OVERVIEW OF PAKISTAN'S POWER SECTOR AND ITS FUTURE OUTLOOK

SEPTEMBER 2022

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ACRONYMS

ADB	Asian Development Bank
AEBs	Area Electricity Boards
AEDB	Alternative Energy Development Board
AJ&K	Azad Jammu & Kashmir
AJK PDO	Azad State of Jammu & Kashmir, Power Development Organization
AJK PPC	Azad State of Jammu & Kashmir, Private Power Cell
ARE	Alternative and Renewable Energy
ASEAN	Association of Southeast Asian Nations
BECL	Baluchistan Energy Company Limited
BEV	Battery Electric Vehicles
BHU	Basic Health Unit
BMC	Balancing Mechanism for Capacity
BME	Balancing Mechanism for Energy
BMP	Biodiversity Management Plan
BOO	Build Own Operate
BPC	Bulk Power Consumer
BRI	Belt and Road Initiative
CCI	Council of Common Interests
CD	Circular Debt
CDM	Clean Development Mechanism
CDMP	Circular Debt Management Plan
CDP	Common Delivery Point
CHASNUPP	Chashma Nuclear Power Plant
CIP	Community Investment Plan
COD	Commercial Operation Date
COVID-19	Coronavirus disease of 2019
CPEC	China Pakistan Economic Corridor
CPGCL	Central Power Generation Company Limited
CPI	Consumer Price Index
CPP	Captive Power Producer
CPPA-G	Central Power Purchasing Agency Guarantee Limited
CRPEA	Contract Registrar and Power Exchange Administrator
CS	Convertor Station
CSAIL	China Three Gorges South Asia Investment Ltd
CSR	Corporate Social Responsibility
CTBCM	Competitive Trading Bilateral Contract Market
CTG	China Three Gorges Corporation

DISCO	Distribution Company
ECC	Economic Coordination Committee of the Cabinet
ED	Energy Department
EHV	Extra High Voltage
ESMAP	Energy Sector Management Assistance Program
EU	European Union
EV	Electric Vehicle
FATA	Federally Administered Tribal Areas
FDI	Foreign Direct Investment
FESCO	Faisalabad Electric Supply Company Limited
FFV	Fossil Fuel-based Vehicles
FY	Financial Year
G2G	Government to Government
GATT	General Agreement on Tariffs and Trade
GDP	Gross Domestic Product
GENCO	Generation Company
GEPCO	Gujranwala Electric Power Company Limited
GIS	Geographic Information System
GOB	Government of Baluchistan
GOP	Government of Pakistan
GOS	Government of Sindh
GS	Grid Station
GTPS	Gas Thermal Power Station
GWh	Giga Watt per hour
HESCO	Hyderabad Electric Supply Company Limited
HPP	Hydropower Project
HV	Hybrid Vehicle
HVDC	High Voltage Direct Current
IA	Implementation Agreement
IAA	Independent Auction Agent
IESCO	Islamabad Electric Supply Company Limited
IFC	International Finance Corporation
IGCEP	Integrated Generation Capacity Expansion Plan
IPP	Independent Power Producer
IRR	Internal Rate of Return
JCC	Joint Cooperation Committee
JPCL	Jamshoro Power Generation Company Limited
JWG	Joint Working Group
KANUPP	Karachi Nuclear Power Plant
KE	Karachi Electric
KESC	Karachi Electric Supply Company

