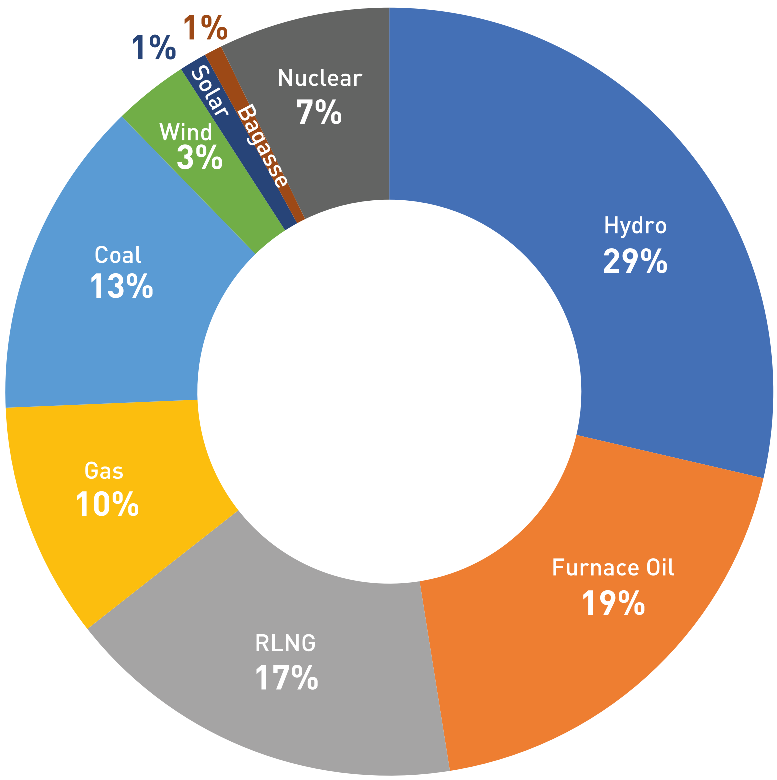


Figure 3: Electricity Generation by Source in GWh (2021)

Pakistan has come a long way in bridging the gap between dependable capacity and the peak demand; the deficit has reduced significantly from 6,620 MW in FY2012 to 434MW in FY2021. The overall electricity consumption has steadily increased with total consumption up from 71,327 GWh in FY2012 to 105,498 GWh in FY2021. The domestic sector accounts for 55% of electricity consumption, followed by commercial and industrial consumption at 27% and 7%, respectively (Figure 4). The residential sector has also witnessed the largest change - it has grown by 64% since FY2012 (NEPRA, 2021; NEPRA, 2013).

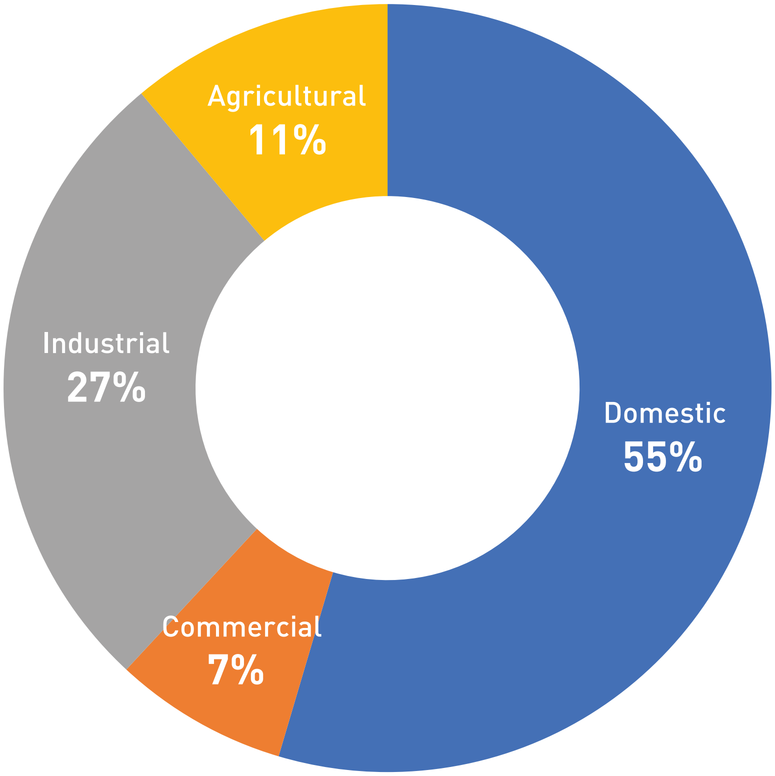


Figure 4: Sectoral Consumption in FY 2021

2021 Renewable Energy Outlook

Pakistan has witnessed a 69% increase in generation capacity over the last 10 years, which has helped bridge the energy demand-supply shortfall from over 6.6 GW in FY2012 to 0.43 GW in FY2021. Over 7.5 GW were added in 2018 alone, attributed to coal and hydro capacity additions. Hydropower remains the most dominant source among non-fossil fuel generation technologies, contributing 25% to the total power capacity and 30% to the power generation mix.

Table 4: Generation Licenses issued in 2021		
Source	No. of Licenses	Cumulative Capacity
Coal	1	55
Hydroelectric	4	294
Wind	0	0
Solar	19	49
Bagasse	2	47
Nuclear	1	1145

21 Generation Licenses (GL) were issued to renewable power generators in FY 2021, as shown in (Table 4). Net-metering licenses, with the cumulative installed capacity of 145.9 MW, were also issued during this period (NEPRA, 2021).

COVID-19 Impact

The COVID-19 pandemic impacted all sectors of Pakistan's economy, evident by the negative growth of economy -0.47% in 2020 (PBS, 2022). Pandemic lockdowns globally resulted in disruptions in supply chains and affected the timelines of power plants that were in the construction phase. Even though the country's economic growth recovered in 2021 showing a 6% annual growth in GDP (WBGDATA, 2022), the supply chain is yet to normalize to pre-COVID levels.

Investment in Renewable Energy Sector

Despite COVID-19 related challenges, a positive outlook in terms of investment in the electricity sector was observed. During FY 2021, net Foreign Direct Investment (FDI) in the power sector rose to $ 911.7 million from $ 765.6 million in the previous year. However, more than half of these investments, i.e. 56% were in the coal sector (SBPFDI, 2022). As of June 2021, the total cumulative investment in renewables (including foreign and domestic) amount to $4,796 million, of which $786 million was in solar, $3,752 million in wind, and $258 million in bagasse. The expected investments for upcoming renewable energy power plants (solar, wind, and bagasse) over the next two years stand at $866 million. The estimated investment to expedite the hydropower potential for the next 10 years stands at $12.98 billion (NEPRA, 2021).

Power Sector Reforms

The powe sector in Pakistan has seen multitude of transformations in the past decade. Some of the major milestones that have helped shape the current landscape are: i) creation of a market operator 'Central Power Purchasing Agency Guarantee Limited' (CPPA-G); ii) targeting of subsidies to improve system cost recovery; iii) parking of circular debt in a Power Holding Private Limited (PHPL); iv) Launch of the Competitive Trading Bilateral Contract Market (CTBCM) in 2022; v) Revised Indicative Generation Capacity Expansion Plan (IGCEP) for forecasting grid expansion; vi) Launch of the National Electricity Policy, 2021; vii) Launch of renewable energy auction bidding packages; and viii) national consultations on the National Electricity Plan.

Key Renewable Energy Developments

In 2021, the following notable developments took place (Figure 5):

Jan 2021 - Decision on stranded cost of the grid system and cross-subsidy charge, which would not be included in wheeling charges.

↓

Feb 2021 - The World Bank launched VRE Locational Study for Pakistan.

↓

April 2021 - Decision on reduction of Return on Equity (ROE) for 7 bagasse, 3 wind and 2 solar PV generators (355 MW).

↓

April 2021 - Pakistan & Denmark formed a joint technical working group for strategic renewable energy cooperation.

↓

June 2021 - The World Bank approved $ 800 million loan for the Pakistan Program for Affordable and Clean Energy.

↓

Aug 2021 - AEDB enacted the new Alternative Energy Development Board (Certification) Regulations, 2021.

↓

Sept 2021 - Decision on inclusion of hydro power in renewable energy generation.

↓

Oct 2021 - SBP allowed all RE Investment Entities to avail financing on easy conditions.

↓

Oct 2021 - Oracle and Power China agreed on development of the first Green Hydrogen production facility in Pakistan.

↓

Oct 2021 - Engro and Govt of Sindh signed MoU for 400 MW Renewable Energy park at Jhimpir.

↓

Nov 2021 - Decision on solar/wind power generation facility (upto 25 kW), which does not require GL for net-metering connection.

↓

Dec 2021 - NEPRA released draft Micro Grid Regulations.

Figure 5: Key Renewable Energy Developments in 2021

Renewable Energy Policy Landscape

Institutional Framework

Several public and private sector institutions are responsible for the adoption of renewable energy technologies. Key stakeholders involved in this sector, along with their roles and responsibilities, are shown in Figure 6.

CCOE	>>	Strategic Decisions
Provincial Depts	>>	State Level RE Implementation
MoE (Power & Petroleum Divisions)	>>	Control, Establishment, Policies, Sectoral Planning & Coordination (Power & Petroleum)
ECC	>>	Pricing & Subsidies
Planning Commission	>>	PC-1, Third-Party Role
NEPRA	>>	Independent Regulator of the Electricity Sector responsible for Licensing Tariffs & Oversight etc.
NTDC (including NPCC)	>>	Micro-planning, Scheduling, Dispatch & Operations of the 220kV & 500kV Transmission Network
CPPA (G)	>>	Market Operator & Power Purchaser
IPP, GENCO, WAPDA, PAEC	>>	Power Generation
DISCOs	>>	Distribution Companies
PPIB, AEDB	>>	Project Facilitation & Tariff Proposals
NEECA	>>	Energy Efficiency & Small Size Renewable Energy Based Programs

Figure 6: Key Renewable Energy Actors

The Alternative Energy Development Board (AEDB) was established in 2003, as the lead agency that operates as a single window operator to facilitate, promote, and encourage development of all RE related projects. It plays a pivotal role in investor facilitation, providing standardized documents for each technology and energy purchase agreements. AEDB's activities are guided by several policies and plans issued by the government such as the Alternate Renewable Energy (ARE) Policy, 2019, which sets several targets for future renewable energy development, Integrated Generation Capacity Expansion Plan (IGCEP), and net-metering rules, among others.

Under the ease of doing business initiative in the power sector, the federal cabinet approved the merger of AEDB with Pakistan Power Infrastructure Board (PPIB), an agency that has a similar role, but involved exclusively in thermal power generation. The merger is still in the finalization phase. It is hoped that combining the two agencies will help create synergies and avoid duplication of effort.

BOX 3 | IGCEP Forecasting on Renewables

The Sept 2021 version of IGCEP envisions accelerated adoption of renewables through inclusion of low cost solar, wind, and hydro energy. Furthermore, to decrease reliance on imported fuels, it has also forecasted adoption of local coal-based power production as shown in Figure 7.

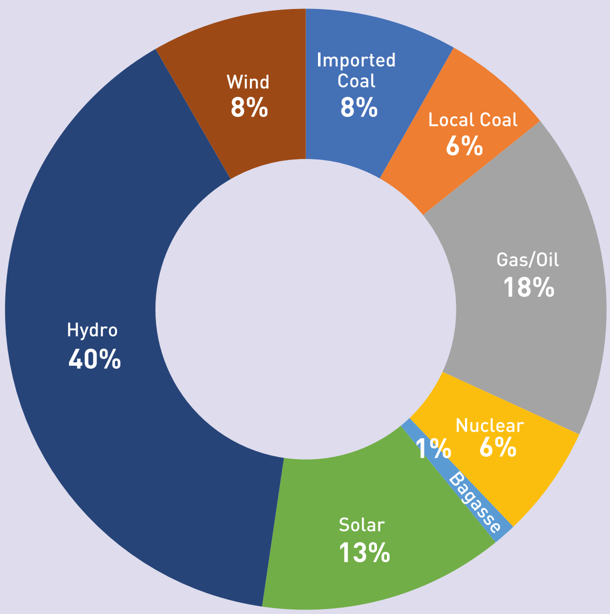


Figure 7: Forecast Generation by 2030 (IGCEP)

The base case scenario forecasts total generation capacity of 61,112 MW by 2030, including 5,005 MW and 7,932 MW of solar and wind, respectively (NTDC, 2021).

IGCEP dictates the integration of renewables based on different growth-based scenarios. The long-term IGCEP 2047 has been revised to give a medium-term outlook through IGCEP (2021-30). The IGCEP was formulated by the NTDC and is going to be approved by NEPRA on a recurring basis.

BOX 4 | Evolution of Power System Planning

Restructuring of the formerly vertically integrated power system started in 1992 with the restructuring and unbundling of Water and Power Development Authority (WAPDA), under transmission, generation, and distribution segments. Following this unbundling, the transmission sector was handed over to the National Transmission and Dispatch Company (NTDC) – established in 1998. To overlook the management affairs of corporatized DISCOs and NTDC, a holding company – Pakistan Electric Power Company (PEPCO) – was formed.

In order to leverage private sector investment in the generation and renewable energy sector, and as facilitators of one-window operations, PPIB (thermal) and AEDB (RE) were established in 1998 and 2003, respectively.

On the operations side of the electricity market, the Central Power Purchasing Agency (CPPA-G) assumes the role for transactions, billing, and settlements between generators and Distribution Companies (DISCOs). The National Electric Power Regulatory Authority (NEPRA) performs regulatory oversight over the electricity market of Pakistan.

The Economic Coordination Committee (ECC) approved a competitive electricity market in April 2015. The NEPRA Act (Amendment), 2017, envisages the role of market participants, i.e., generators, distributors, traders, suppliers, and bulk power consumers to buy and sell in a competitive marketplace. Moreover, the exclusivity of DISCOs as the sole distributors of electricity is expected to expire by 2023.

Launch of the Competitive Trading Bilateral Contract Market (CTBCM) in April 2022 is one of the pivotal milestones towards deregulation of the power sector. The transition to CTBCM will lead to key opportunities for solar and wind developers to enter a multi-buyer, multi-seller model with lesser reliance on single-buyer model.

Net-metering

Net-metering enabling policies remain a key prerequisite for distributed renewable generation, and NEPRA introduced a basic framework for net-metering under the Distributed Generation and Net-Metering Regulations, 2015. The process for installing net-metering is illustrated in Figure 8.

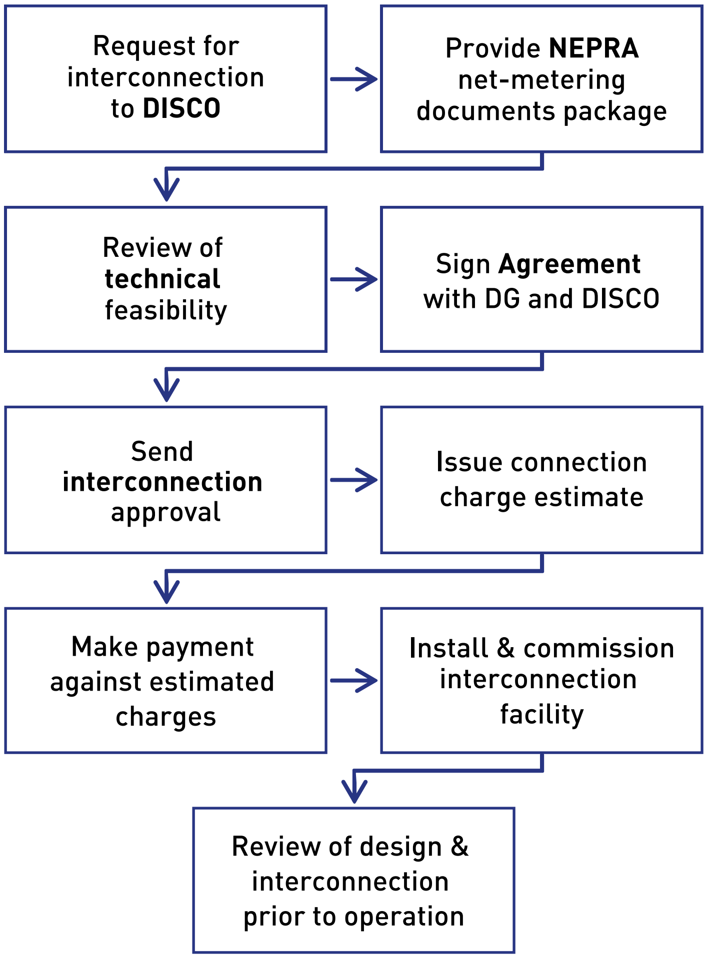


Figure 8: Net-Metering Application Process

Policy Landscape

The energy sector is a top priority for the GoP, especially given that it contributes significantly to the economy and well-being of the state. The GoP first issued a 'Renewable Energy Policy' in 2006, followed by an updated version in 2019 (Figure 9). The 2019 ARE Policy sets the specific target of at least 20% renewable energy generation by 2025 and 30% by 2030. According to the updated 2021 NDCs, solar and wind generation will only begin to accelerate after 2030 due to current system constraints related to the grid, operational procedures, and storage facilities.

Alternative Renewable Energy (ARE) Policy, 2019

The significant features of the policy include:

- 20% share of grid-connected renewables in Pakistan's power mix by 2025 and a 30% share by 2030, replacing the earlier target of 5% renewable capacity share by 2030.

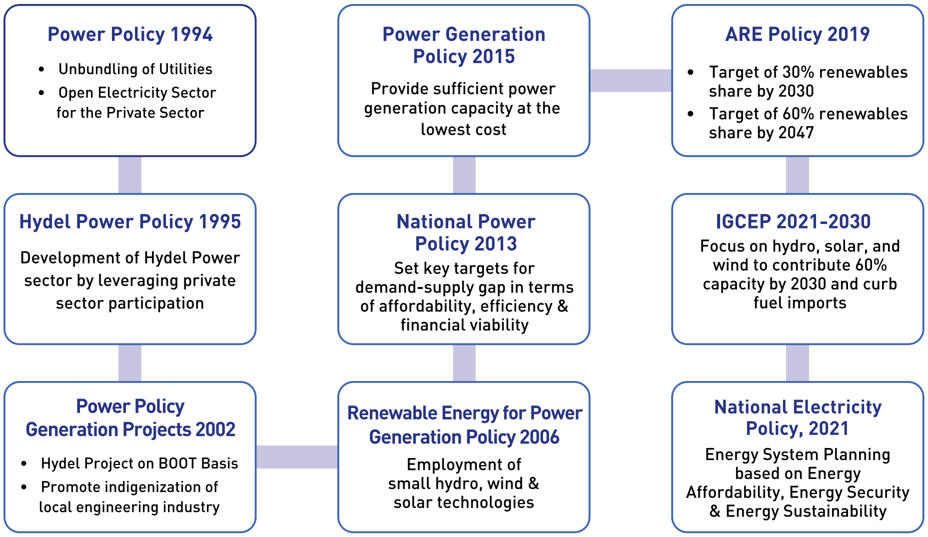


Figure 9: Evolution of Power Sector Policies

- The international competitive bidding process to allocate specified quantum of capacity on annual basis depending on IGCEP 2021-2030 and its subsequent revisions.
- A key feature of the policy includes in its scope the Micro-grids and Local Energy Systems (LES). It identifies these two systems as crucial interventions to achieve targets.

National Electricity Policy (NEP), 2021

The National Electricity Policy (NEP) was launched in 2021 which envisions capacity expansion based on least cost and transparency. It also complements the ARE Policy 2019 by including the competitive bidding model instead of the previously prevalent cost-plus tariff mechanism. NEP remains a difficult subject to tackle as each provincial stakeholder has its own political economy objectives which it intends to promote. For instance, Sindh has large wind and domestic coal reserves and wants clear allocation of its own resources. Khyber Pakhtunkhwa (KP), on the contrary, has large hydel reserves and run-of-the-river projects that it wants to mainstream. Balochistan has large land resources and favourable solar irradiation. National Energy Policy 2021 includes principles of competitive bidding, environmentally responsible expanded generation through renewable energy. Further, the policy aims to internalize transmission costs as part of generation. It also stresses off-grid and micro-grid solutions to promote electricity access to areas where grid expansion is financially unviable.

National Climate Change Policy (NCCP), 2021

NCCP 2021 provides policy measures for energy generation and efficiency across both the electricity and wider energy sector. Some salient features of the policy are: proper assessment of the impact of hydropower projects on environment and local communities; promotion of futuristic building designs with solar panels (discussed further in the subsequent section); exploration of clean coal technologies such as Pressurized-Fluidized-Bed-Combustion and near-zero emissions technologies; consideration of the introduction of carbon taxes; gradual introduction of 'Green Fiscal Reforms'; incentivization of energy audits, and enactment of energy conservation legislation.

National Action Plan, 2019

The National Action Plan 2019 was aligned with Sustainable Development Goal 7 ('Sustainable Energy for All'), which is an all-encompassing approach linking energy access to other goals. The three key goals of the plan are to i) achieve universal access to energy by 2030; ii) double the share of renewable energy; and iii) double the rate of energy efficiency in the country. Some of the priority action areas identified to achieve these goals are as follows:

- Launch of a nationwide programme for the provision of improved cookstoves through Public-Private Partnerships (PPPs), requiring an investment of $657.54 million (UNDP, 2019).
- Reform the power market towards becoming a fully functional market operator by 2022.
- Provision of solar water heating for areas with no access to the traditional gas network, through consumer financing.
- Introduction of the small grants programme of $20 million to accelerate the adoption of proposed actions.
- Mandate energy audits and launch national level awareness campaigns for energy efficiency and conservation.
- Promote innovative mechanisms to support the proliferation of distributed energy access across the country.

Renewable Energy Targets

The targets put forth in relevant policies present ambitious strategies for clean energy transition. The active targets of the GoP for decarbonization of economic growth are mentioned in Table 5. In addition, many national and sub-national sectoral policies are also in place accelerating pathways to clean energy transition.

Supplementing the national power sector policies, several provinces adopted internal policies for provincial projects on renewable energy. The Punjab adopted the 'Punjab Power Policy, 2009', which provides a basic framework for developing provincial public and private renewable power plants. Sindh is currently developing its first renewables policy that aims to set up wind power corridors in the province. It also launched the 'Sindh Waste to Energy Policy, 2021' which is intended to promote the utilization of Municipal Solid Waste (MSW) for energy production. Khyber Pakhtunkhwa focuses on enhancing hydro energy through the Pakhtunkhwa Energy Development Organization (PEDO) under the 'KP Hydro Power Policy, 2016.'

Table 5: Pakistan's Renewable Energy Targets & Status

Policy	Current Scenario	Target	Target Year
ARE Policy	5% share of renewables (including Bagasse)	30% capacity share of renewables (including bagasse)	2030
IGCEP 2021-2030	• 4% capacity share of solar and wind • 3% generation share of solar and wind	• 21% capacity share of solar and wind • 10% generation share of solar and wind	2030
SDG 7 – Affordable and Clean Energy	• 75.4% population with access to electricity • 49.1% population with access to clean fuels for cooking (WBG, 2020)	• 100% population with access to electricity • 100% population with access to clean fuels for cooking	2030
National Electric Vehicle Policy, 2020-2025	2000 passenger electric vehicles on roads by mid-2021	• 30% of new sales of cars and trucks to be electric vehicles • 50% of new sales of 2-3-wheeler electric vehicles	2030
Nationally Determined Contributions	24% share of renewables (including hydro)	60% capacity share of renewables (including hydro)	2030

Renewable Energy Programs

Given below are the renewable energy programs, spearheaded by the public and private sector, including international donor agencies which are active in Pakistan:

Private Sector Programs

- Pakistan Private Sector Energy Project (PPSE) focused on supporting Small and Medium Enterprises (SMEs) for clean energy access.
- Sarhad Rural Support Program (SRSP) financing and development of micro-hydel and off-grid solar solutions for marginalized communities in Khyber Pakhtunkhwa.

- Hydro Power and Renewable Project, under the Pakistan Poverty Alleviation Fund (PPAF), focused on micro-hydel and off-grid solar solutions.

Public Sector Programs

- State Bank of Pakistan (SBP) Financing Schemes for Renewable Energy, 2016-24.
- Sindh Solar Energy Project aimed at increasing solar power generation and access to electricity in Sindh, assisted by the World Bank.
- Green Banking Guidelines focused on compliance with environmental standards and regulations for the banking industry.
- Solarization of Schools and Health Facilities Program by PEDO, Khyber Pakhtunkhwa.
- United Nations Nationally Determined Contributions, 2021.

Multilateral Programs

- Access to Clean Energy Investment Program by the ADB.
- Renewable Energy and Energy Efficiency Concepts in Cities and Industry (REEE Scale) Project.
- Energy Sector Management Assistance Program (ESMAP) focused on financing interventions to achieve three SDG 7 targets on energy access, renewable energy, and energy efficiency.
- Variable Renewable Energy Locational Study by the World Bank to find attractive locations for solar and wind deployment in Pakistan.
- Variable Renewable Energy Integration and Planning Study to provide research base for integration of renewables in Pakistan's electricity mix.
- Variable Renewable Energy Competitive Bidding Study to explore suitable distributive energy competitive bidding models for Pakistan.
- Program for Affordable and Clean Energy initiated by the World Bank to improve financial viability of the power sector by leveraging renewables.
- Result Based Financing (RBF) pilot project in Sindh and Punjab initiated in 2019 to encourage private sector investment for off-grid solutions based on the International Finance Corporation's (IFC) global standard products in off-grid communities. A four-year campaign has been launched to encourage private sector investment towards the lighting needs of consumers in remote areas.
- The German International Development Agency (GIZ) undertook a small-scale RBF project serving a limited number of villages in the Punjab and Sindh. Based on the initial success, Sindh started a partial RBF program for electrifying 200,000 households (Karandaaz, 2022).

Renewable Energy Market and Integration Trends

Resource Potential

Pakistan has abundant potential in major clean energy generation technologies, including solar, wind, bagasse, and hydro. There have been various studies conducted to ascertain the potential for each technology and a summary of each resource has been presented in the following sections.

Solar

Placed among the countries with high solar irradiance, Pakistan has enormous potential for solar energy. Figure 10 shows the solar irradiance map of Pakistan (Atlas, 2020).

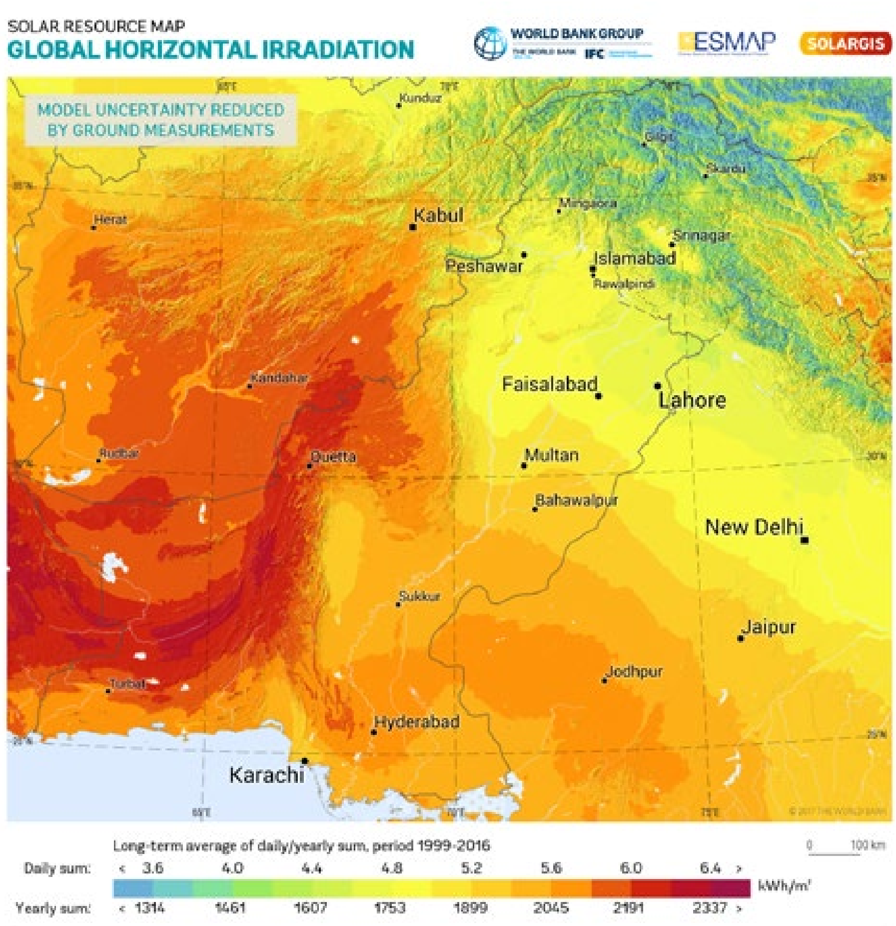


Figure 10: Solar Irradiation Map of Pakistan (Atlas 2020)

Even though, Pakistan lies in a high solar potential region, the solar irradiance varies vastly within the country with southern and southwestern parts having the maximum average Global Horizontal Irradiance (GHI) reaching as high as 2,337 kWh/m2 (Ibid.). The GHI gradually decreases towards the north and northeast and is lowest in the mountain ranges of Himalayas and Karakorum. Although, the estimated values decline gradually as one moves up north of the country, yet it exceeds 1,500 kWh/m2 in more than 90% of the land area making it viable for PV based generation technologies. Research shows that Pakistan could meet its energy needs through solar by utilizing only 0.071% of its land area for PV generation (WBG, 2021).

A significant advantage for the Punjab is the presence of high load centers in the vicinity of potential areas for PV parks, as the consumption of power close to power generators reduces transmission losses. Increasingly, land availability remains a challenge for the province, which has large agricultural lands and extraordinarily little presence of barren land (more suitable for solar parks), except in southern Punjab. Overall, the average specific production of PV power ranges from 1,250 kWh/kWp to 1,850 kWh/kWp. This corresponds to high-capacity factor of 16 to 22% (assuming solar installations are with fixed inclination), which is considered a decent factor at international level for PV suitability (Ibid.).

Wind

Pakistan has considerable potential for using wind energy in the coastal belt of Sindh and Balochistan (in southern Pakistan). The National Renewable Energy Laboratory (NREL) in the United States (US) estimated the theoretical wind power potential of Pakistan to be 340 GW, using satellite imagery data on wind speed and power density (RRAP, 2020). Although, this estimate does not consider binding constraints of technical and economic nature, it provides a good benchmark for future in-depth studies. Wind turbines of medium and large utility scale require an annual average wind of speed 4 – 5.8 m/s. In Pakistan, this range occurs in vast areas of Sindh and Balochistan with limited corridors in the Punjab and Northern regions. Moreover, the capacity factor for IEC-II type (for windier sites up to 8.5 m/s) wind power plants (for windier sites up to 8.5 m/s) average in Pakistan ranges from 15 to 60%, which is excellent based on the international benchmark potential of wind power plant sites (WBG, 2021).

A Variable Renewable Energy (VRE) locational study by the World Bank, showed the attractiveness of wind power in Pakistan across different regions while considering grid connectivity feasibility. The two most attractive areas that stood out for wind power were found to be in western Balochistan and the South-west region of Sindh, as shown in Figure 11. The Punjab and northern regions remain least attractive for wind power.

One of the major wind corridors of interest, prioritized by the GoP at the very beginning of renewable energy development in the country, is the Gharo-Keti Bunder wind corridor in Sindh, with approximately 50 GW of theoretical potential.

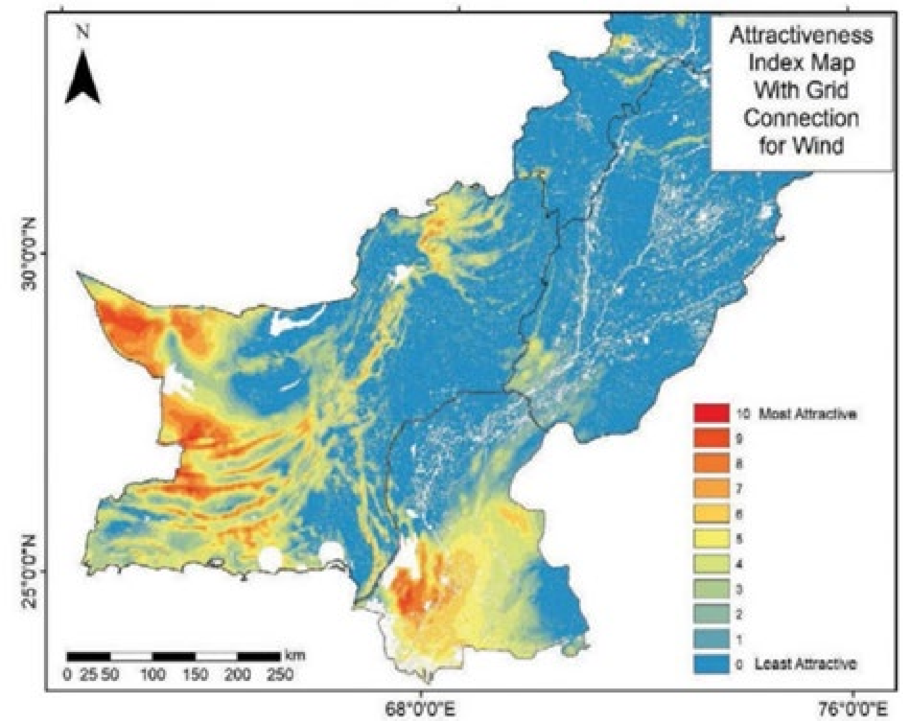


Figure 11: Wind Attractive Index Map of Pakistan (WBG VRE Study)

Currently, all major wind farms are within this corridor with potential for further projects. There are 24 wind projects of 1,235 MW operating in Jhimpir-Gharo region by mostly private wind developers. Additionally, 12 wind projects, with cumulative capacity of 610 MW, are under construction (NEPRA, 2021).

Although, the Sindh corridor investment is ready with little grid enhancement requirements, policymakers can further look towards regions in Balochistan that can be coupled by major investments into transmission lines (WBG, 2021).

Hydro

The International Renewable Energy Agency (IRENA) has estimated a potential of 60 GW in the hydropower sector of Pakistan, out of which only approximately 14% is currently exploited. The hydropower potential primarily lies in the mountainous north region along the Indus River (which touches almost all provinces of Pakistan). WAPDA is a federal authority that plans, builds and manages public sector hydropower projects. It has an in-house hydro planning organization which is responsible for identification, planning and investigation of hydropower and water schemes on a regular basis. WAPDA has a ready pipeline of hydropower projects to tap this potential; some of them even have approved funding from the Public Sector Development Programme (PSDP) and some of these projects are at feasibility stage.

The hydropower projects have long construction period and are capital intensive. They are often faced with cost-overruns, land acquisition and resettlement challenges, which especially crowds out private sector investment, as it is considered too risky. Most of the hydropower facilities lie with WAPDA with the exception of a few Independent Power Producers (IPPs). The hydropower plants are long gestation projects and require consensus among provinces. However, among non-fossil fuel technologies, hydro remains one of the most dominant resources with existing installed capacity of 9,915MW (NTDC, 2022). In addition to large hydro projects, small hydro projects (having capacity of less than 50 MW), with combined capacity of 128 MW, are currently operational in Pakistan (IRENA, 2018). Provincial outlook for hydro potential is shown in Figure 12.

FIGURE 12 | Provincial Resource Potential of Hydel

Punjab

- Potential sites: Tributaries of Sutlej, Ravi, Jhelum, and Indus.
- Synergy with irrigation systems: Punjab Power Development Board in the Irrigation Department identified about 324 potential sites with a total capacity of 5895 MW.

Sindh

- Private Power & Infrastructure Board identified six potential sites with an estimated capacity of 178 at low head along different canals in Sindh.
- No hydel projects are operational or in construction stage within the province. There have been some potential sites for which feasibility studies have been completed. These include Rohri and Guddu Barrage Projects.

Balochistan

- Several potential sites for small dams and barrages. However, no technical viability to generate electricity.

KP and Northern Regions

- Potential sites: Indus, Kunhar, Swat, Kabul, Kohat, Kurram, Tochi, Chitral, Panjkoora, and Gabral Kalam. Swat river has several potential sites for run-of-river hydropower projects of varying capacity ranging from 10 MW to 200 MW.
- The KP Hydro Master plan by the Sarhad Hydel Development Organization (SHYDO) identified about 150 potential sites for hydropower projects with cumulative capacity of 18698 MW .
- PEDO identified five big sites with a total capacity of 5,000 MW and 67 small hydel sites with a full capacity of 400 MW.

Biomass

Pakistan has widespread biomass available that could be used for electricity generation, which includes 30 million metric tonnes of Municipal Solid Waste (MSW) produced annually (ADB, 2022). Additionally, it produces over one million tonnes for animal manure, an ideal feedstock for biogas generation, which could be used for heating purposes or electricity generation. Biogas can help replace fuel wood that rural settlements use for daily heating needs. Numerous studies have pointed out that the use of inefficient fuelwood leading to increasing deforestation (Naila Nazir, 2018).

Currently, bagasse-based commercial generation is the only crop residue-based biomass generation facility used by the sugar industry, where bagasse, the by-product of sugar cane, is used as fuel for generators. Sugar mills in Pakistan are doing two types of co-generations from biomass: i) Bagasse is burned in boilers to produce steam for running turbines to generate electricity; ii) Biogas is extracted from spent wash in mills which is then treated to reduce Hydrogen Sulfide (H_2S) content and later burnt in boilers to produce steam for running turbines to generate electricity. Crop residues in Pakistan and their potential energy content are given in Table 6.

Table 6: Theoretical Potential of Crop-Processing Residues

Type	Annual Residue Production (1000 tonnes)	Energy Content (GWh)
Bagasse	19,577	40,720
Rice Husk	3,351	12,566
Maize cob	1,406	6,481
Maize Husk	937	3,018
Total	25,271	62,785

Source: World Bank & ESMAP 2016.

Table 6 shows that substantial potential for biomass-based generation exists in crop residues other than bagasse-based power plants. However, the biggest challenge is the collection of crops from farmers. For instance, if the aim is to utilize cotton silk residue for electricity production (cotton silk has strong combustible properties and energy content), the quantity of raw material available to every farmer would be extremely low, therefore, a robust collection system would be needed, which would lead to higher costs. Therefore, it becomes cheaper for the farmer to burn the residue by himself, than to sell it to industries.

Geothermal

Geothermal energy is thermal energy trapped within the Earth's crust. It can only be harnessed at a few locations around the world where the Earth's crust is thin or fractured. In 2020, the global geothermal installed capacity was 15.61 GW (Zaigham, 2005). Seismic belts linked with areas of weak crusts, such as plate margins and centers of volcanic activity, are also key areas with high geothermal resources. These belts also pass through Pakistan that has historically resulted in several geotectonic events, including rifting of the Iran-Afghanistan microplates and the Indo-Pakistan Plate; widespread volcanism due to the appearance of a 'hot spot' in the region; the collision of India and Asia, and the consequent Himalayan upheaval; and volcanism in the Chagai district. The geotectonic topography suggests commercially viable geothermal potential across different regions in Pakistan. However, no documented geothermal plant for heating or power production purposes has been installed in the country.

In Pakistan, the appearance of geothermal energy can be classified into three categories:

1. Geo-pressurized systems: These systems, existing as deep as 6,000 m, have temperature ranges from 930C to more than 1500C. These zones are overwhelmingly found in the Indus Basin in southern Sindh, and Potohar Basin of the Punjab province, and the western region of the Indus Plain. Research shows additional systems in South-Suleiman and South-Kirthar ranges as well.
2. Seismotectonic systems: These geothermal systems are formed because of tectonic movements in the Earth's crust. They are found in Karakorum, Hindukush, and Himalayan Mountain ranges - areas that show strong seismic activities.
3. Neogene-Quaternary Volcanism Systems: These systems possess encapsulated geothermal energy which can be attributed to volcanic activities. These systems are confined to the Koh-e-Sultan volcanic system in Balochistan (Ibid.).

Renewable Energy Integration Trends

Transition from Energy Shortfall to Energy Surplus affixed on Imported Coal

Pakistan's total current electricity generation witnessed an increase of 69% in last ten years, whereby the country transitioned from being energy deficient to energy surplus. However, most of the capacity additions during this period took place between 2016 to 2018, i.e., 66% of all the capacity additions over the past ten years (Figure 13). This could be attributed to the China-Pakistan Economic Corridor (CPEC) coal power plants coming online. Furnace oil has been replaced by coal, which has grown from 1% capacity in 2016 to 13% in 2021 (NEPRA, 2021).