KPCL	Karot Power Company (Private) Limited
kWh	Kilowatt per hours
LCP	Least Cost Plan
LESCO	Lahore Electric Supply Company Limited
LOI	Letter of Intent
LOS	Letter of Support
LPGCL	Lakhra Power Generation Company Limited
MCC	Market Commercial Code
MEPCO	Multan Electric Power Company Limited
MO	Market Operator
MoU	Memorandum of Understanding
MPA	Market Participation Agreement
MSP	Metering Services Provider
MW	Mega Watt
NDMA	National Disaster Management Authority
NEP	National Electricity Policy
NEPRA	National Electric Power Regulatory Authority
NGC	National Grid Company
NPCC	National Power Control Centre
NPGCL	Northern Power Generation Company Limited
NPP	National Power Plan
NPSEP	National Power System Expansion Plan
NREL	National Renewable Energy Laboratory
NTDC	National Transmission and Despatch Company Limited
NUST	National University of Sciences and Technology
PAEC	Pakistan Atomic Energy Commission
PCI	Pakistan China Institute
PEDO	Pakhtunkhwa Energy Development Organization
PEPCO	Pakistan Electric Power Company Limited
PESCO	Peshawar Electric Supply Company Limited
PGC	Provincial Grid Company
PHEV	Plug-in Hybrid Electric Vehicles
PHPL	Power Holding Private Limited
PITC	Power Information Technology Company
PLAC	Partial Loading Adjustment Charges
PLAC	Partial Load Adjustment Charges
PMD	Pakistan Meteorological Department
POE	Panel of Experts
POL	Petroleum, Oil, and Lubricants
PPA	Power Purchase Agreement
PPDB	Punjab Power Development Board

PPIB	Private Power & Infrastructure Board
PPMC	Power Planning and Monitoring Company
PPP	Power Purchaser Price
QESCO	Quetta Electric Supply Company Limited
RE	Renewable Energy
RFP	Request for Proposal
RLNG	Regasified Liquefied Natural Gas
ROE	Return on Equity
SCA	Sindh Coal Authority
SCED	Security Constrained Economic Dispatch
SDPI	Sustainable Development Policy Institute
SEPA	Sindh Environmental Protection Agency
SEPCO	Sukkur Electric Power Company
SGCC	State Grid Corporation of China
SIPP	Small Independent Power Producer
SO	System Operator
SOLR	Supplier of Last Resort
SOP	Standard Operating Procedure
SPP	Small Power Producer
SPT	Special Purpose Trader
SS	Sub Station
STDC	Sindh Transmission and Dispatch Company Limited
T&D	Transmission and Distribution
TCEB	Thar Coal and Energy Board
TDS	Tariff Differential Subsidy
TESCO	Tribal Area Electricity Supply Company Limited
TGS	Three Gorges Second Wind Farm Pakistan Ltd.
TGT	Three Gorges Third Wind Farm Pakistan (Pvt.) Ltd.
TNO	Transmission Network Operator
TPS	Thermal Power Station
TSA	Transmission Services Agreement
TSEP	Transmission System Expansion Plan
UoSC	Use of System Charges
USAID	U.S. Agency for International Development
VRE	Variable Renewable Energy
WAPDA	Water and Power Development Authority
WPP	Wind Power Project
WTO	World Trade Organization
WUA	Water Use Agreement

FOREWORD

The availability and affordability of reliable electricity for the people are necessary for economic progress as well as the social uplift of any country. The rapid technological advancements and unique commercial dynamics of the power sector pose complex challenges for the policy makers, planners, and investors/lenders to develop a sector capable of ensuring energy security and affordability for all segments of society. The complexity of the power sector calls for robust planning based on accurate and reliable data and the flexibility to adjustto the changing technological and commercial realities.

Pakistan's Power Sector is very complex in which many institutions perform various tasks. The data and information related to the Pakistan Power Sector are scattered across various organizations and entities and are not available in one place. The key and authentic information need to be placed in one document so that it could be used by investors, lenders, various government departments, etc. Besides, the availability of accurate data and information is a prerequisite for bringing new investments in power sector projects, including but not limited to indigenousenergy-based projects and proper planning, development, and formulation of investment programs bringing down the overall tariffs. Furthermore, the direction in which the Pakistan Power Sector is moving forward must be documented in one place to bring clarity to the matter.

Given the above, a report on the overview of the Pakistan Power Sector and its Future Outlook has been prepared after collecting key information and data related to Pakistan Power Sector from authentic studies and reports so that various stakeholders are aware of the current status and key issues of Pakistan Power Sector. Furthermore, the report highlights the way forward and makes some recommendations, so that the concerned stakeholders may take appropriate steps to move in the right direction with collective wisdom.