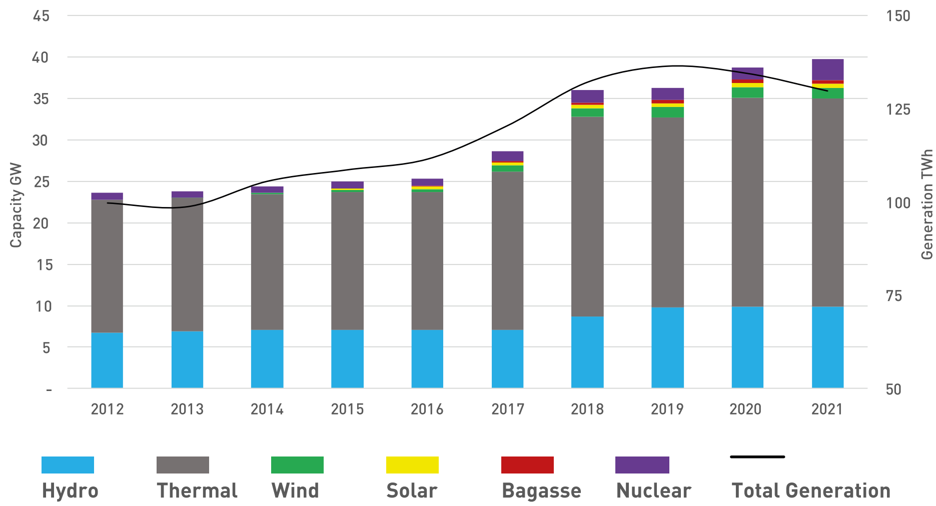


Figure 13: Installed Capacity by Fuel (2012-2021) (NEPRA 2021)

Renewables Offtake in Electricity Generation from FY 2017

Given a predominant reliance on the combination of hydro and imported fuel power plants, Pakistan's energy mix witnessed an offtake of renewable energy generation over the past decade, whereby energy generated from solar and wind jumped from almost zero to 4,320 GWh of electricity units generated in 2021, as shown in Figure 14. Renewables contribute about 4% of total generation, while wind alone contributes more than two-thirds of Pakistan's renewable energy generation. The electricity output from the renewable energy witnessed a drop in output by 14% in FY2020, on account of evacuation constraints. Although the net energy demand fell by almost 5% during the pandemic, the units generated from hydro power plants increased by 17%. Solar and wind share in electricity generation peaked in FY 2019 at 4%.

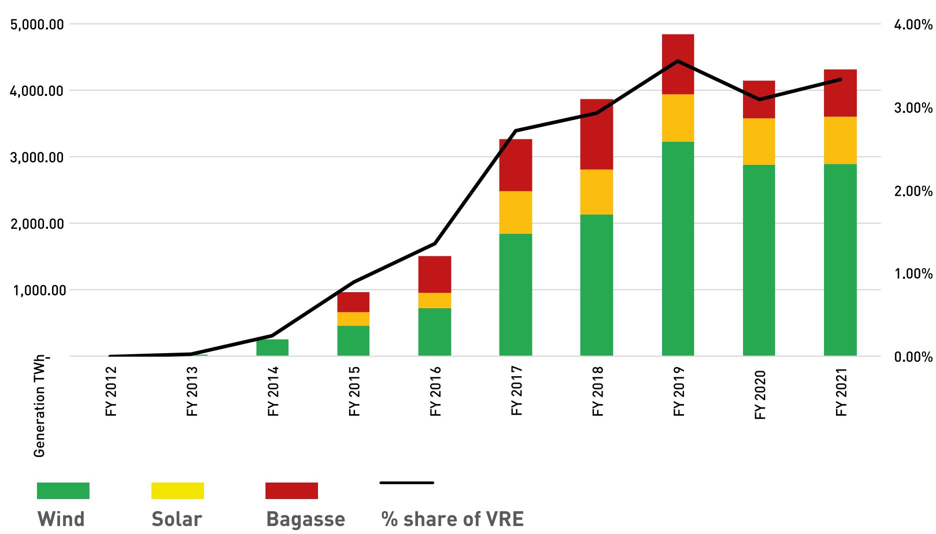


Figure 14: Renewables Share in Electricity Mix (NEPRA 2021)

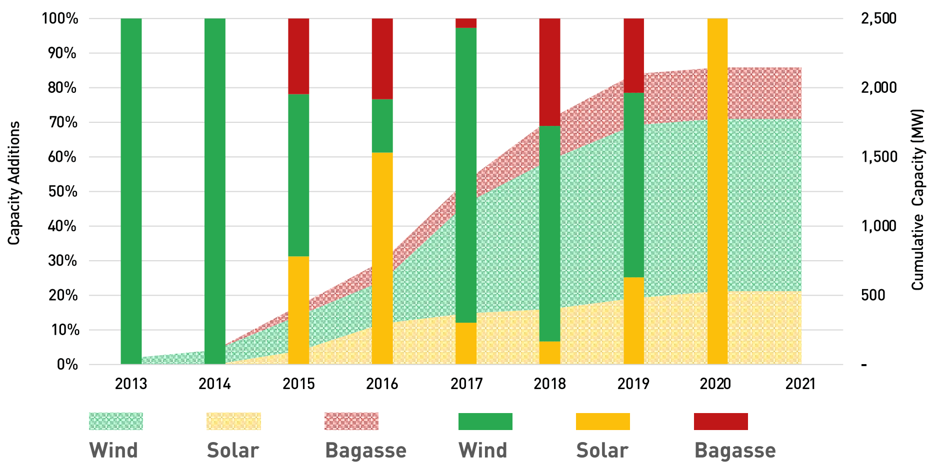


Figure 15: Renewables Capacity Addition Trends

The cumulative capacity trend (Figure 15) shows that although solar and bagasse-based power plants show a linear trend, wind power share increased from 2013 to 2018. Despite wind successess of the past years, there has been no wind power utility generator addition to the grid in 2020 with solar alone contributing to all cumulative capacity additions.

Revival of Private Sector Share in Capacity Mix

Private power generation capacity registered high growth on account of the 2001 Power Policy. However, owing to cumulative circular debt and tariff renegotiations, private participation slowed down during the next phase of the project development cycle, between 2005-10. CPEC in 2014 added impetus to new project development, with a particular focus on coal power plants, which was backed by Generation Policy, 2015. Under the 2015 policy, there were additions of two coal-based power projects (2.6 GW), a hydropower project (0.7 GW) and three combined cycle RLNG based projects (3.6 GW). The capacity mix gradually transitioned towards i) higher share of private ownership; and ii) phasing out of furnace oil with RLNG and coal. Hydro capacity, though available with potential sites, lacked private sector impetus to undertake long-gestation projects with high risk profile and WAPDA remained the dominant player to undertake new hydel projects. The private sector, nonetheless, invested 100% in all new wind and solar power projects.

Capacity Additions Pipelines: Dominated by Hydro Power Plants

Based on current trends, and IGCEP's planned expansion, wind power will remain the most dominant renewable source in the energy mix followed by solar and bagasse. The total number of committed power plants under IGCEP are shown in Figure 16. Hydropower is expected to remain the most dominant source, mainly due to its lower tariff offering, indigenous resource availability, and strategic importance of mega projects like Diamer Bhasha Dam (expected to be operational by 2029 with a total capacity of 4,500 MW representing 34% of total hydro capacity to be added over the next nine years). All the planned power plants from wind and solar developers are expected to be operational in the next three years (NTDC, 2021).

Figure 16: Committed Non-Fossil Fuel Power Plants (IGCEP 2021)

Renewable Generation Peaks in Mid-summer

One of the key issues with renewables is the intermittent nature of wind, solar, and bagasse power due to seasonal and hourly variation in resource availability, which necessitates back-up capacity of almost equal magnitudes in the system. Renewable energy generation, particularly wind and hydro are site-specific and usually situated away from the load centers. Hydro remains the predominant non-fossil fuel resource for monthly energy production, peaking in August, with minimal production during January (Figures 17 and 18).

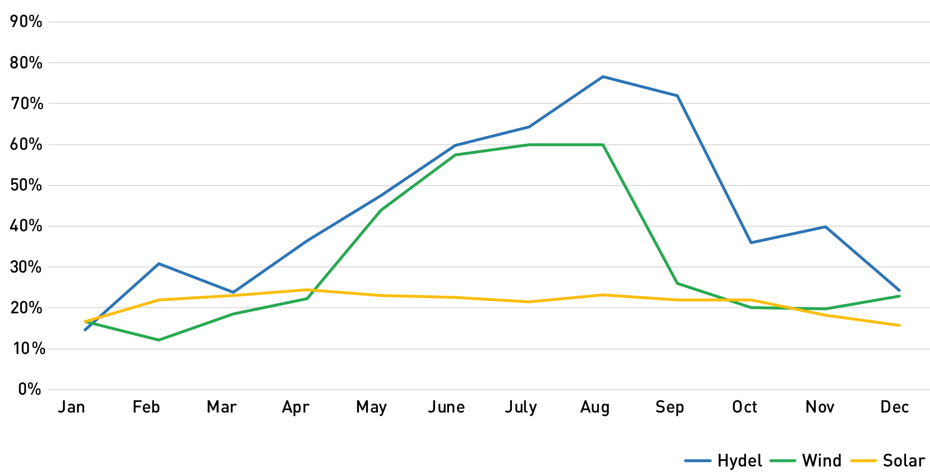


Figure 17: Monthly Capacity Factors of Solar, Wind and Hydro (NEPRA Monthly Energy Data)

Solar power plants with average capacity factor of around 20% show little seasonal variation, but depict highly intermittent nature diurnally. Wind generation is minimum from September to April, while peaking from June to August with a monthly capacity of 60%. Even though month-wise wind variability differs based on geographical locations, all the wind power plants are situated along the same corridor –Jhimpir-Gharo - therefore, reduction in wind production from all power plants remains the same. For hydel, the capacity factor varies on monthly basis, while peaking in August at around 75%. It should be noted that the capacity may not only be directly associated with resource availability, but also electricity demand in the system which peaks in summer and remains lowest in winters, especially for hydro power plants, since solar and wind run on priority basis, based on ARE Policy.

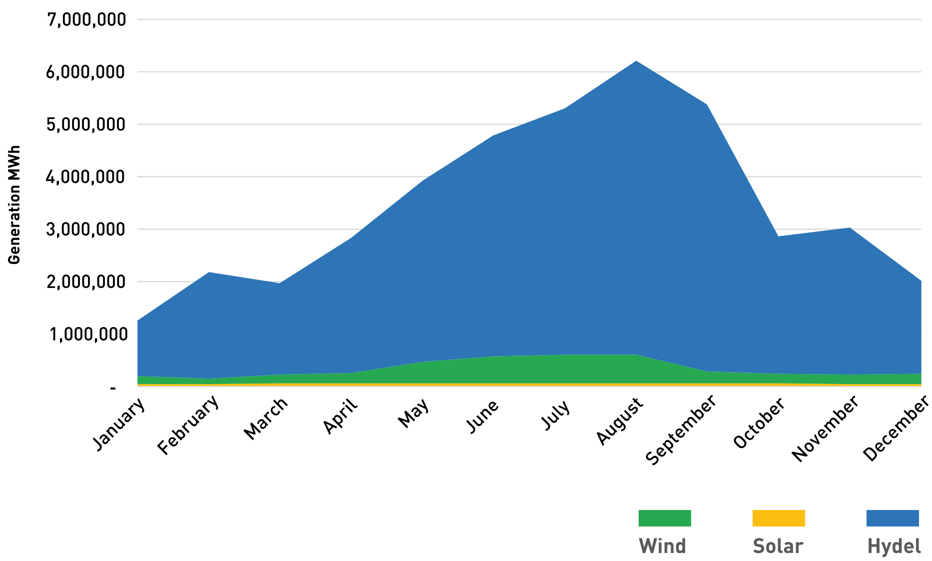


Figure 18: Monthly Renewable Generation Variability (NEPRA Monthly Energy Data)

Distributed Energy

Pakistan can tap into its viable distributed energy infrastructure given its abundant potential of solar and micro-hydel. Following is an overview of different distributed energy schemes and infrastructure in the country, including mini-micro grids.

Mini-Micro Hydel Power Plants (MHPPs)

Pakistan can set up small-scale MHPPs, in the range of 5-500 kW, in Gilgit-Baltistan, Khyber Pakhtunkhwa, and Azad Jammu & Kashmir. The first MHPP-1 MW was developed in Chitral by WAPDA in 1975. Since then, the number has increased manifold. The most significant development in this regard has been the 'Construction of 356 Mini & Micro Hydropower Plants – Phase I' by the Government of Khyber Pakhtunkhwa (GoKP) in 2014. However, based on technical feasibilities, the total number of plants was later dropped to 332. These projects were constructed by Non-Government Organizations (NGOs) and operated in either community-based mode or public sector driven mode. The status of all projects under this scheme is shown in Figure 19 (Clean Energy, n.d.). Under Phase II, more potential projects will be executed on identified sites in the province. In addition to this project, many non-public sector projects have been executed by the Sarhad Rural Support Program (SRSP), Aga Khan Rural Support Program (AKRSP) and Pakistan Poverty Alleviation Fund (PPAF).

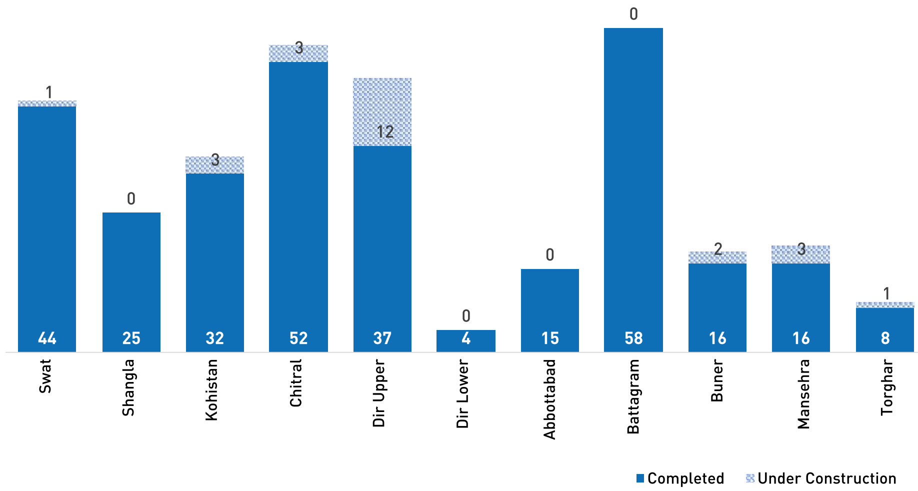


Figure 19: Status of Mini-Micro Hydel

Off-grid Solar

As discussed earlier, Pakistan is blessed with high solar irradiance in almost every province, which is a compelling case for off-grid solar based distributed energy. 'In Pakistan, the first solar power distributed energy was tied with grid through net-metering in 2012. As of September 2020, 5,502 customers of cumulative 94.39 MW have been issued licenses for net-metering' (SEC, 2020). Most of the off-grid systems in rural areas are installed by NGOs, Civil Society Organizations (CSOs), and provincial energy departments. Some other key projects include:

- 68 solar mini grids (3-51 kW) set up in Karak, Laki Marwat and Swabi districts by PPAF (PPAF, 2021).
- PV-wind hybrid power system of 50 kW installed in Khushab by ADB (ADB 2018).
- Solarization of 10,762 schools in southern Punjab benefiting 1.27 million students, by the Punjab Energy Department (PMU, n.d.).
- Solar tube wells (5-25 kW) used for groundwater extraction being installed in the Punjab, Balochistan, Sindh, and Khyber Pakhtunkhwa.

Off-grid Wind

Off-grid wind as a distributive energy resource is not common in Pakistan. The first project of its kind was introduced in 1980 where a Wind Turbine Generator (WTG) of 1-10 kW capacity was installed in Sindh and Balochistan. Followed by this pilot project, 12 more WTGs were installed by the Pakistan Council of Renewable Energy Technologies (PCRET) for water extraction. PCRET also installed 155 small WTGs with capacity ranging from 0.5 kW to 10 kW in Sindh and Balochistan.

These WTGs have a combined capacity of 161 kW and are providing electricity to 1560 houses and 9-Coast Guard checkposts. Additionally, more than 1,000 WTGs (0.3-1 kW) by various NGOs, including the Aga Khan Foundation, are operational in Sindh (ZakiFarooqui, 2014).

Pay-As-You-Go Schemes

Energy service companies, providing Pay-As-You-Go plans in Pakistan, include:

- Brighter Lite has been offering solar PV products on rent since 2015. The service has subscription fee of Rs 1,000-2,000 along with monthly fee (Rs. 490-1,090). Payments are made through easy-paisa (Atta, 2015).
- Nizam Energy launched 'Nizam Bijli' which is a Pay-As-You-Go scheme for plug-n-play system in off-grid areas. They are operating in 14 different districts in 3 provinces of Pakistan since 2015 (Reuters, 2018).

Hard to Decarbonize Sectors

The Paris Agreement (2015) brought renewables and energy efficiency into the spotlight as main levers to achieve climate goals. Pakistan, in the backdrop of being among the most affected countries from the adverse impacts of climate change as well as air pollution, needs to set its path right towards decarbonizing its economy. To do this, the country needs to redirect its energy and industrial sector towards less polluting and carbon neutral options through climate change mitigation and adaptation options.

Total emissions per capita in Pakistan stand at 0.982 MtCO2eq as compared to the global average of 4.5 MtCO2eq. The total emission levels of Pakistan are 235 MtCO2eq, ranking 136th in the world (OWID, 2020). A major source of emissions in Pakistan is electricity generation which accounts for 45% emissions, preceded only by agriculture (MoCC, 2021). In 2020, the electricity sector accounted for 27% of annual CO2 emissions from fuel combustion (Transparency, 2020). Currently, this sector emits 0.353 kg-CO2/kWh of generation. Based on upcoming integration of renewables, the emissions indicator is expected to come down to 0.202 kg-CO2/kWh by 2030 (NTDC, 2021).

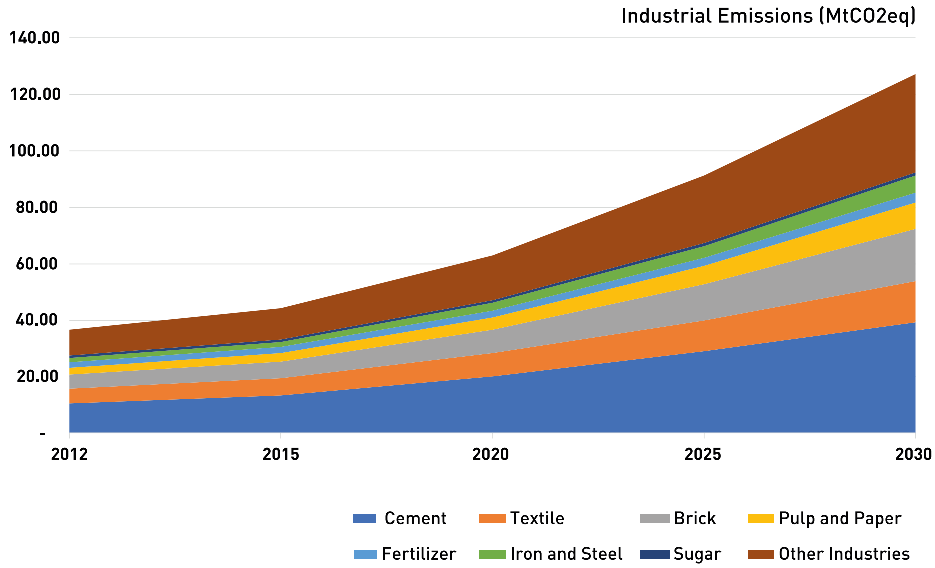


Figure 20: Pakistan's Industrial Sector Emissions

Industry emissions in Pakistan are projected to rise by 230% between 2012 and 2030. This represents a growth from approximately 59 $MtCO_2eq$ in 2012 to approximately 196 $MtCO_2eq$ in 2030. A fact sheet by the International Institute for Sustainable Development (IISD) has projected national level GHG emissions from energy demand of different industrial sources in Pakistan, as shown in Figure 20 (IISD, n.d.).

The cement industry remains at the top accounting for 39.3 $MTCO_2eq$ out of 127.2 $MTCO_2eq$ industrial emissions. The cement industry will account for almost 31% of total industrial emissions by 2030. Textiles and brick industries also remain at the forefront accounting for 14.5 $MtCO_2eq$ and 18.5 $MtCO_2eq$ emissions, respectively. It is pertinent to mention that most of the big textile players have captive power plants based on coal, oil, or bagasse as sources of primary energy, but have started decarbonizing significantly using the State Bank's renewable energy financing scheme. Recent developments, including hikes in electricity tariff and reduction in solar development cost, have led several industries towards solarizing their processes. However, the limited availability of land for solar still makes it difficult for these industries to completely turn towards solar energy reliance. In Pakistan, the multinational Fast-Moving Consumer Goods (FMCGs) brands like PepsiCo, Unilever and Nestle have taken the lead in order for transition towards renewables driven by their sustainability agenda, while medium and smaller enterprises are also investing in solarization, purely out of economic compulsions.

The current status and potential of hard-to-decarbonize sectors and the penetration of renewable energy, is listed below:

Cement is one of the most energy intensive industries, which makes it the biggest emitter among all sectors. In Pakistan, this sector is highly dependent on coal as a primary source of energy. This is because coal is considered an ideal fuel to provide the required flame shape, while the remaining ash becomes part of the clinker. Therefore, the industry relies heavily on coal for energy purposes while the remaining energy requirements are met through oil, gas, and electricity. The national production capacity of the cement sector is 45 million tonnes with energy demand of over 700 MW. Each tonne of cement production requires about 80 to 100 kWh of electricity, which presents a huge opportunity to shift towards renewable energy-based solutions. Although, solarization in this sector has not yet taken off, market leaders and large cement corporations have shown interest for renewable energy -based solutions to fulfil their electricity needs. Recently, Lucky Cement, the largest cement producer in Pakistan, launched a solar-plus-storage project with 5.589 MWh of energy storage, which is expected to be the largest in the country. The listed company has partnered with solar developer (Reon Energy) to build the 34 MW solar PV project with storage at its Pezu plant, located in the northern province of Khyber Pakhtunkhwa (Murray, 2022). Other cement developers have also benefited in the past from the State Bank of Pakistan's concessional renewable energy financing facility.

Textile is the most significant industrial sector in Pakistan contributing approximately 10% of GDP and more than 50% of total exports. It further provides employment to approximately 30% of the country's workforce. This industry depends on electricity for chemical processing, spinning, weaving and miscellaneous purposes, and gas and oil products for non-electrical energy demand. The lack of compliance with environmental regulations by textile manufacturers remains one of the key environmental challenges of the country. However, factories linked with international supply chains tend to comply with these regulations. To decarbonize this sector, one of the key interventions include the NAMA Facility Project which aims to decarbonize textile manufacturing through adoption of Energy Efficiency and Renewable Energy technologies on reduced interest rates. The project is expected to reduce 354,000 tonnes of CO_2eq from this sector in five years (NAMA, 2022). The export competitiveness of this sector makes it more important to accelerate adoption of sustainable energy options like solar and wind, to compete regionally with other peers.

Iron and Steel: About 6% of total fossil fuel demand in the industrial sector comes from Iron and steel industries, which overwhelmingly rely on natural gas as the primary fuel for combustion along with oil as a backup fuel (IISD, n.d.). The high energy intensity of this sector and elevated temperature requirements for melting steel, make it difficult to use solar thermal based applications, except in hybrid mode for pre-heating iron. A more viable option is to use electric arc furnace powered by renewable energy. Although, the energy cost corresponds to

20% of the total operating cost of this industry making solar deployment more viable, high capital cost remains the key barrier for medium-sized plants to transition towards alternate sources of energy. In Pakistan, the first solar power plant in the steel industry (Amreli Steels) was introduced in 2021 with a capacity of 4.43 MW.

Fertilizer: Significant energy efficiency gains in the fertilizer sector will be achieved by investing in co-generation, and improvement of power factors. Among these industrial players, Fauji Fertilizer Company (FFC) remains the first fertilizer industry player to get into the business of commercial wind energy as the company launched its Wind Farm in Jhimpir, Sindh in 2012. In terms of renewable energy for primary energy use, Fatima Energy Ltd has developed a 120 MW co-generation power project based on fuel mix of biomass and coal.

Transport: This sector currently accounts for 50.8 $MtCO_2eq$ emissions, which are expected to reach 80.2 $MtCO_2eq$ by 2030. Out of the current emissions inventory, vehicles account for 95% of emissions. This shows that any effort to decarbonize this sector should be focused on vehicles. There are several options for this which include efficient passenger cars, taxis, and vans; switching from road to rail transport; switching to two-wheeler electric vehicle bikes; Bus Rapid Transit (BRT) systems; car maintenance; switching to efficient fuels; switching to biofuels; and promotion of non-motorized transport. Although, decarbonization of this sector is not possible by directly integrating renewable energy, it could be decarbonized through electric vehicles and integration of renewables in the grid.

Renewable Energy Tariff

BOX 5 | Tariff Evolution in Pakistan

In Pakistan, Electricity Tariff is determined by NEPRA based on 1998 Tariff Rules. The end-consumer tariff is notified based on several components related to the Generator, Transmission Provider, Distribution Provider, and subsidies by the government. Figure 17 shows different components of tariffs and the agencies/companies responsible for the components. Conventionally, contracts of IPPs have been on 'Take or Pay' basis. Recently, new contracts of IPPs have been negotiated on 'Take and Pay' basis, in addition to conversion of older 'Take or Pay' contracts to 'Take and Pay' contracts wherever possible. Similarly, NEPRA is aiming to convert hydroelectric plants, old units of GENCOs and other plants with low utilization to 'Take and Pay' contracts.

Current cost of generation from various sources shows that renewables are becoming increasingly competitive with conventional fossil fuel-based sources. This can be primarily attributed to:

1. The decreasing cost of development of wind and solar farms through tapping into economies of scale, and

2. The increasing cost of global imported fuel prices like oil which reached historically high levels in 2022.

With fluctuation in imported fuel prices, driven by global instability like the Russia-Ukraine conflict, it becomes prudent to account for risk of imported fuel price fluctuations in the power system planning process due to political instability in the region. The GoP needs to remain focused on indigenizing renewable energy sources of the country.

Current composition of electricity tariff is given in Figure 21.

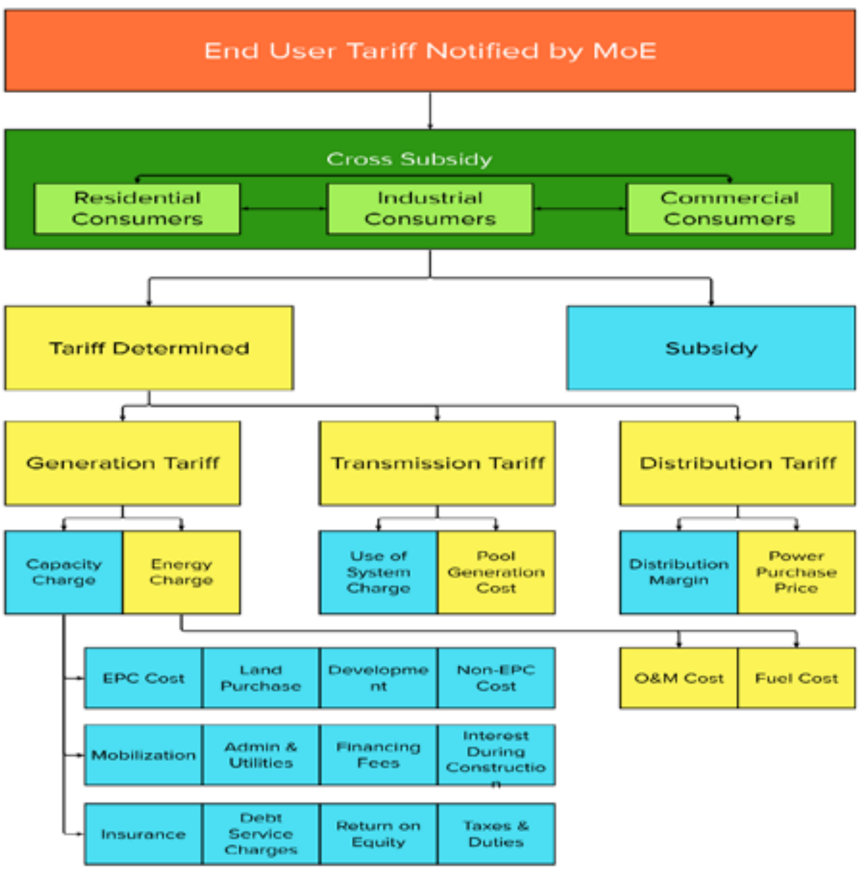


Figure 21: Power Sector Tariff Components

The tariff components as shown in Figure 21 are all individually indexed against certain indicators and are adjusted periodically. The Return on Equity (ROE) is linked to the exchange rate; O&M is linked with USD and local CPI, debt component is linked with Karachi Interbank Offered Rate (KIBOR) or London Interbank Offered Rate (LIBOR), and fuel price is adjusted based on actual cost (all called 'pass-through').

IGCEP estimates reveal low capex and tariff for wind and solar power plants. However, these estimates may not reflect prevailing market conditions. For instance, the tariff for wind power plants reached as low as 4.34 c/kWh (Rs/kWh 5.21) for the newest wind power plant in Pakistan - Trans-Atlantic Wind Power Plant. However, the same wind corridor extends to Rajasthan region of India that offers 5.2 c/kWh (INR/kWh 3.47) to wind generators at an average. This means higher returns for investors as compared to Pakistan (NEPRA, 2018) (IWP, n.d.). Nevertheless, a more in-depth analysis is needed to find viability of a 'true' wind tariff while ensuring private sector participation through adequate returns and keeping the basket price of the system at a lower end.

The current power generation mix includes wind and solar with much higher older tariffs of Rs /kWh 25.25 and Rs /kWh 24.41 as well as latest plants with tariff as low as Rs /kWh 16.20 and Rs /kWh 19.14 (index adjusted). The tariff, determined by NEPRA for wind power plants over the last decade, has reduced from Rs /kWh 12.77 (c/kWh 15.02) to Rs. /kWh 6.39 (c/kWh 3.78) (NEPRA, 2021). For solar plants, NEPRA issued solar Feed-In Tariffs (FITs) in the range of c/kWh 14.06 to c/kWh 13.05 depending on the region (North and South) and the plant's capacity (Enerdata, 2015). The following indicates the latest tariff trends:

- In 2019, NEPRA approved tariff of 4.87 c/kWh for a 13.4 MW wind power project in Sindh by Burj Capital (exchange rate Rs/$ 120).
- In 2019, AEDB issued of Letters of Support (LoS) to 11 wind power projects of a total capacity of 550 MW. The approved tariff of all these projects ranged between 4.7 to 4.8 c/kWh (exchange rate around Rs/$ 155).
- NEPRA has approved levelized tariff of 3.76 US cents per unit for a period of 25 years for a 50 MW solar power project, installed in Bostan District in Balochistan by Enertech Holding Company on Build Own Operate Transfer (BOOT) basis (exchange rate Rs/$ 155.35).

Investment in Renewable Energy Sector

According to GoP figures, the costs of energy transition will be $101 billion by 2030, and an additional $65 billion by 2040, based on the completion of in-progress renewable energy projects, additional hydropower, transmission, and phasing out coal by replacing it with hydropower (GoP, 2021). The cost breakdown of these areas, as included in the NDCs, is:

- **Hydropower:** For the rapid expansion of renewables and hydropower, reaching 60% production by 2030 would require an estimated investment of $50 billion by 2030 and $80 billion by 2040.
- **Transmission**: An estimated $20 billion would be required to upgrade the transmission network by 2040. This figure could increase as the share of variable power from solar and wind increases.
- **Phasing out coal:** Buying out the new coal power projects, including the local Thar coalmines, would have an upfront estimated cost of $18 billion. An additional estimated $13 billion would be required to replace energy generation by coal power plants with solar.
- **Other renewables:** More than 12 GW projects under consideration would require about $20 billion.

Pakistan's current energy sector investments have many foreign investors and have been a major source of FDI. FDIs are expected to increase in hydro, wind and solar, while their share in coal and thermal energy is expected to decline. In addition to FDI as a source of equity, there are other funding channels/and instruments for financing renewable energy projects.

Financing Channels, Institutions and Tools

Multilateral Development Banks (MDBs)

The major Multilateral Development Banks (MDBs) active in investing in the renewable energy in Pakistan include the World Bank Group (WBG), Asian Development Bank (ADB), and KfW Bankengruppe. The World Bank, through IFC, has been funding private sector wind energy projects, including Wind Super Six (310 MW). KfW, ADB, CDC Group, and USAID, have also been active in providing co-financing, direct equity, loans, grants, and technical assistance through programming activities for solar, wind, and hydropower projects with an aim to promote clean energy. Key recent investments by these MDBs include:

$320 million financing for six Wind Energy Projects, with a combined capacity of 310 MW was transacted by IFC (IFC, 2019). IFC has also supported Laraib

Energy with a $35 million loan to finance a run-of-the-river hydropower plant in northern Pakistan. It has also invested $38.1 million in a wind power project by Zorlu Enerji Pakistan Limited in Sindh (IFC, n.d.).

The ADB has supported Pakistan with projects and technical assistance through a total of $38.68 billion and 825 projects to-date, much of which related to climate action. It recently made a $300 million commitment for Balakot KP HPP, and another $300 million as policy-based loan to support reforms in Pakistan's Energy Sector (ADB, 2022a). The Bank has already invested $10.3 billion in the energy sector of the country through 143 projects.

KfW and AFD France has provided a loan of € 70 million for development of Harpo HPP in Gilgit-Baltistan (WAPDA, n.d.).

USAID is supporting WAPDA for the rehabilitation and construction of Mangla Dam, Tarbela Dam and Kaitu Weir hydroelectric projects, which would add 340 MW of power generation capacity by 2024.

The CDC Group has signed an $82 million debt agreement to support two local industries in Pakistan on a wind power project in Jhimpir, Sindh. This will fund three wind farms, each of 50MW capacity, two by Liberty Mills and one by Indus Group, to reduce the country's dependence on fossil fuels.

The WBG is specifically engaged in assistance to Khyber Pakhtunkhwa's hydropower development. These include: $594 million for hydropower and renewable energy investments, $25 million for strengthening institutions, $59 million for E&S engagement, and $30 million as Project Implementation Support (Karandaaz, 2022).

The Dutch entrepreneurial development bank, FMO, along with Proparco has announced a $100 million syndicated facility to support K-Electric, the private power utility in the city of Karachi. The funding will support K-Electric in importing more electricity from the national grid, allow better integration of renewable power, and improve the distribution network (FMO, 2022).

Banks and Non-Bank Finance Companies (NBFCs)

In Pakistan, the banking sector controls over 75% of all financial assets, and the top 20 corporate borrowers are estimated to account for 30% of all lending and 50% of total corporate lending. Furthermore, Pakistan's six largest banks dominate over 50% of the banking market. Large project finance transactions happen on the back of GoP providing sovereign guarantees. With tight fiscal space, GoP has been unable to undertake many infrastructure projects (Infracoasia, n.d.) and there is a need to expand on project development through private sector offtake.

Local and international institutes, banks, and Non-Bank Finance Companies (NBFCs) in Pakistan have invested in major renewable energy projects in the form of equity, loans, and guarantee structures. The push by SBP to accelerate investment in renewables, through financing schemes, has led to several private banks developing their own product structures for renewable energy project financing. The SBP also launched the 'Renewable Energy Financing Scheme' for solar, wind, hydro, biogas, bagasse co-generation, and geothermal based projects. As of June 2021, it had funded 717 projects with the capacity of 1082 MW worth Rs 53 billion (Karandaaz, 2022). The scheme aims to provide concessionary financing to attract investment in the renewable energy sector and absorb costs associated with risks. Even though the scheme has been extended till June 2024, it is likely to phase out over the long-term, leaving this sector to commercial banks and FIs only.

Currently, several banks are engaged in offering products under this scheme along with their own products for financing of residential and commercial scale solar projects. Details of all financing products for renewable energy projects by different banks is in Table 7:

Table 7: Renewable Energy Financing Schemes in Pakistan

Banks	Scheme	Facility Parameters	Project Type / Size
SBP	SBP Financing Scheme for Renewable Energy A shariah compliant version (Islamic Financing Facility for RE). *Source:* https://www.sbp.org.pk/Incen-others/Rene.asp	**Category I** • Prospective sponsors setting up renewable energy projects • Duration: 12 + 2 years • Cap @ Rs. 6 billion each borrower **Category II** • Prospective sponsors setting up renewable energy projects • Duration: 10 + years (3 months grace period) • Cap @ Rs. 400 million each borrower **Category III** • Renewable Energy Investment Entities • Duration: 10 years (6 months grace period) • Cap @ Rs. 2 billion cumulative lending	Category I: 1-50 MW RE projects Category II: Up to 1 MW RE Projects Category III: Up to 5 MW
Bank Al Habib	SBP Financing Scheme for Renewable Energy Category II *Source:* https://www.sbp.org.pk/Incen-others/Rene.asp	• Domestic, agricultural, commercial & industrial borrowers • Duration: 10 years (3 months grace period) • Mark-up @ 6% per annum • Cap @ Rs. 400 million	Category II: Up to 1 MW RE Projects

Table 7: Renewable Energy Financing Schemes in Pakistan

Banks	Scheme	Facility Parameters	Project Type / Size
Bank of Punjab	SBP Financing Scheme for Renewable Energy *Source:* https://www.sbp.org.pk/Incen-others/Rene.asp	• Finance Facility of up to Rs. 25 million for SEs and up to Rs. 200 million for MEs & above • Duration: Up to 10 years • Mark-up @ 6% per annum	4 – 1000 kW solar projects
	BoP Shamsi Tawanai *Source:* https://www.bop.com.pk/BOPShamsiTawanaii	• Duration: Up to 8 years (3 months grace period) • Mark-up as per prevailing market rates • Cap @ Rs. 100 million	
	BOP Solar *Source:* https://www.bop.com.pk/BOP%20Solar	• Duration: Up to 7 years (3 months grace period) • Cap @ Rs. 5 million	Residential systems
JS Bank	JS Smart Roshni Solar Panel Financing *Source:* https://jsbl.com/business/sme/js-smart-roshni-solar-panel-financing/	• Duration: 3-7 years • Mark-up @ 6% per annum • Cap @ Rs. 10 million	Commercial and industrial Systems
	JS Ghar Apna Solar Solution *Source:* https://jsbl.com/business/sme/js-gharapna-solar-panel-financing/	• Duration: 3-5 years • Mark-up @ 6% per annum • Cap @ Rs. 3.5 million	Residential and commercial
	JS Zarkhez Solar Tube well Finance *Source:* https://jsbl.com/business/agriculture-finance/js-zarkhez-solar-tubewell-finance/	• Duration: 3-7 years • Mark-up @ 6% per annum • Cap @ Rs. 2.5 million	Solar tube wells
Meezan Bank	Meezan Solar *Source:* https://instaenergy.net/solar-finance/	• Duration: 1-5 years • Mark-up @ 6% per annum • Cap @ Rs. 2 million	From 1KW up to 1000KW solar systems
Allied Bank	Allied Aabayari *Source:* https://www.abl.com/business-banking/agriculture-financing/agriculture-financing-products/allied-aabayari/	• Duration: up to 10 years	Solar Irrigation Systems

Table 7: Renewable Energy Financing Schemes in Pakistan			
Banks	**Scheme**	**Facility Parameters**	**Project Type / Size**
Bank Alfalah	Alfalah Green Energy *Source:* https://instaenergy.net/solar-finance/	• Duration: Up to 5 years • Mark-up @6% per annum • Cap @ Rs. 400 million	Residential, commercial, SME and agri businesses
Faisal Bank	Faysal Islami Solar Solutions *Source:* https://www.faysalbank.com/en/islamic/faysal-islami-solar-solutions/	• Duration: 1-7 years • Mark-up @6% per annum • Cap @ Rs. 3 million	4 KW to 20 KW solar systems
Habib Bank	Farm Irrigation Solutions *Source:* https://www.hbl.com/assets/documents/Investor_Day_-_Rural_Banking_and_Development_Finance.pdf	• Duration: 3-5 years • Mark-up as per prevailing market rates • Cap @ Rs. 10 million	Solar tube wells
Soneri Bank	SBP Financing Scheme for Renewable Energy *Source:* https://www.soneribank.com/sbp-financing-schemes/	• Duration: Up to 12 years • Mark-up @6% per annum • Cap @ Rs. 6 billion	1 -50 MW Renewable Energy projects

PE Funds and Capital Market

Long-term private finance is critical to support growth and structural transformation in transitioning towards a clean energy economy. The financial system in Pakistan is characterized by low levels of financial participation and development. Generally, only the largest corporate groups have access to formal finance channels. There are smaller pockets of liquidity represented by insurance companies, pension funds, DFIs, mutual funds and the National Savings Scheme, but their presence in leveraging finance for renewable energy projects remain untapped. However, they have the potential to become meaningful investors through long-term credit enhanced debt instruments. The current scenario has resulted in lack of availability of funds for infrastructure financing in Pakistan. Nonetheless, positives have started to emerge. DFIs such as InfraZamin can issue credit guarantees for renewable projects based on its (expected and forthcoming) AAA rating from PACRA - a local credit rating agency. This has already started attracting private capital that would otherwise not participate in lending to the renewable energy sector in Pakistan.