We endeavor to ensure that accurate data and information related to Pakistan Power Sector and its Future Outlook is disseminated to all concerned stakeholders. We hope this report will be beneficial and informative to the concerned stakeholders. We want to acknowledge the hard work done by the teams of NUST Energy Center, PCI, SDPI, APCEA and CSAIL and various power sector experts in collecting, compiling, and processing all the data and information contained in this report. Collecting and processing the data and information and simultaneously maintaining a high level of authenticity/accuracy is quite a strenuous work. Hence, their efforts and support for completing this report are highly acknowledged and appreciated.

DISCLAIMER

Preparation of a report on the Power Sector of Pakistan and its Future Outlook relies extensively on the authentic and proprietary data acquired from a large number of stakeholders, including but not limited to NEPRA, PPIB, AEDB, CPPA-G, NTDC, Provincial / AJK entities, etc. and various other sources and holding several meetings with the concerned stakeholders, which have been duly mentioned in the References chapter at the end of the report and we are in no way responsible for the integrity and authenticity of any such data and information contained in this report.

Any other party using this report for any purpose, or relying on this plan in any way, does so at its own risk and cost. No representation or warranty, express or implied, is made concerning the accuracy or completeness of the information presented herein or its suitability for any particular purpose.

EXECUTIVE SUMMARY

Presently Pakistan is facing increasing pressure on its resources to provide affordable access of electricity to its population. With a total consumption in 2020-21 of 121 billion kWh and electricity consumption per capita of 584 kWh, Pakistan is among those countries with lowest per capita consumption of electricity in the world. Against a total electricity generation of 143 billion kWh, the consumption represents, losses of more than 15 percent relative to total electricity generation. At the same time, provision of electricity at competitive rates to more than 24 percent population (still without electricity) is adding burden on the public- sector- run utilities to expand their infrastructure to remote areas of the country.

Despite huge additions to installed generation capacity in the system over the past five years, the country still faces power shortages in non-summer months due to water availability issues, which in turn has added to dependency of the country on imported fuel.

In this backdrop a number of efforts were made by the government to arrest the situation by emphasizing on increased role of indigenous resources like renewable energy based on wind, solar and hydel and further on local coal. In addition, to improve liquidity in the sector, Nepra Act 1997 was amended in 2018, while a competitive market model has also been approved by Nepra in 2020. The role of participation of private sector has also assumed critical importance to meet the short and long term goals of the country.

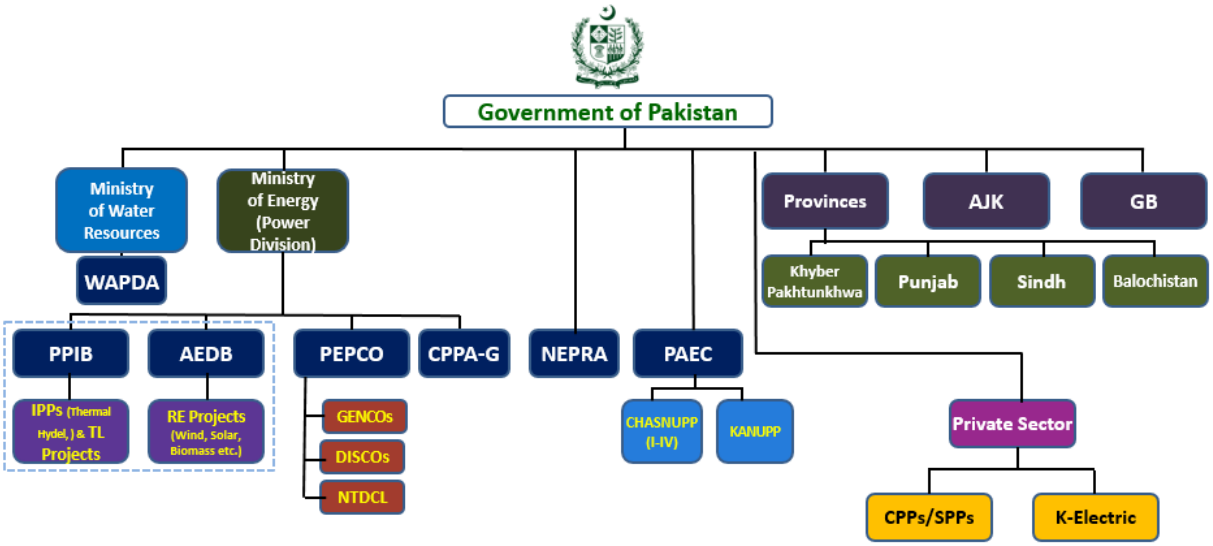
Scattered reports by various sources are available in the field, providing information and discussing various issues individually, however a collective insight on the sector issues through provision of reliable information is lacking. This report is oriented towards presenting all relevant issues including, existing structure, transformation taking place in the sector, future roles of key stakeholders in view of the government long term policy objectives and opportunities for the private sector participation in the development of power sector as a whole.