Micro-finance

Micro-financing is the most suitable product for off-grid renewable energy projects, especially in countries with low energy access. In Pakistan, the Micro-Finance Institutes (MFI), including National Rural Support Program

(NRSP) and the First Microfinance Bank, have initiated several programs and schemes for renewable energy deployment in households and Small and Medium Enterprises (SMEs). Some MFIs like Pakistan Microfinance Investment Company (PMIC) have also initiated programs for pico-solar devices in rural areas of Pakistan. However, these initiatives require further scaling up for achieving national climate and renewable energy targets.

Green Bonds

Pakistan launched its first Green Bond - 'Indus Bond' in May 2021 for financing large hydel projects. The bonds, valued at $0.5 billion, were floated @7.5% interest rate with tenure of up to 10 years. However, the overwhelming response of international investors led to oversubscription of bonds by six folds (Karandaaz, 2022). The high demand of these bonds indicates that Pakistan can attract foreign investment for renewable energy projects through 'Green Bonds.' To enable investors and bond issuing institutions, the Securities and Exchange Commission of Pakistan (SECP) also issued guidelines for floating 'Green Bonds' and 'Sukuk' in 2021. Additionally, the GoP is also currently performing assessments to evaluate the feasibility of floating 'Blue Bonds' and 'Nature Performance Bonds.'

CPEC Investments in the Energy Sector

CPEC is an initiative to build economic activity and regional integration between China and Pakistan. The total planned investment under the corridor is $62 billion between FY2015 and FY2030, of which $27.4 billion projects have been realized, with energy sector (power generation, coal mining and transmission lines) representing 76% (Aman, 2022).

It covers power generation projects (both fossil fuel and renewables) of about 11 GW (Hussain, n.d.). To-date, about 5,520 MW energy projects have been completed. More than half of these projects are coal-based power plants, as shown in Figure 22. However, Pakistan has committed in NDC 2021 that no new coal plant will be financed. Balance of Payment (BoP) crisis, along with high circular debt and surplus capacity have already scaled back future CPEC investment, as indicated by the shelving of the 1,320 MW Rahim Yar Khan coal power project in 2019 (Kiani, 2019). In November 2020, Pakistan announced suspending coal-based power projects under planning and initial construction stages as part of Pakistan's climate action efforts and formalized this under the country's revised 2012 NDCs. The decision was a follow-up to a report from an independent nine-member committee set up in 2019-20 to review the independent power project contracts, including CPEC contracts, which offered higher returns compared with global standards.

FIGURE 22 | List of CPEC Projects

Completed Projects

- 1320MW Sahiwal Coal-fired Power Plant
- 1320MW Coal-fired Power Plant at Port Qasim, Karachi
- 1320MW China Hub Coal Power Project, Hub, Balochistan
- 660MW Engro Thar Coal Power Project
- 1000MW Quaid-e-Azam Solar Park, Bahawalpur
- 50 MW Hydro China Dawood Wind Farm, Gharo
- 100MW UEP Wind Farm, Jhimpir, Thatta
- 50MW Sachal Wind Farm, Jhimpir, Thatta
- 100MW Three Gorges Second and Third Wind Power Project
- Matiari to Lahore ±660 KV HVDC Transmission Line Project
- 720MW Karot Hydropower Project, AJK/Punjab

Under Construction Projects

- 1320 SSRL Thar Coal Block-I (2×660MW)
- 330MW HUBCO Thar Coal Power Project
- 330MW HUBCO ThalNova Thar Coal Power Project
- 884MW Suki Kinari Hydropower Project, KP
- 300MW Coal-Fired Power Project, Gwadar

Under Consideration Projects

- 1124MW Kohala Hydropower Project, AJK
- 700.7MW Azad Pattan Hydropower Project, AJK/Punjab
- 1320 MW Thar Mine Mouth Oracle Power Plant
- 50MW Cacho Wind Power Project
- 50MW Western Energy (Pvt.) Ltd. Wind Power Project

Climate Finance

Under the Paris Agreement, and more recently under Conference of Parties (CoP 26), there has been an emphasis on funneling $100 billion per annum fund commitment to developing countries to build climate resilient projects and avert a potential climate crisis in the future (Kaya, 2022). In this regard, Pakistan tapping into 5% of the committed funding, would translate into $5 billion per annum under climate finance activities. However, current flows of international mitigation and adaptation finance to Pakistan have been less than $500 million to-date (including bilateral flows) (CDKN, 2013). This is compared with average per year adaptation needs of $7-14 billion till 2050, which far exceed the existing funds mobilization.

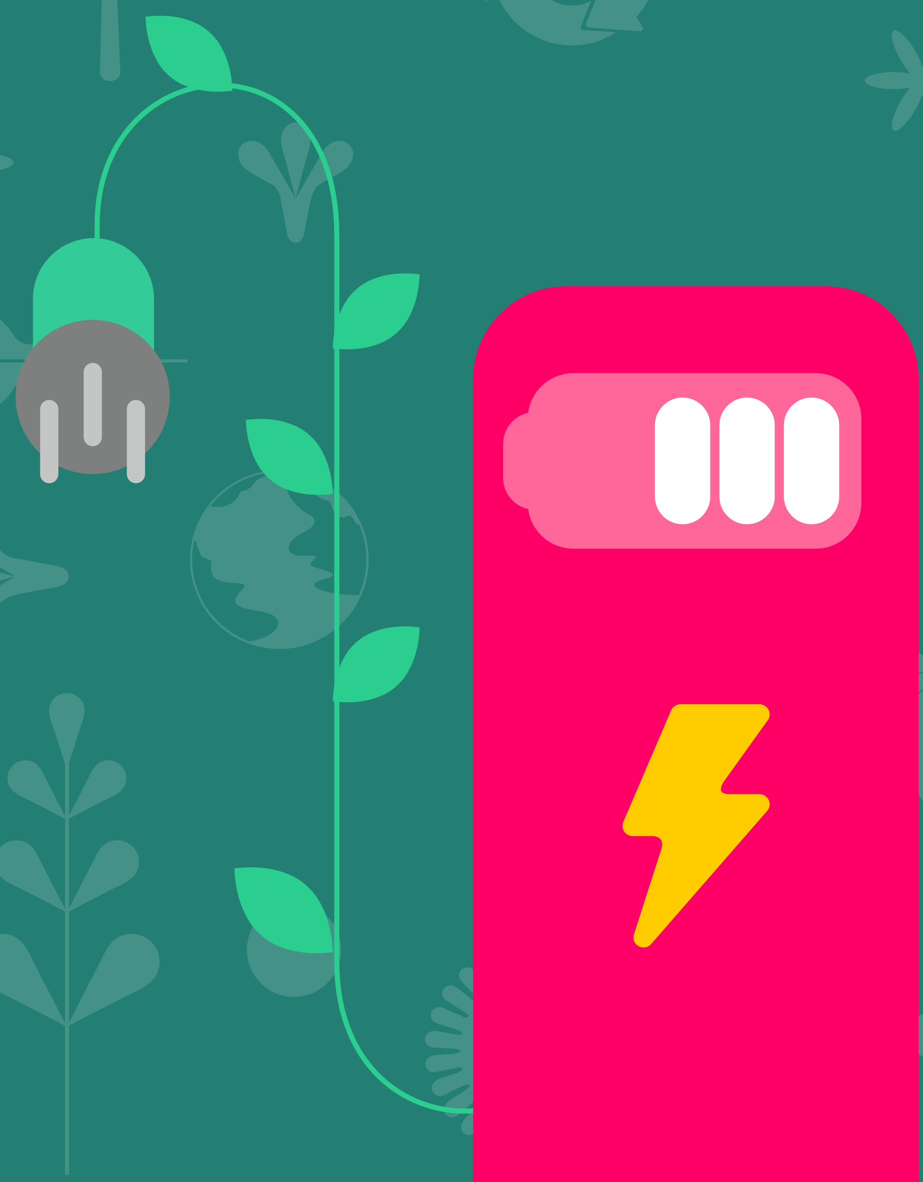
Currently, Pakistan has received only $121 million from the Green Climate Fund (GCF) under different instruments, to finance climate projects worth $668.7 million. Additionally, GCF is also providing technical support for five country level readiness activities. All GCF related mitigation and adaptation projects were public sector driven up until May 2022 with the approval of the first private sector project – 'Pakistan Distributed Solar Project' by JS Bank (GCF, 2022). This opens the door to the private sector to tap into GCF funding. Details of different projects is given in Figure 23:

$54 Million ($10 Million by GCF)	**$47.7 Million ($35 Million by GCF)**	**$583.5 Million ($49 Million by GCF)**	**$37.5 Million ($37 Million by GCF)**
Pakistan Distributed Solar Project	Transforming the Indus Basin with Climate Resilient Agriculture and Water Management	Green BRT Karachi	Scaling up of Glacial Lake Outburst Flood (GLOF) risk reduction in northern Pakistan

Figure 23: GCF Projects in Pakistan

Section II

Challenges and Recommendations for Renewable Energy



Challenges and Recommendations

Pakistan has an average of nine and a half hours of sunlight daily, globally certified wind corridors, and an extensive network of surface water system in the form of Indus river and its tributaries. However, the true potential of renewable energy has not been adequately tapped and transition towards this area has been slow.

Some of the key challenges pertaining to integration of renewable energy are given below along with recommendations and key action items to address those challenges over the short- (1 year), medium- (2-5 years) and long-term (5-10 years).

Policy and Regulatory Uncertainty

Investor confidence is the primary driver of renewable energy deployment. However, policy and regulatory uncertainty remain the foremost obstacle for renewable energy investors. Following are the key issues causing this uncertainty:

Issue 1 -Lack of coherent policy and planning

There is a mismatch in timelines between targets set out in the ARE Policy, and IGCEP power planning processes. Initially, the ARE Policy aimed for 30% share

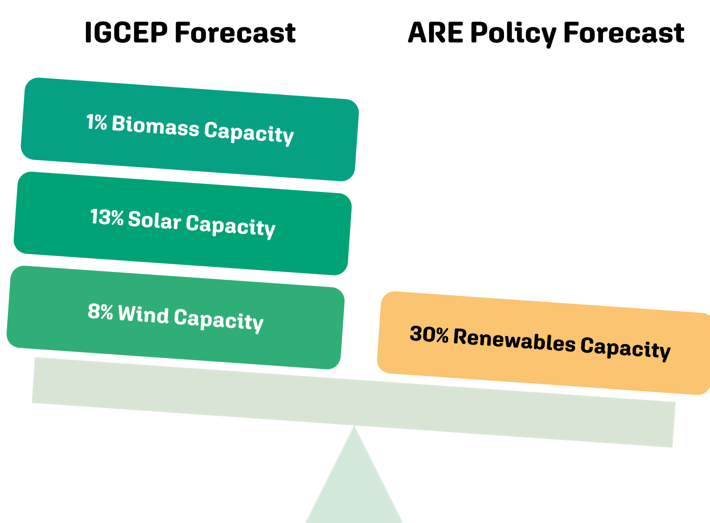


Figure 24: Renewable Energy Targets Mismatch

of solar and wind in the generation mix by 2030, while IGCEP committed plants result in only 21% of wind and solar share in total capacity (Figure 24). There needs to be greater synchronization between two formative policy documents for greater clarity on the future of renewables in Pakistan.

Issue 2 – Lack of coordination between national and sub-national entities

Institutions under the Ministry of Energy (MoE) show limited inter-institutional coordination. Progress in renewable energy development is limited by a general lack of cooperation, coordination, and delays, which dampens investor confidence. One such instance is where projects have been commissioned without evacuation plans such as wind power projects under Jhimpir-Gharo corridor.

Another example is the merger between the AEDB and PPIB, which was initiated in 2017, and was approved by the Cabinet Committee on Energy (CCoE) in 2021. However, the process is not fully completed yet. In another instance, the National Electricity Plan (NEP) was formulated, which underwent consultative sessions in 2021. A draft structure was consequently developed, which is yet to be launched. Completion of such vital steps are critical for providing certainty to investors and a possible roadmap for the sector.

Issue 3 – Renegotiation of contracts

The tariff renegotiation process in 2020 dampened investor confidence. Most of the generators signed MoUs with GoP to renegotiate tariffs to address power sector circular debt. However, the impact of these has been adverse on renewable energy providers which mostly had to reduce tariff for more than 15 years of their remaining contract period as opposed to thermal generators which had less than five years of average remaining contracts. This has also set an untimely precedence that sovereign independent agreements with the GoP could be renegotiated, ultimately impacting investor ROE and future potential to attract FDI.

Issue 4 - Slow transition to competitive markets

Pakistan is moving towards new procurement regimes through renewable energy auctions and CTBCM. However, overall transition has been slow. NEPRA conceptualized competitive bidding for solar and wind projects in 2014, but the auction mechanism never fully materialized. This halted projects, which were ready for the execution stage. Similarly, the concept of CTBCM, first envisaged in the original NEPRA Act of 1997, continues to be in the pilot stages, though background work has been fast tracked for implementation. Lack of clarity on the future road map for the electricity market is also slowing pace of unlocking private investment in the renewable energy space.

Issue 5: Lack of institutional capacity

The human resources capacity needs to be augmented at every level of policymaking. First, the workforce in institutes, agencies and ministries is not sufficient and must be increased. Second, well-established research centers are not available for renewable energy infrastructure. For instance, there are no technical centers that provide technical backstopping to policymakers on critical and upcoming technologies, such as bagasse, solar and wind. Last, besides PCRET, there are insufficient institutions and laboratories that can provide standards, certifications as well as validate quality and suitability of renewable energy technologies.

Issue 6 – Payment delays

With an outsized circular debt, GoP as a single off taker tends to make payments after considerable delays. A typical invoice generated is paid after eight to ten months, and that too partially. The delayed interest payments as per PPAs, normally accrue in books, but are never paid on time. When any payments do come through, the SBP puts restrictions on repatriation of dollars. All these issues compound payment delays and dampen project Internal Rate of Return (IRR).

Issue 7 – Lack of observance of 'must-run' status

There were instances in the past where the must-run status of wind power plants was violated. Although the ARE Policy lays out wind and solar plants to run on priority basis, the actual dispatch fails to follow this policy directive. In 2019, for instance, the Jhimpir-Gharo wind corridor had total installed capacity of 980MW. Three plants near Gharo, witnessed continuing offtake because of the K-Electric purchases of renewable energy. However, those who sold to the CPPA were curtailed to zero. This happened on the back of GoP's decision to continue power purchase from coal and RLNG plants which were closer to the load centers and a safer option for system reliability.

Recommendations

- The Ministry of Energy (MoE) (Power Division) should provide a comprehensive action plan for the promotion of renewable energy. The action plan should be prepared in consultation with all stakeholders, including provinces, backstopped by concrete timelines.
- The GoP must provide a way forward on competitive markets framework. Under the CTBCM framework, NEPRA has taken a lead and has committed to operationalize the market by 1 December 2022. The endorsement from the Federal Government must be unequivocal in this regard.
- A national merit order list for renewable electricity generation should be published annually in line with IGCEP commitments. Such a merit order list will help in ranking the sources of renewable energy in an ascending order of price to provide forward guidance to investors on project development as well as to demonstrate the GoP's commitment to renewable energy. The GoP must also provide suitable codes and minimum performance standards on each technology to incorporate reliability, durability, and performance standards.
- There is a need to devise a Renewable Energy Certificate (REC) policy for developing a REC ecosystem. New wind and solar power projects in Pakistan can especially benefit from additional REC windows, such as upcoming GCC certifications.
- The GoP should open communication channels, especially with project developers, to build uniformity and consensus. Such topics can include DISCOs financials, must-run status, problems of transmissions and evacuation, on-time payments, CPPA provided payment guarantees, liquidity damages, and deemed generation benefits. There is also a need to stimulate dialogue in the public sector to encourage respect for the sanctity of contracts, irrespective of political governments. Tariff renegotiations should not become a norm and all tariffs should treat all consumers equally.
- Larger policy framework decisions, such as formulation of NEP or merger of AEDB and PPIB must be expedited. The GoP must seize the opportunity to reduce bureaucracy, trigger improvement opportunities, cut documentation handling and excess procedures to create supporting environments and increase global investor participation in renewables space of Pakistan.
- There is also a need to establish a 'Net-Metering Policy' and expedite net-metering approvals. Large customers continue to face delays, sometimes up to one year to receive requisite regulatory approvals.
- At a policy level, the GoP must work to create social recognition of renewable energy in urban Pakistan. Awareness is a crucial factor for broad base use of renewable energy and its positive externalities with climate change. There is a need to provide further information on renewable energy and environmental benefits that can cascade to each member of the society. Policy thrust is also required to organize awareness programs throughout the country, especially in villages and rural areas. People should be trained regarding new techniques, especially focusing on community led initiatives involving renewable energy.

Term	Role	Key Action Items
Short-Term	MoE	The MoE to provide an action plan for promotion of the renewables sector in its regulatory framework, including a consolidated fiscal framework. The action plan should be prepared in consultation with provinces within a fixed timeframe.
	NEPRA	Operationalize CTBCM for wholesale transactions of greater than 10MW by 1 December 2022.
Medium-Term	MoE	Develop a 'Renewable Energy Certificate (REC) Policy' for Pakistan. Identify new windows of opportunities in REC's markets, such as GCC.
	MoE	Execute and finalize PPIB-AEDB merger.
Long-Term	AEDB, MoE	Establish synergistic frameworks for greater renewable energy offtake in key sectors, such as renewable energy in agriculture (agrivoltaics, solar sharing or vertical farming) or renewable energy in water and sanitation.

Financing Challenges for Renewable Energy

Unlocking private sector investment is key to financing new renewable energy projects. Costs for renewable energy are rapidly decreasing and in certain cases is less expensive than generating electricity from fossil fuels. This has helped change the power sector dynamics in Pakistan, with a larger share of the energy mix expected to be renewable in the future. Nonetheless, to avail significant opportunity for private sector investment, the following challenges must be addressed:

Issue 1 – Limited recourse financing challenges

There are few developers in Pakistan who sponsor profiles to develop renewable energy projects independently. Many newly-established developers (up and coming, small and local developers) do not have significant institutional history or local equity to backstop projects considering high capital cost structure. Banks and Financial Institutions (FIs) consider it risky to provide financing to new and upcoming local developers and generally take a risk averse view on renewable energy projects. FIs mainly look for contractor profiles, who have experience in construction, come on the back of well-established suppliers with proven equipment and operator track record and project development experience. In turn, limited private financing from lenders result in long lead times to close renewable energy projects and limited financing potential.

Issue 2 - Constrained margins in solar and wind tariff

Project developers have shown limited interest in renewable energy projects due to low approved benchmark tariffs by NEPRA. For wind developers, NEPRA has allowed a benchmark tariff of c/kWh 4.28, which is lower than the benchmark tariff in India for the same corridor. Add to this, prolonged delays in circular debt payments coupled with foreign O&M payments, the tariff becomes unviable for investors to scale renewable energy projects.

Issue 3 – Securing land rights and Right-of-Way (ROW)

Secured Right-of-Way (ROW), including land rights are critical for long-term investment and financing, which needs to be backed by a nimble judicial system along with a land record system that assures transparency and integrity in project contracting. The main assets considered as a security for commercial banks is the project itself (typically land, equipment, and receivables). The project's ownership relies mainly on legal rights over the land and a ROW established for project evacuation, enabling the project company to hold, build and operate the plant and its ancillary assets during the lifetime of the project agreements. Typically, developers assess a country's land tenure system, its ROW procedures, its evacuation systems, and judicial record to evaluate the level of confidence the state provides. If the project cannot be secured in a bankable manner, the project developer will stay shy from investing or it will demand a higher return.

Issue 4 – Lack of bankable studies

Typically, the GoP provides less than ideal, bankable technical studies to project developers for further assessments. A general concern has been a sub-par grid interconnection study provided by the GoP, which results in (i) the developers spending excessive time to get information from the government; and (ii) an incomplete grid integration study that may have been done in the past, but is not relevant today. In either of the two cases, there is a potential risk of curtailment because the project would not have been conceived on sound technical or commercial footing.

Recommendations

- There is a need to provide additional windows of concessional financing, augmenting the already successful SBP Renewable Energy Financing Facility. More funds could be tapped using structured finance products, such as using PCGC or InfraZamin through first-loss guarantee structures or junior equity provisions. These products need to provide as much offtake of concessional financing as possible for small, medium, and large-scale developers to take renewable energy mainstream.
- There is an immediate need for the implementation of competitive bidding for new solar and wind capacity in line with IGCEP requirements of 1,500 MW per year of reverse auctions starting from 2022. The World Bank has highlighted the potential to immediately auction solar energy through an existing utilization of substations, which would be faster to implement and less burdensome on a public agency with minimal project preparations.
- The GST introduced by the previous government was reversed by the new government in 2022. Anomalies in the capital cost structure or tariff structure through sudden imposition of GST can worsen investor confidence and can lead to an increase in cost, posing viability threat to existing projects and hampering NDC target achievements. The GST as well as customs issues must be streamlined.
- There is a need to include the renewable sector as a priority sector for commercial lending such as housing target of 5% of total advances. This would increase the availability of credit and lead to more sustained participation by commercial banks.
- Urban housing projects, such as in Karachi, Lahore, and Islamabad region, must be tied up with a coherent renewable energy policy framework. The mortgage financing of housing markets has picked up with the creation of Naya Pakistan Housing Authority and the Pakistan Mortgage Refinancing Company (PMRC). The GoP can now allow an interest rebate on housing loans if the owner is installing renewable applications such as solar lights, solar water heaters, and PV panels in his house. This will encourage individuals to use renewable energy further. In addition, income tax rebates could be extended to those who install or invest in solar energy products and technologies.
- There is a need to introduce PPP mechanisms, including both Project Development Facilities (PDF) and Viability Gap Funding (VGF) mechanisms. Detailed transaction feasibilities of diverse business models tailored to market needs such as grid-tied modes (Power Purchase Agreements (PPAs), Engineering Procurement Construction (EPC) owned power plants, rentals, and lease models), and off-grid models (such as micro grids, community driven power plants) could be studied and executed in detail.
- Newer climate finance opportunities such as GCF need to be tapped. GCF provides both readiness support as well as project execution in the form of Simplified Approval Processes (SAP) for faster execution and normal funding mechanisms. A dedicated cell at the Ministry of Finance (MoF) in collaboration with the Federal Ministry of Planning and Development and MoE can work together on quality renewable energy, off-grid energy, battery storage and utility scale project proposals where GCF can typically provide concessional financing (first loss, junior equity, sub-debt) with financial institutions contributing the remaining under normal commercial parameters. A concerted effort in mobilizing "blended finance" can go a long way.

Term	Role	Key Action Items
Short-Term	MoE	Accelerate competitive bidding auctions for first set of solar and wind energy projects in line with IGCEP in 2022.
	MoF	Streamline GST and custom duty issues for renewable energy offtake.
Medium-Term	MoF, SBP, Banks and DFIs	Develop structured finance products for renewable energy offtake under concessional financing framework, such as using PCGC or InfraZamin through first-loss guarantee structures or junior equity provisions.
	MoE, MoF, GCF	Identify and work on project readiness facilities for GCF transactions to scale up climate finance potential.
Long-Term	MoE	Formulate and establish a long-term private finance led policy for renewable energy and NDCs implementation.

Project Development Delays

The occurrence of project development delays in construction of renewable energy projects is common in Pakistan which impact investor confidence and increase project development cost. Following are the key issues pertaining to project development delays that a renewable energy developer faces:

Issue 1 – Regulatory approval delays

One of the key challenges includes delays from project approval entities. The delay in project documents approval, such as obtaining Letter of Support (LoS), Letter of Intent (LoI), Generation License (GL), and Tariff issuance leads to unpredictable timelines. A typical project requires several steps including support and authorization letters from multiple agencies including AEDB, NEPRA, provincial governments and NTDC. In the absence of inter-agency coordination, delays can compound. For instance, the first LoI was issued to wind power plants in 2008, but it took four years to commission the first project. Some projects have struggled to receive even the LoI for five to six years.

Issue 2 - Delays in evacuation infrastructure

Another problem is the absence of timely arrangement of evacuation infrastructure. Most of the project developers notice delays in project commissioning due to lags in transmission infrastructure, which affect the viability of the project due to lost revenues. Two issues occur in this regard: i) lack of funds to lay new lines by NTDC; and ii) General project development delays due to inadequate planning.

Although, NTDC is solely responsible to ensure timely evacuation of power from newly-built plants, yet project developers have had to make efforts for timely completion of evacuation milestones out of their own funds. In few instances, project developers paid upfront for the transmission lines with an agreement for cost reimbursement in three years. However, reimbursement was never made on this account. Such ad-hoc planning always discourages utility scale deployment of renewable energy.

Issue 3 - Lack of regulations around innovative technologies

Pakistan needs to develop a set of curated regulation for each up and coming and modern technology. Without a coherent policy and regulation framework, the scale up of such technologies could become a challenge. For instance, new regulations have been formulated for micro-grids, but on-ground implementation has not progressed. Though micro-grid regulations allow tariff negotiations bilaterally, discussions on minimum performance standards, and license requirements require resolution. Further, in case of bagasse generation, the price and quality of bagasse remains a challenge. Generally, the market faces a demand-supply gap, which results in continuous and dramatic increase in prices because the supply is unreliable (as there is no organized market for fuel), with high price fluctuations. Also, the type of input is not the same in all the provinces, therefore, demand and price elasticity is different for each area.

Such on-ground technical and financial issues need to be addressed to ensure that respective technologies flourish under private sector investment model.

Issue 4 - Capacity building

Moving towards CTBCM and auction-based procurements, respective line departments and agencies require capacity building to efficiently execute new procurement regimes. Based on CTBCM, all DISCOs need to establish market interface departments, improve human capabilities, liaise with regulators, and coordinate with market operators for training to equip itself with newer technological models. With limited human, technical and financial capacity at present, the transition to competitive markets could remain a persistent challenge.

Recommendations

- Conducting specific capacity building on fiscal management provisions, CTBCM process changes subsidies, and contract management. Capacity building offers a good opportunity for any government to enhance its knowledge and skills, as well as improve their teams' learning curve. Some of the benefits of conducting capacity building in Pakistan's context are improved governance under contracting framework, improved subsidy management, transition to competitive markets, and an increased number of qualified workers updated on recent technology changes.
- There is a need to foster regular tripartite discussions between CPPA-G, project developers, and distribution companies to address billing delays and evaluate contract management issues. One recommendation is to formulate a strong steering committee that can oversee operational issues with regular monthly meetings. Steering committee recommendations (all operational in nature) can then be taken up by a policy committee (chaired at the ministerial level every two months) to provide policy directions on urgent payment issues and to resolve complex challenges. The role of a policy committee could go beyond operational jurisdiction and may include suggesting policy recommendations to CCOE on outstanding issues. Such a process is vital to ensure that project developers have confidence in policy makers to convene at regular intervals and guide them with a way forward.
- An improved planning architecture is necessary. The funds available with local distributing agencies must be in line with their infrastructure expansion plans, feeding into high level generation planning. IGCEP should not only be a generation planning exercise, but should follow a more rigorous financial planning exercise.

Term	Role	Key Action Items
Short-Term	CPPA (MO), NEPRA	Organize intensive capacity building on fiscal management provisions, CTBCM process changes, subsidies, and contract management for renewable energy projects.
Medium-Term	MoE, NTDC	Develop Minimum Performance Standards (MPS) for deployment of renewable energy technologies.
Long-Term	MoE	Develop a comprehensive policy for domestic manufacturing of renewable energy with emphasis on localization targets.

Market and Infrastructure Barriers

Electricity market of Pakistan comes with certain inherent characteristics that impedes the high penetration of renewables. Key issues pertaining to market and infrastructure barriers to deployment of renewable energy include:

Issues 1: Single buyer, single seller model

Pakistan operates under a single buyer, single seller model where a GoP owned entity, CPPA-G, has the monopoly over electricity trading and is the sole off-taker for all electricity produced. With this model, Pakistan has faced several challenges. For instance, the single buyer model has created a series of unanticipated problems such as excess capacity, high tariffs, and stranded costs. It continues to lack transparency and accountability, and in some cases has exacerbated corruption problems, leading to contract renegotiations. Because of the rigidity in the PPAs, the single buyer has also impeded the development of competition and the evolution of power sector reforms with delays in operationalization of CTBCM. The result is over-reliance on subsidies and a ballooning circular debt, which has resulted in payment delays with dampened investor confidence. Renewable energy development should be seen in this context where market barriers continue to result in lack of a competitive framework for efficient price discovery.

Issue 2: Subsidy and fiscal support

Pakistan continues to provide subsidies to conventional fossil fuel power plants, sending the wrong impression that power from thermal generation is at a higher priority than renewables. Second, the fiscal support to renewables is also not at par with thermal generation. For instance, while Balloki and Haveli Bahadur Shah RLNG plants are examples of GoP's own efforts to build, finance and operate large power plants, there are no real examples to support renewable projects of the same magnitude.

Issue 3 - Inefficient grid

Much of the T&D network in Pakistan, especially in the rural areas, remain overloaded in peak times. In August 2020, the ratio of overloaded transformers reached as high as 60% of all the power transformers, resulting in increased loadshedding and maintenance charges. DISCOs continue to bleed on account of high T&D losses (18.3%: FY2021) and low recoveries (90%: FY2021) (Karandaaz, 2022). Perpetual lack of stability in grid leads to technical problems, especially for distributive energy generators. Large-scale thermal type power plants still have higher capacity to absorb grid fluctuations with their own sub-stations and interconnections at high voltage lines. However, grid fluctuations for small-scale distributive energy generation with limited resources can lead to more equipment failures and tripping issues than large power plants.

Issue 4 - Slow offtake of wheeling

Pakistan has yet to witness full-fledged wheeling business. An indigenous, competitive framework for wheeling, breaking away from the monopolistic single buyer model could help renewable energy development reach its full potential. While GoKP moved forward in their plans for wheeling in 2021, the DISCOs took stay orders from the courts on applicable wheeling charges from NEPRA.

DISCOs have normally argued that their infrastructural investments will remain under-utilized if open access becomes applicable and a considerable number of large well-paying customers jump ship. CPPA-G estimated that a reduction of 1% in sales from its system would have a fiscal impact of Rs. 14 billion. On the other hand, NEPRA maintained that the wheeling charges suggested by DISCOs (Rs. 8 per unit) is at the higher end and has now recommended wheeling to be amalgamated with the operationalization of CTBCM. In any case, it is imperative that guiding principles are followed to enable an open access regime, with wheeling as a natural conduit for renewable power generation.

Issue 5 - Slow offtake of net-metering

Though Pakistan has been an early mover in the net-metering space, it has faced multiple obstacles in the path of implementing net-metered solar and wind systems. The major barriers include discouragement by DISCOs based on the fears of revenue losses, technical capability at different organizational levels of the utilities which continues to remain weak, lack of awareness among stakeholders, including the public, high upfront cost of net-metering, and inadequate access to tailored finance options, such as through commercial banks. Net-metering has the potential to quickly ramp up solar PV potential, ease the grid with excess load burden and provide opportunities to add incremental power back to the grid, essentially curtailing the need to spend on expensive imported fuel.

Issue 6 - Rural off-grid solar interventions have low quality

Lack of standards for Solar Home Systems (SHS) has led to establishment of low-quality solar systems in rural areas. For instance, in the merged areas of KP, the supply chain for solar PV remains overwhelmed with low quality panels and poorly designed systems. They average life of these systems is 4-5 years as opposed to high-quality systems with more than 20 years life. Similarly, some of the programs by the public sector have witnessed a similar fate. For example, AEDB initiated a rural electrification programme in 2005 to provide over 7,000 villages in Sindh and Balochistan with electricity by deploying SHS. Project evaluation in 2011-12 revealed that most systems were not operational as the batteries had become obsolete or a project component was not functional.

Issue 7 - Lack of local manufacturing industry

For solar and wind developers, most of the mechanical and electrical equipment's are imported. For wind developers, the O&M component is also outsourced to international contractors, which inflate project cost. The import component typically runs end to end in Pakistan and needs localization, from doing project R&D, to design and manufacturing of turbines and PV panels; generators and excitation; other hydro-mechanical components (e.g., valves, penstocks); electrical components (e.g., transformers, power, electronics, etc.); governor and control systems, quality assurance, and bulk of the O&M (outsourced as foreign O&M). It is imperative that for any future renewable energy offtake, commitment to the domestic industry must be provided.

Recommendations

- There is a need for transition to competitive markets with an unequivocal support from the Federal Government to lead the transition. The operational date of 1 December 2022 set by NEPRA for CTBCM must be adhered to in letter and spirit. Along with this, institutional capacities must be strengthened to ensure the transition remains seamless. Eventually, markets will reward innovation — the search for and discovery of price, development, adoption, and commercialization of new products, services, organizational structures, processes, and procedures—that meets market demand to originate from the CTBCM model.
- The GoP must strengthen new transmission and distribution infrastructure by funding improvement expenditures. Transmission developments have not kept pace with power generation and investment and project execution lags exist. There is a need to improve coordination between the MoE and NTDCL to make evacuation plans and ensure that wind and solar projects have requisite evacuation facilities available in line with IGCEP implementation. The solution is to develop numerous sub-stations and transmission lines, which requires holistic stakeholder engagement and robust planning. Also, through this, the "must run" status of renewable energy projects is not compromised, thereby eliminating the effects of curtailment on project profitability.
- The NTDCL needs to identify transmission needs both in and outside of their service territories that will affect electric service for upcoming projects. The GoP should take a stock of project execution under the ambit of CCOE requesting distribution companies and CPPA to assess available transmission inadequacies that can affect upcoming projects. The scope of these efforts should be beyond provincial boundaries and must be action oriented.
- The GoP must move forward on wheeling on principled basis. Simple principles of open access can be forged through consensus which can then decide the pricing regime. Simple principles may include, for instance, the following: i) wheeling transactions should include technical but not commercial losses; ii) all commercial losses must be minimized before the start of a wheeling regime; iii) actual fees for losses should be distributed to all load and not only to the wheeling contract; and iv) incentives produced by the wheeling should promote reliable operations of the electricity network with economic efficiency. Any methodology adapted by the government should be backed with evidence with an emphasis to forge consensus. Any methodology adopted should be understandable, transparent, and replicable.
- To make effective use of infrastructure and land resources, Pakistan must focus on hybridization of renewable projects. For instance, policymakers should consider battery storage in hybrid projects, which support optimizing production, power at competitive prices, and decrease variability. A key start could be formulation of mandatory standards and regulations for hybrid systems (such as wind-solar hybrid framework or hydel-solar framework). Selective fiscal and financial incentives can be created for offtake of hybrid projects for demonstration and then wider offtake.
- There is a need for GoP to carve out its areas of focus. Amongst the low hanging fruits, net-metering is one. Net-metering proliferation requires more than objective setting by the government. Instead, a clear comprehensive implementation plan is required that covers policies with clear actionable targets and way forward. In addition, regulations on new technological developments or operational areas of focus (such as in the case of Bagasse generation or micro-grid regulations) must be acted quickly to stay in line with technological developments and operational realities.

- For off-grid financing, the GoP must contribute an additional budgetary allocation in the clean energy sector. Today, bulk of the subsidy quantum in the power sector is under the Tariff Differential Subsidies (TDS), which inherently provide subsidies to fossil powered generation plants tied with large grid connected power generation. Pakistan needs to remodel its subsidy regime to better suit renewable energy offtake. In its current form, consumer subsidies in the form of TDS, have proved less efficient than producer subsidies as the former is poorly targeted given their much wider scope. They also tend to benefit high-income households disproportionately. There is a need to incorporate a small, renewable energy subsidy, mainly for distributive power generation. Such a subsidy could be routed to fund off-grid solar energy requirements in Merged Areas (MA) and Balochistan where grid access is intermittent or where grid construction is both financially and economically unviable.
- Pakistan should aim to move to domestic manufacturing. To augment domestic manufacturing, the state needs to provide a "safeguard duty," which could extend up to five years to compete with Chinese imports. Foreign investors desiring to set up joint ventures in Pakistan have stayed away as the country continues to lack technical skills, safeguard policies, and R&D to spur the domestic renewable energy industry. A first step could be a comprehensive policy for solar and wind domestic manufacturing launched with an aim to support cost reductions in the long-term. In the medium-term, focus could be built to augment capacities for operations and maintenance regimes, which are consistently outsources to foreign O&M contractors.

Term	Role	Key Action Items
Short-Term	NTDC, MoE	Coordinate action plans to ensure that evacuation plans for wind and solar energy are on track for timely execution.
Medium-Term	CPPA, NEPRA	Expand CTBCM to allow participation of consumers of less than 10MW to participate in open access market.
	MoE, NEPRA	Devise a clear methodology for use of system charges under wheeling regulations. Encourage bilateral contracting, first at a demonstration level and then at a scale up.
	AEDB, NEPRA, NTDC	Establish policy framework and performance standards for new technologies in renewable energy, in particular battery storage and hybridization projects.
	MoE, AEDB	Develop and launch "Net-Metering Policy", implementation plan and targets.
Long-Term	MoE, NEPRA	Expand electricity markets to a retail level with an open access regime for less than 1MW participation.
	MoF, MoE	Reform current budgetary supported subsidies to project and end user-oriented subsidies with evidence-based targeting. Set yearly targets for quantum of subsidies towards fossil fuel versus renewable energy.
	MoE	Develop long-term renewables-based climate adaptation and mitigation plans. Continue to evaluate renewable energy's impact with a social, environmental, and institutional focus.

Section III

Socio-economic Impact of Renewable Energy Facilities

Socio-economic Impact of Clean Energy Power Plants on Local Communities

Socio-economic Impacts of Wind Farm Development – A Case for Jhimpir-Gharo Region in Pakistan

Global research shows positive externalities of wind plants on the surrounding communities, mainly through jobs for rural communities in manufacturing, transportation, and project construction. Globally, the sector employment reached a new high of more than 116,800 full-time workers at the end of 2020 (DoE, n.d.). Similarly, the GoP could leverage socio-economic growth by tapping the vast wind energy market for increased income, improved trade, job creation, infrastructure, and industrial development.

This case study - first of its kind in Pakistan - aims to assess the socio-economic impacts of wind power plants on the community as well as stakeholder perceptions associated with wind power development in the country. The study included field surveys and interviews with local communities of Jhimpir and Gharo wind farms in Sindh. Cross-sectional research design was used to collect information by a structured questionnaire and Key Informant Interviews (KIIs). The study conducted 42 Household (HH) Surveys with community individuals.

BOX 6 | Jhimpir Gharo Snapshot

Jhimpir and Gharo are situated in southern region of Sindh province. Gharo is situated on the coastline, and hence, the economy is mostly based on fishing followed by agriculture. Located in Thatta district, Gharo houses more than 2,000 families, while Jhimpir is more developed with access to the power distribution network of HESCO. The entire area from Gharo to Jhimpir is dry, with small patches of land used for agriculture. Scattered human settlements can be found in the outskirts of cities.

The Jhimpir-Gharo wind corridor is the only wind corridor in Pakistan that has been assessed by international agencies, including the National Renewable Energy Laboratory (NREL) and USAID. The 180km long and 65km wide corridor stretches from Gharo to Jamshoro can accommodate wind power plants with a combined capacity of approximately 50 GW. The high potential of this region is due to its topography, which creates a natural belly in between two points along with temperature difference so as to create a natural average wind flow of 7-8 m/s through the corridor. Currently, 24 wind plants are operating in the region, with a combined capacity of 1,235 MW that accounts for all the wind power production of Pakistan.