The following sections provide salient aspects of the discussions in the subsequent part of the report.

1. **Background and Existing Scenario**

- The report notes that Pakistan has grown a long way in terms of the expansion and restructuring of the sector. The Power sector has been run by two vertically integrated utilities namely Water and Power Development Authority (WAPDA) and Karachi Electric Supply Company (KESC). Between 1980s and 1990s as the thermal generation expanded, WAPDA was unbundled into power sector, and water sector. WAPDA was responsible for water sector only. Four thermal power generation companies were established along with a National Transmission and Dispatch Company (NTDC) and eight distribution companies (Discos) were also established in public sector.

- An independent regulatory body; National Electric Power Regulatory Authority (Nepra) was also created in 1997 for the regulation of the three sectors i.e. generation, transmission and distribution.
- As on 30 June 2021, the Installed Generation Capacity of the country was reported as about 40 GW, whereas total energy generation in the country was 143 Terawatt Hour (TWh). It may be observed that the share of hydel Energy generation is 27% while thermal based energy generation including nuclear energy share is close to 69.5%. Renewable energy contributed only 3.15% in the total generation. In global perspective, the share of renewables in electricity generation is projected to increase to almost 30% in coming years.
- Transmission sector of the country operated and controlled by NTDC, comprises of approximately 19500 kM long EHV network of 500 and 220 kV transmission lines and substations with a transformation capacity of 56000 MVA. An HVDC 660 kV transmission line with a capacity of 4000 MW has also been completed to transmit power from power generation plants located in the south to the load center i.e. Lahore. The distribution sector consisting of 10 distribution companies in PEPCO system (Ex Wapda Discos) and KE distribution, is responsible for serving about 33 million consumers. The performance of Ex-Wapda Discos has not remained satisfactory with high transmission and distribution losses with some companies recoding losses more than 30%. KE distribution also had high losses. Distribution companies also had low recovery ratios.
- For integrated control of power sector the Ministry of Petroleum and Ministry of Power were merged in 2017 to form Ministry of Energy. There are 29 main institutions for the planning, management and control of power sector as shown here



In addition to the organizations discussed above, PPIB, AEDB and Provincial setups facilitate private sector for thermal, renewable power generation and transmission line projects. PPIB's portfolio includes commissioning of close to 19000 MW installed capacity, including projects based on Hydro (1053 MW), Thar Coal (1320 MW),

natural/low BTU gas (5372 MW), RLNG (3633 MW) , Imported coal(3960 MW) and Oil(3593 MW). AEDB, responsible for renewable energy based projects has helped commissioning of 2,134 MW including Solar (430 MW), Wind (1,355 MW) and bagasse/Biomass cogeneration Projects (369 MW). Similarly Energy departments of Sindh and Punjab provinces are actively supporting development of projects, mostly in renewable energy. The Government of Sindh has also established Thar coal and Energy Board (TCEB) for approval of Coal mining and coal for power generation plants based on Thar Coal. Pakhtunkhwa Energy Development Organization (PEDO) has so far completed seven (7) hydro power projects with a cumulative capacity of 161 MW. The Private Power cell of Azad Jammu and Kashmir has facilitated four (4) hydro power projects with total capacity of 335. 48 MW.