Results and Discussions

The study is focused on evaluating impact across seven key areas i.e. i) Access to electricity; ii) Economic activities; iii) Employment; iv) Access to water; v) Social impact; vi) Health and education; vii) Environment and biodiversity. Overall, the findings revealed that the impact of wind generators in the Gharo-Jhimpir corridor is positive on the regional community, sans few concerns regarding the impact on bird habitats and social conflicts.

Results of the survey are shown in Figure 25.

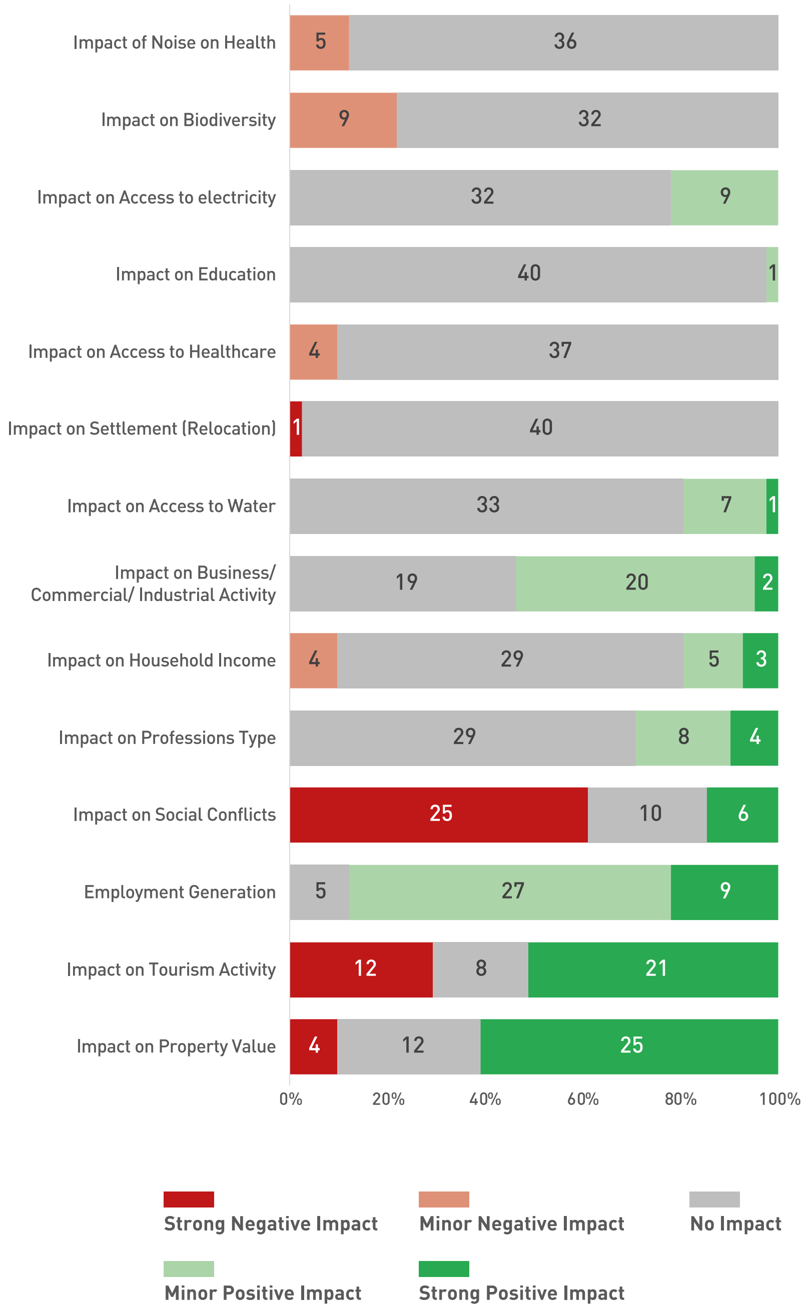


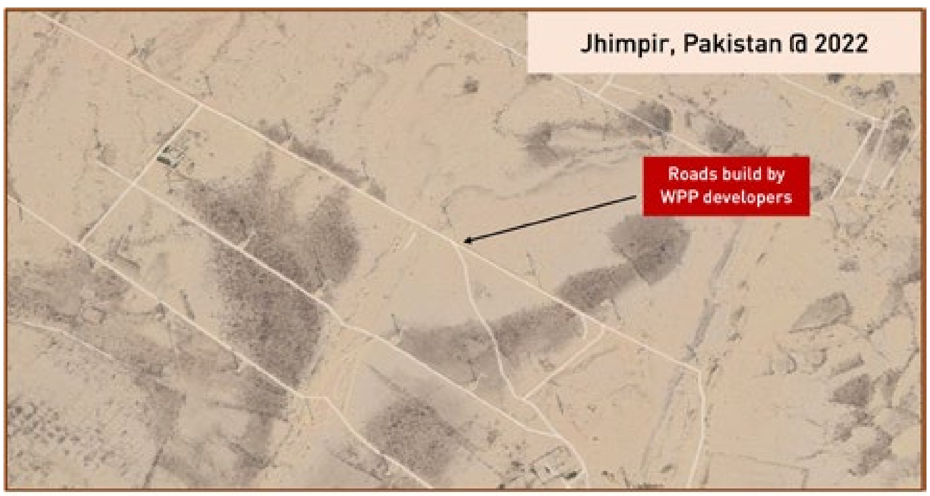
Figure 25: Wind Farms Survey Results

Key Insights

Wind power plants' social and economic development provided that the project follows the approach of "localness'' and "inclusiveness" during construction, operation, and decommissioning stage. Following are the key insights stemming from survey results along with stakeholder consultations, including the developers of these projects:

1. Infrastructure development is a direct outcome of a wind power project.

Development of wind farms is complemented by other infrastructure development, including road and water networks. Wind farms in rural areas are accompanied by road infrastructure due to logistical requirements of transporting large blades of WTGs to the site, as shown in Figure 26. Similarly, wind power plants in Jhimpir-Gharo region are complemented by road networks within the farm that have been built by developers. The robust network of paved and un-paved roads leads to increase in access to major highways for the local rural population which historically had much limited or no access to these highways. As shown in the figure, the robust road infrastructure was developed



because of Zorlu Wind Energy project in Jhimpir-Gharo. Similarly, development of water infrastructure was also observed as a direct result of wind farm construction. A water line was built along the bank of highways for WPPs, which also served the purpose of providing water to remote communities.

2. Wind farms enhance economic growth and change the economic structure of the region

WPPs not only enhance overall economic growth, but also change the economic structure of the region through new employment opportunities, new infrastructure development, new technical and education centers. Global energy transition could increase the global GDP by USD 2 trillion, as compared to business-as-usual scenarios - employing approximately three million people by 2050 (KPMG, 2019). Similarly, 49% of respondents witnessed a positive impact of wind power plants on economic activities in the region, which can be attributed to:

- Tourism: Many of the tourist spots, like in Keenjhar Lake in Jhimpir came into the limelight post-wind power project construction. This is significant in the backdrop of current efforts towards making tourism an important part of the local economy in Pakistan. Survey findings revealed that half of the respondents were of the view that tourism activities had increased post-WPPs construction.

- Value of Land Assets: Wind farm construction increase the land value of areas surroundings the projects, attributed to complementary infrastructure that accompanies WPPs like road networks, highways construction, and water supply, among others. 61% of the respondents shared that land value had increased due to WPP construction in the area.

- New employment opportunities: IRENA's Leveraging Local Capacity series estimates a 500-megawatt offshore wind farm requires around 2.1-million-person days of work (KPMG, 2019). Similar trend has been noted in Pakistan, where many people were employed during wind power plant development and construction, including local construction services and companies from outside the community. Each wind farm construction results in employment for thousands of people. They are employed for construction activities. It was found that during the operation phase, most people were employed as security guards, which is the most common position available for unskilled labor.

- Increased Income: The household income level was reported as unchanged by respondents. This is largely because most of the job opportunities are created during the construction stage of wind power plants. However, a few respondents shared that the household income level had increased during operational stage of wind power plants as well. Regarding skilled labour, local community lacked the skills to be employed for on-site skilled positions. However, some WPPs like FFC had taken the initiative of developing a Technical and Vocational Center to train educated individuals in the community about the operation of wind power plants. The success of the Center was evident, whereby many individuals from cities near Jhimpir WPPs were trained, and are now working on different WPPs in the region. Such an activity could further be expanded by nurturing partnerships with the government, NGOs and CSOs to increase skilled labor and generate employment opportunities.

3. Public sector development is a key requirement for obtaining maximum benefit from CSR initiatives of WPPs

To fully benefit from CSR activities of wind farms, it must be complementary to public sector development in the region. Stand-alone CSR efforts will always be inadequate. Similar scenario was observed in Jhimpir-Gharo region lacking basic facilities in health and education sector. Daily wages reported as low as Rs 100 per day, which is not enough to even feed an average family of six with one meal. Basic Health Units (BHUs) were mostly non-operational, and the Rural Health Centers (RHCs) did not have adequate medical equipment. People travel to Nooriabad, Karachi, Thatta, or Hyderabad in case of emergencies. Wind power plant's CSR activities to improve health facilities in the region included provision of medical equipment, ambulances, and skilled doctors. Even though these steps had been taken by developers, the impact on healthcare remained minor or unchanged. 90% of the respondents shared that investment in WPPs had had no impact on health, while 10% witnessed minor positive impact on health facilities. In the absence of basic health infrastructure, these complementing activities have only limited impact.

Similarly, only one respondent observed minor impact on education level of the community. This is due to lack of basic educational institutes in the region. Some of the wind farms had refurbished/constructed new primary energy schools, but such initiatives are not enough to have sufficient impact. This needs public sector interventions to provide basic educational infrastructure, which may then be complemented by CSR activities.

4. Negative impact of WPPs on biodiversity is limited

Wind farms may still have an impact on biodiversity, particularly birds. Globally, the industry is engaged in initiatives to address these concerns. The wind farms in Jhimpir-Gharo region were developed after a comprehensive study on bird habitats in the region. The study found that WTGs are not placed in migration routes of birds. Yet few respondents observed negative impact of these farms on bird populations pointing out instance of bird collisions, changes in migratory patterns, and overall decline in population of bird species in the region.

5. Gender mainstreaming through WPPs is conditional to security situations of the region

Renewable energy addresses gender equality by employing relatively more women than other industrial sectors, most of them are highly qualified jobs.

Research reveals that while the global share of women in the energy sector is 22%, it is significantly higher - 32% in the renewables sector. However, the involvement of women in WPPs in Jhimpir-Gharo region is limited and conditional to social values and security situation of the region. Presence of high criminal activities and lack of security personnel and their limited response; all leads to limited involvement of women in wind power plants O&M.

6. Exploration of community-based models is the key to untapping further benefits.

The distributive nature of renewable energy has some intrinsic benefits such as increased access to electricity. Small wind turbines could generate electricity for lighting and powering appliances for cooling, processing for commercial and industrial enterprises. However, these benefits could not be achieved in Jhimpir-Gharo due to integration of wind farms with the national grid only. This is the reason that even some of the settlements and dwellings situated within the wind farm boundary had no access to electricity. This is due to lack of adequate transmission and distribution infrastructure to provide reliable grid supply to all settlements. 78% of the respondents observed that construction of wind power plants in their vicinity had no impact on access to electricity on the local population. About 22% were of the view that there was minor increase in access to electricity. This is due to the CSR initiatives where many WPPs have been involved in distributing low cost or free SHS to different households.

Conclusion

Overall, the key takeaways from survey findings include:

- Increase in economic activities and employment generation are two major benefits of WPPs and hence, further development of farms along the corridor could be leveraged to increase employment in the communities and spur economic activities.
- Fossil fuel power plants, including coal power plants, emit particulate-matter and emissions which adversely impact the health of surrounding communities as well as biodiversity. No such negative externality is accompanied by WPPs development.
- Initiatives by developers for the socio-economic uplift resulted in positive impact on the communities. However, they remain inadequate if the basic infrastructure remains weak and dilapidated.
- Wind power plants occupy a small, covered area and have large plant area. So, crops can be grown, and livestock can be grazed close to the base of the turbine offering rural landowners a new cash crop.

There is a need for robust policy framework for wind power projects, and since already developed projects have proven dependable, investing in renewables is set to become more attractive and the market is likely to pick-up. The manufacturing industry of wind power plants needs to be indigenized by local production so that value can be created in several segments of the value chain, including manufacturing (and the accompanying needed R&D) and installation. Moreover, with the strengthening of local capabilities, more activities, such as project planning, should be undertaken by local suppliers. As installations increase, more O&M activities may be needed, which will increase the potential of value creation. Therefore, all these opportunities must be tapped to fully realize the potential for WPP and leverage it for socio-economic uplift of marginalized communities.

Socio-economic Impacts of Community-Driven Micro Hydel Power Plants on the Local Communities – A Case for KP and Gilgit-Baltistan Region of Pakistan

Micro-Hydro Power Plants (MHPPs) are considered the most feasible decentralized renewable energy option for providing reliable and affordable electricity to remote and isolated Northern areas of Pakistan. Unlike solar and wind energy, the country has substantially tapped its hydro potential, which accounts for 24% of total capacity. Yet, there are still several MHPP sites in northern regions that could be tapped for clean energy.

BOX 7 | Large Vs Small Hydro

Large-scale hydro projects have almost no fossil fuel emissions, but they do have other negative impacts such as biodiversity loss, carbon footprint of materials, and social displacement. On the contrary, MHPPs have minimal impact on these factors, resulting in net-positive externalities for the population.

This case study is focused on assessing the social impact created by MHPPs in northern regions of Khyber Pakhtunkhwa and Gilgit-Baltistan. Cross-sectional research design was used to collect information by a structured questionnaire and Key Informant Interviews (KIIs). The study conducted 101 Household (HH) surveys within local communities of Hunza, Chitral, Nagar, Dir, and Skardu.

BOX 8 | Micro Hydel Snapshot in Paksitan

The northern mountainous regions of Khyber Pakhtunkhwa and Gilgit-Baltistan have large potential for MHPPs. Coincidentally, these areas have little penetration of the national grid, while most of the areas remain unelectrified and poverty-stricken. Most of the MHPPs installed in these regions have been financed by MDBs and non-profit organizations. Currently, there are 372 MHPPs in Khyber Pakhtunkhwa, with a combined capacity of 53.14 MW. Mansehra and Chitral have the largest number i.e., 90 and 81, respectively. Most MHPPs are constructed in collaboration with the Aga Khan Rural Support Programme (AKRSP), Khyber Pakhtunkhwa Energy Development Organization (PEDO), Pakistan Poverty Alleviation Fund (PPAF), and Sarhad Rural Support Program (SRSP). These HPPs are run on three modes:

i) Community-driven: Community members operate the power plants, which are mostly funded by SRSP, PPAF, or AKRSP.

ii) Public Sector Organization (PEDO/WAPDA)-driven: Operated by the skilled labor force of the public sector entity, i.e. PEDO or WAPDA

iii) Hybrid Mode: PEDO/WAPDA operates the plant for a limited period along with community members for training purpose, followed by control completely transferred to the community for operation and maintenance.

Results and Discussions

The study mainly evaluates the impact across 7 key areas, which are: i) Access to electricity; ii) Economic activities; iii) Employment; iv) Access to water; v) Social impact; vi) Health and education; and viii) Environment and biodiversity. Additionally, it also evaluates the benefits across different operating models of MHPPs.

Results of the survey are shown in Figure 27.

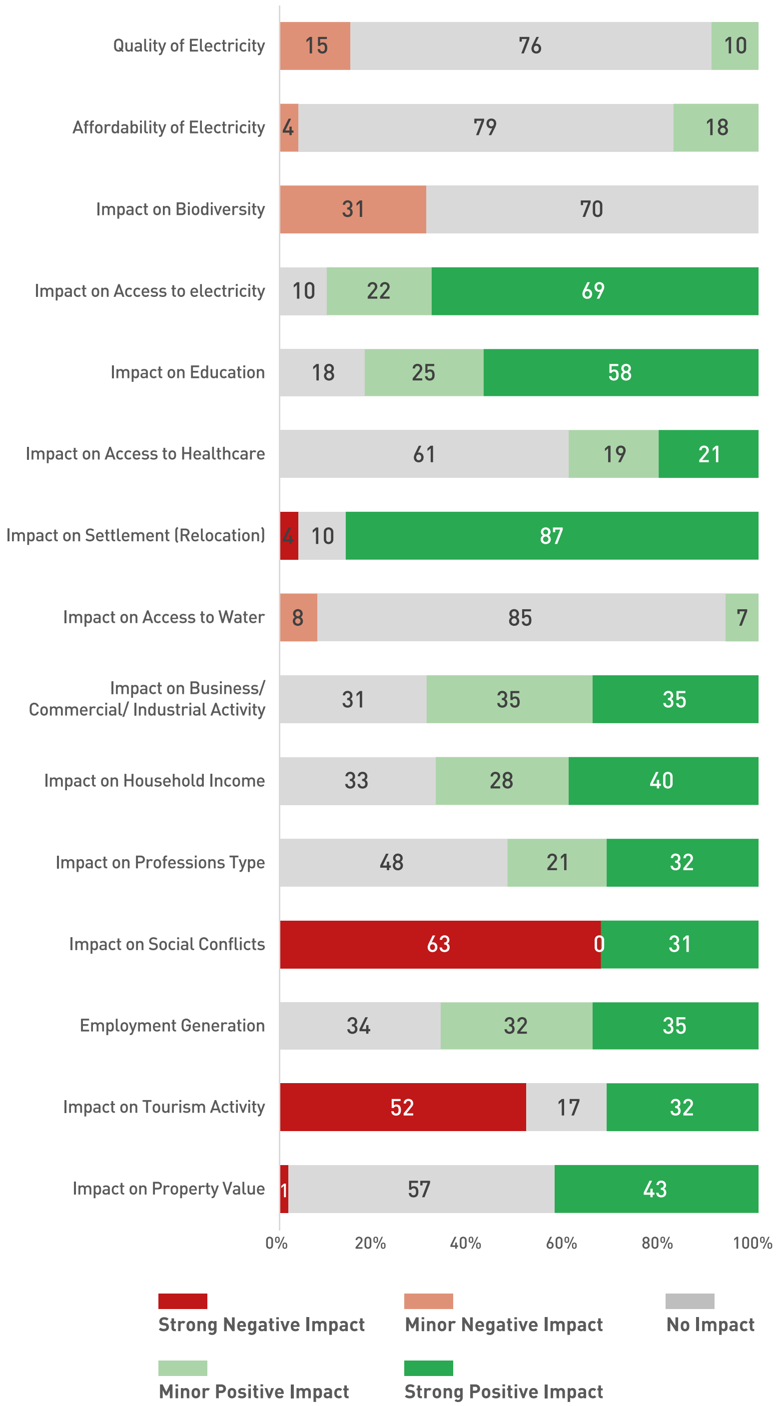


Figure 27: Micro Hydel Power Plants Survey Results

Key Insights

Following are the key insights stemming from survey results along with stakeholder consultations:

1. **MHPPs increase access to electricity for local communities with trickling benefits on the education and health sector.**

   MHPPs have direct impact on access to electricity for surrounding communities. Areas that were previously unelectrified due to high cost for laying transmission lines, are able to utilize local resources to generate electricity. 91% of respondents witnessed increased access to electricity after installations of MHPPs in their regions. Most of the MHPPs were providing free electricity to schools and hospitals. This had a direct impact on the health and education sector of the community.

- Overall, 40% respondents observed improved healthcare due to MHPPs. Many hospitals procured new equipment and machines like X-ray machine, CBC testing machine, etc. that were previously unavailable due to shortage of electricity.
- Schools were able to procure computers and other equipment. Children now had access to educational content from watching television and were able to study at night. 58% of the respondents believed that there was significant increase in education level of the community, while 25% respondents witnessed minor increase.

2. **MHPPs have limited social and environmental impact as opposed to large hydel power projects.**

   MHPPs have very minimal negative social and environment impact as compared to large-scale hydropower projects compounded by issues like land-use, displacement, degradation of wildlife habitat and high lifecycle emissions. Following are the key differences in the impact of large hydro and MHPPs:

- Population Displacement: Large hydel requires large land area per unit energy of energy produced, as compared to MHPP. For instance, the large Balbina hydroelectric plant in Brazil utilizes more than 2,000 acres per MW of energy production. In contrast, a small run-of-the-rivers plant in a hilly location can use as little as 0.25 acre per MW (UCSA, 2013). In many instances, such as the Three Gorges Dam in China, entire communities had to be relocated to make way for the reservoir. The impact for MHPPs in Pakistan is minimal - 96% of the respondents witnessed no relocation of locals from MHPP construction. Few respondents pointed out that 8-9 households had to relocate due to safety risk associated with construction of MHPPs. At several sites, the compensation for land use was given through provision of free electricity.

- Land Use: Flooding land for large hydel reservoir not only displaces people, but also impacts their income sources by destroying forests, wildlife habitat, and agricultural land. On the contrary, small hydro run-off-river instead increase water availability for irrigation as pointed out by 7% of respondents.

- Social Conflicts: 67% of respondents observed no social conflicts in the communities due to MHPP, something observed quite frequently with large hydel - fueled by land displacement disputes. However, 33% observed social conflicts arising due to inequitable distribution of electricity and MHPP associated job opportunities. Conflicts also flare up due to land ownership disputes. However, majority of the respondents noticed that they were adequately compensated for their lands.

- Biodiversity: The MHPPs have minimal impact on the environment and biodiversity of the region as opposed to large hydel with significant impact on local habitats. 15% respondents witnessed a decrease in the bird population after construction of the MHPP. This could be attributed to transmission networks as birds collide with power lines. The impact on fisheries was largely positive with 8% respondents pointing out increase in the fish population (Figure 28).

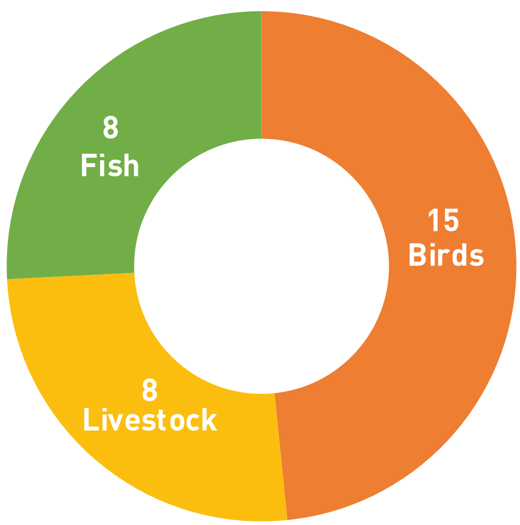


Figure 28: Micro Hydel Survey: Impact on Biodiversity

3. **Community driven MHPPs bring high skills jobs.**

   Many people are employed during MHPPs development and construction, including local construction services and companies. The MHPPs running on community-driven modes offer additional direct job opportunities for community members for operating a power plant. For a 50kW system, two people are employed for each shift, with a total of three shifts for each power plant. For a 500-kW system, 3-4 community members are employed for each shift. 37% of respondents noted major positive impact on their professions due to construction activities of these MHPPs, while 25% witnessed a 'Minor Impact'. Moreover, the construction and relevant employment opportunities also increase the household income level of community members, as noted by 69% of respondents.

4. **Economic development is a direct outcome of MHPPs.**

   Development of MHPPs spur economic development in the region. In survey areas, most community members were engaged as MHPP workers; engaged in businesses; labour; private and public sector jobs. 69% of the respondents observed that construction MHPPs had resulted in increased commercial/industrial activity. New flour mills had opened after the provision of reliable electricity. Other developments that followed included new telecom centers, schools, hospitals, and hotels.

   The availability of electricity has attracted tourists as hotels and guest houses have electricity, with the associated amenities. Among the respondents, 38% witnessed increase in tourism after construction of MHPPs. This, in turn, resulted in higher land prices. 48% of the respondents witnessed increase in property value.

5. **Key impediments to proliferation of MHPPs**

   The off-grid MHPPs, although with largely positive impact, face several challenges during construction and operation, as opposed to grid-based electricity. Following challenges pertaining to construction and maintenance were pointed out by the respondents:

- *Transport & Logistics:* Lack of adequate infrastructure and supply chain is the major challenge for construction and maintenance of the MHPPs. In case of malfunction, many sites must wait for relevant people from public sector departments concerned. Meanwhile, the community has no alternate source of electricity. At some sites, the mechanics were brought from far-off areas due to lack of skilled workforce in the local community. Lastly, the northern regions are prone to snowfall, glaciers and flooding which lead to difficulties in the transportation of equipment and workforce.

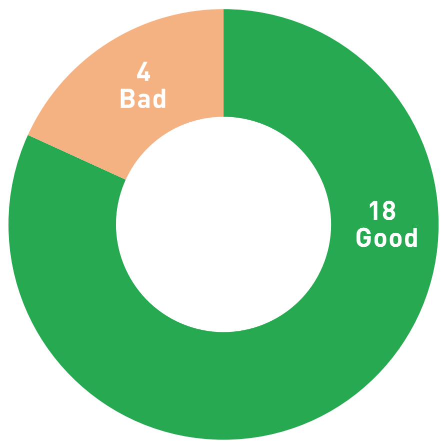
- *High Cost:* The excessive cost of construction and operation remains a key challenge. This is the major reason for lack of private sector participation in these MHPPs, as they are mostly dependent on Non-Profit, and CSOs, backed by international donors. Many plants require overhauling and renovation but lack the funds to undertake such ventures.

- *Technical Feasibility / Complexities:* Another challenge identified by the respondents were technical ones linked to plant design and construction. For instance, in Mardan and Swat districts, there were issues with the turbines, which incur an increase in their maintenance cost. Detailed analysis showed faulty bearings as key reason for these issues.

- *Electrical Safety:* Electrical safety issues were pointed out by 6% respondents as another challenge to the maintenance and operations of MHPPs. There were risks of electrocution from electricity lines coming from the powerhouse.

How would you compare the quality of electricity supply (Voltage) from community- driven plants vs. government supplied power?

Figure 29: Micro Hydel Survey: Quality of Electricity



How would you compare the cost of electricity supply from community-driven plants vs. government supplied power?

Figure 30: Micro Hydel Survey: Cost of Electricity

- *Lack of HR:* Lack of adequate Human Resource was also a major hurdle as community members usually do not have sufficient education to run the plants. Therefore, the community-driven plants followed a training mode where an off-site expert is placed with a community member teaching him/her how to operate these plants. After completion of training (usually 1 -2 years), the control of MHPPs is completely transferred to the local community members.

- *Quality of Electricity Supply:* The quality of the electricity supply from the plants is a concern especially when compared to the national grid (where available). 60% of respondents reported quality issues such as voltage fluctuations (Figure 29). However, in some regions, the impact of MHPP on quality of electricity was found to be positive.

- *Cost of Electricity:* 82% of the respondents shared that the cost of electricity was lower from MHPPs as compared to PESCO bills (wherever grid was available) (Figure 30). It is pertinent to mention that cost of electricity varied from plant to plant and different modes of operation. Community-driven plants only recovered maintenance cost from the local communities.

Conclusion

The study finds that MHPP has a net positive impact on the surrounding communities, and certain levers accompanying investment in renewables sector could be leveraged for their development. Increase in economic activities, employment generation, access to electricity, and access to education are core areas with huge positive impact. Few factors leading to accelerated deployment of MHPPs in Pakistan include:

- Creating a sense of ownership, through community-driven plants, is the only way that these projects will become success stories. Contribution of the community through 'sweat equity,' could be leveraged to ensure inclusiveness and localization of these MHPPs.
- A lot of estimates have been made regarding the hydel potential of northern regions of Pakistan, but no such study has been performed on identifying the actual sites for MHPPs in the region – like WBG effort for solar and wind zones mapping through VRE locational study. A similar study, coupled with a rural electrification map of the region, focusing on community driven off-grid MHPPs could pave way for accelerated deployment of MHPPs in Pakistan.
- MHPPs are currently funded by donors and although appreciable, long-term sustainability can only come through private (corporate) sector participation. Introducing policies that provide an enabling environment to the private sector, through innovative models to fund and operate MHPPs, need to be developed and implemented.
- Given the large number of MHPPs, it would be pertinent to initiate program activities by MDBs and the provincial government to localize the manufacturing and supply chain of equipment for these plants. Several workshops in the region could be built with capacity to maintain and repair equipment. Similarly, local skilling centers need to be established to make community self-sustaining to operate MHPPs.
- The distribution network of TESCO and WAPDA in the northern regions demonstrate sub-standard quality due to voltage related issues. There needs to be a 'Grid Resiliency' and 'Power Infrastructure Development Plan' that sets standards for grid resiliency and reliability.

Key Takeaways

This section summarizes the contents of this report and provides an overview of the policy framework to support the integration of renewable energy in Pakistan's context. Pointing out various challenges facing renewable energy development, the report discusses three takeaways to derive investment and funding, including showcasing best practices on renewable energy deployment.

1. Investment mobilization

Pakistan requires a substantial increase in investments to accelerate renewable energy transition. Policy support and institutional coordination will be crucial to mobilize capital towards sustainable solutions. In the run-up to NDCs targets for 2030, Pakistan requires investment to see significant transition. Solar PV is a good example, as it will be a key to Pakistan's short-term energy transition. The recent announcement by the Prime Minister to install 10,000 MW of solar power plant will require an investment of around $5 billion. Investments in enabling infrastructure, such as transmission, will also be crucial, as planning process, siting and construction take time, especially for large projects. According to the NDCs, Pakistan's cost of energy transition alone would require $101 billion by 2030, and additional $65 billion by 2040, on account of completing the in-progress renewable energy projects, additional hydropower, transmission, and phasing out of coal and replacing with hydropower.

Attracting foreign private investment is crucial. Considering the large investment effort, leveraging FDI in Pakistan's greenfield projects is crucial across all value chains, in generation, transmission and distribution. For this to happen, current investment contracts must be adhered to, both in letter and spirit. Signing PPAs first and then reneging them later will only dampen investor sentiment. If a project is unviable from commercial and value for money standpoint, it should be ruled out upfront and not later.

The single buyer model will only worsen investment flows. Pakistan's adherence to single buyer, single seller model has only negatively impacted investment flows. Under the model, weak (and bankrupt) T&D companies have only survived on the back of sovereign support. System reliability has deteriorated substantially. Major systems have collapsed several times, and grid in its current shape will fail to bear the burden of current and future calamities, such as the super floods of 2022. The effect of years of poor planning and underinvestment is compounded by poor system expansion planning and weak project execution. As the demand increases with rising population, weaker parts will only fail with increasing frequency. Such an environment is not ideal for renewable energy development and must be course corrected. In effect, the transition to competitive markets and the GoP's own role as a single offtake needs to change. Private parties need to contract power bilaterally with open access becoming a norm than an exception. Open access will lead to price discovery, system efficiency and contract enforcements, leading to higher investment potential. In Pakistan, the telecom sector has already offered a template – multiple companies in wire and carriage business, backed by an open access regime and a sound regulator to oversee private operations. This template can be replicated in the power sector as well.

Leveraging public finance through blended finance will remain the key. Today, Pakistan has an enabling framework where blended finance can flourish. Institutions such as Karandaaz, InfraZamin and Pakistan Credit Guarantee Company Limited did not exist in the local landscape before but can now mobilize support through investment and risk mitigation instruments such as guarantees and blended finance. Pakistan's own share of public resources available to invest in renewable energy will remain limited and more often be constrained to address socio-economic challenges, already exacerbated by the current super floods. However, targeted public investments through structured finance products, blended finance and actively working on project readiness support will open access to capital.

Tapping into climate finance opportunities through Green Climate Fund will improve access to investment flows. The Paris Agreement of 2015 was a landmark deal that changed the overall climate financing landscape for the countries like Pakistan. Funds are now available for the countries which can procure it competitively, based on robust project feasibilities, technical assessments, and scientific studies. Pakistan has been slow to tap into the GCF, with the approval of only four projects up till now with a total funding commitment of $131 million. Nonetheless, the potential to scale financing from GCF remains huge and will require Pakistan to establish a new institutional framework, transcending provincial boundaries and creating a robust project pipeline.

2. Policy Framework

A robust policy framework is required for enhanced renewable energy deployment. Despite remarkable global progress in advancing renewables, Pakistan's full potential in renewable energy deployment is yet to be realized. In Pakistan, several key barriers (discussed above) hamper renewable energy's deployment and to this extent, policymakers within the Ministry of Energy can facilitate the energy transition by focusing on policies to address them.

Fiscal and market framework for renewable energy deployment is required to support market creation of renewable energy products. These typically include fiscal and financial incentives (such as State Bank's renewable energy financing scheme) and regulatory and pricing policies (up-front tariffs, etc.).

However, more needs to be done to consolidate the fiscal incentive framework for renewable energy deployment. These may include the GoP's concessional finance framework with targeted incentives (tax breaks, upfront subsidies, guarantee support, concessional finance, etc.) to ensure that renewable energy deployment gets its due priority.

Integrating policies is key for sustained deployment There are several policies that work and exist in isolation and where there is a demonstrable need to update and integrate different policies. Renewable energy deployment, for instance, is related to infrastructure bottlenecks, particularly transmission, and now requires a combined policy framework. This will ensure deployment of resources in efficient manner with sustained system reliability. Other examples where policy integration is required include heating and cooling products, net-metering and off-grid solar products and deployment.

Policies to support a just and inclusive transition has become critical. Social recognition of renewable energy is still not very promising in urban Pakistan. Awareness is the crucial factor for the uniform and broad use of renewable energy. Information about renewable technology and their environmental benefits need to reach society and how it can help them achieve climate goals. Apart from urban areas, the GoP should organize regular awareness programmes, especially in villages and remote locations with particular emphasis on off-grid areas on the benefits of renewable energy deployment. Sufficient agencies should be available for off-grid support to sell renewable products and serve for technical support during installation and maintenance.

Localization of renewable energy component is critical for widespread deployment. Solar and wind supply chain in Pakistan is imports-dependent, i.e. roughly half the solar equipment and almost all major components of wind turbines are imported. Additionally, the O&M for wind farms is also outsourced to international O&M providers and technical experts. This directly impacts the cost of the overall projects, increases probability of global supply chain disruptions, intensifies import bill impact on the national economy, and is a missed opportunity for employment generation for high skilled jobs. More needs to be done to ensure that Pakistan has a robust localization action plan with clear targets.

3.Best practices for RE deployment

There is a need to follow best practices for renewable energy deployment.

Globally energy transition has taken-off with renewables being deployed at record rate for power generation in the last six years. Even in Pakistan, tariffs for new solar and wind power plants are lower than the basket price of the system. It is time for policymakers to follow best practices to accelerate energy transition.

Investing in project readiness efforts always pay and Pakistan must invest in broad-based readiness activities. Pakistan's PPP regime has allowed project readiness activities using development partner's grant money from investment in Project Development Financing (PDF) to augment project concept notes into full-fledged technical, financial, and legal feasibilities. GCF also has a dedicated project readiness support facility that provides aid funding to develop climate resilient project proposals that can then be used for project proposal windows.

Provide concessional on-lending to domestic local developers. In developing countries, this method has enabled domestic developers to leverage concessional funding to access additional local credit for implementation, which is also replicated in Pakistan using SBP facility. However, there is a need to replicate this model to further leverage affordable international development funding for local investors to co-finance and deploy renewable energy solutions on the ground.

Work through PPPs. Across Pakistan, there are institutional frameworks established for PPPs, including the four provinces and the federal government. Now, it's time to work through PPP frameworks to invest in sectors that are not catered through one-window operations of AEDB, such as supply of off-grid electricity in rural areas. For instance, the government can decide to partner with a local developer and successfully secure funding from development partner for curated deployment of solar PV project. Through this approach, the risk profile of the projects can be improved by bringing government concessional equity along with the technical and financial resources of a private developer. The model also encourages participation of DFIs who may never have taken part in either a purely public or purely private sector-led project but may want to come into de-risk the project further by providing concessional debt financing or first loss guarantee structure.

Not leaving behind rural communities will be a just and inclusive obligation of the GoP. Individually, the off-grid communities in Pakistan (for instance, areas of Sindh) will have low electricity demand. However, by developing projects that cover several small communities, governments and partners can roll out distributive electricity services with economies of scale during project development, procurement, financial close and execution. These approaches are also enabling the GoP to support expedited roll-out compared to individual community driven projects that see delays in time, and project execution. Hoping for private sector to partake in off-grid solutions, with weak demand, isolated structures and poor economics will never materialize at scale and speed to help vulnerable communities escape the poverty route.

Annexures

Annex I -Survey Methodologies

Methodology

The report findings (in Section III) are backed by comprehensive survey interviews with communities settled in the surrounding regions of distributive wind and micro hydel power plants. The following methodology was adopted for the surveys:

Survey 1: This survey included field investigations and interviews of local communities of Hunza, Chitral, Nagar, Dir, and Skardu. The target sample was taken to ensure feedback from a geographically widespread area and a maximum number of communities from the surrounding regions of the community-run power plants. The study conducted 101 Household (HH) surveys with community individuals. Additionally, on-site enumerators ensured maximum diversification of samples based on geography (Urban/Rural), demography (Age/Gender), and caste of the respondents. Additionally, the team also conducted Key Informant Interviews (KIIs) with Operators and Owners of the micro HPPs.

Survey 2**:** The study included field surveys and interviews in local communities of Jhimpir and Gharo wind farms in Sindh. The target sample ensured feedback from a geographically widespread area and the maximum number of communities from surrounding regions of the wind farms. The study conducted 42 Household (HH) Surveys with community individuals. Additionally, on-site enumerators ensured maximum diversification of samples based on geography (Urban/Rural), demography (Age/Gender), and caste of the respondents. Additionally, the team also conducted KIIs with Wind Power Management Companies, EPCs, and other public and private sector stakeholders to assess the initiatives taken at the plant level and the macro-economic impacts of wind farms.

Annex II - List of Consultations

Name	Designation	Organization
Mr. Shah Jahan Mirza	Chief Executive Officer	Alternate Energy Development Board (AEDB)
Mr. Muhammad Faisal Sharif	Director Project Appraisal	Private Power and Infrastructure Board (PPIB), Ministry of Energy, Power Division
Mr. Talha Amjad	Executive Director	Pakistan Environment Trust
Mr. Hartmut Behrend	Coordinator Pakistan-German Climate Initiative	GIZ
Mr. Ali Majid	Director of Marketing and Business Development	LONGi Solar
Mr. Irfan Ahmed	Director	HESCO
Mr. Hassan Answer	Director Net Zero	Pakistan Environment Trust
Mr. Tanveer Afzal Mirza	Director Operations and Coordination Strategy	United Energy Pakistan-Wind Power Division
Mr. Ali Zain Banatwala	Team Lead, REEE-II Project	GIZ
Dr. Irfan Mirza	Owner	Renewable Resources Pvt. Ltd.
Mr. Syed Imran Shah	Senior Manager	FFC Energy Ltd.
Ms. Amina Ansari	Senior Manager	Bridge Factor Pvt. Ltd.
Dr. Nasim A. Khan	Former Secretary	AEDB, VC Hamdard University
Mr. Abdul Sattar Jumani	COO & CEO	Yunus Energy Limited
Mr. Mirza Muhammad Umer	Company Secretary	Goldwind Pakistan Pvt. Ltd
Mr. Musadik Azin	Resource Mobilization Manager	Green Crescent Trust
Mr. Amir Kumar Khatri	CEO	
Mr. Azir	Manager	UEP Wind
Mr. Farhan	Plant Manager	UEP Wind
Mr. Assad	-	FFC Wind Energy
Mr. Faruukh	-	FFC Wind Energy
Major (R) Asif	-	FFC Wind Energy
Mr. Muhammad Kashif	CFO & Company Secretary	Lucky Renewables Pvt. Ltd and Yunus Energy Pvt. Ltd.
Mr. Alamgir	Manager	Master Wind Energy
Mr. Waqas	Senior Executive	Master Wind Energy

Mr. Faseeh ud din	Business Development Manager	SUMEC Pakistan Pvt. Ltd
Mr. Yasmin Karim	-	AKRSP
Mr. Abdul Murad	Joint Secretary	WISDOM
Mr. Abdul Murad	Plant Operator	Singor-WAPDA Hydel
Mr. Ehtisham Akhter	Head of Technical, Sr. Project Manager	Artistic Energy (Pvt.) Limited
Mr. Muhammad Ali	CEO	JCM Power
Mr. Saad Masud	General Manager	Shakar Ganj Sugar Mills
Mr. Saif		SED
Mr. Faryal Bhatti	Assistant Manager	Reon Pvt Ltd
Mr. Faisal Naseer	Assistant Manager	Catkin Pvt Ltd

Annex III - Field Visits

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