The share of private sector Independent Power Producers (IPPs) have installed capacity of 20,881.

Sr. No.	Type of IPPs	Capacity (MW)
1	IPPs Hydel	1,192
2	IPPs	17,276
3	Wind	1,248
4	Solar	430
5	Bagasse	369
6	KE IPPs	366
Total		**20,881**

o To attract private sector investment in the country successive governments notified 21 instruments for opportunities and for attracting investment in Pakistan, policies and framework documents in the areas of hydel, thermal, renewable, bagasse and transmission lines. Of these, some of the policies drew tremendous response from the foreign and local private sector. For instance 1994 Power Policy, Power Policy 2002, Power Policy 2015 were instrumental in adding most of the power generation plants in thermal (Oil and Coal) and hydel power projects. ARE Policies of 2006 and 2019 and Power Co-generation Policy 2013 were behind the addition of renewable and bagasse based power generation plants in the country. Transmission Line Policy 2015 was key to

develop a ±660 kV HVDC Transmission Line from Matiari to Lahore for which NEPRA determined the tariff. The Project has been completed in Sept 2021 under the CPEC framework. Annexures to the Report provide the number of projects implemented through various Policies.

2. **Regulatory Regime**
    - NEPRA was established in 1997 through NEPRA Act No. XL 1997 to regulate the provision of electric power services in Pakistan. One of the main objectives of NEPRA is to improve the efficiency and availability of electric power services while protecting the interests of consumers and investors and to encourage competition through, specifically its tariff determinations. Nepra Act provided a broad framework for development of the Pakistan Power Sector; unbundled following the 1992 power sector Reform Process. NEPRA Act contains a number of provisions and obligations for regulating generation, transmission and distribution entities.
    - In order to provide a framework to move towards a competitive market, federal government amended existing Act in 2018 (Amendment Act 2018). The amendment in 2018, brought major changes to Nepra Act, like opening of the sector and wholesale competition in the market. A separate section has been included to define the role of provinces, specifically in transmission of electric power. The following sections provide an overview of the Amendment Act 2018.

3. **NEPRA Amendment Act, 2018**
    - The Regulation of Generation, Transmission and Distribution of Electric Power (Amendment) Act, 2018 was passed by the Government of Pakistan on 27th April 2018. The Amendment Act has restructured and evolved the power sector in material respects and completely reformed the role and responsibilities of the Nepra and other stakeholders in the sector.
    - Separation of Network and Supply Functions: The Amendment Act has separated network and supply functions, which were earlier bundled in distribution business.
    - No Exclusivity for Distribution Companies: The Amendment Act has also ended the exclusivity of distribution companies, earlier allowed in their licenses under Nepra Act 1997.
    - Cessation of Generation Licenses: The Amendment Act has provided a mechanism that shall implement a gradual cessation of generation licenses in the forthcoming years, with the Generation license requirement to be abolished gradually under a mechanism to be formulated by the Federal Government after consultation with the Authority.
    - Steps for liberalization pf markets: NEPRA will now grant System Operator and Market Operator licenses, who will be tasked with overseeing transmission systems and dispatch and market transactions respectively. The Authority will also be granting Provincial Transmission licenses where required. The

Amendment Act further introduces two new class of licensees, namely the Electric Power Trader and Electric Power Supply.

- The National Electricity Policy and Plan: The Amendment Act has introduced the concepts of the National Electricity Policy and the National Electricity Plan under Section 14A. The National Electricity Policy is a policy document that shall be prepared by the Federal Government, with the approval of the Council of Common Interests (CCI). The Policy's scope shall be focused *inter alia* on development of power markets, energy sustainability, transmission systems and optimal utilization of resources. The National Electricity Plan, however, is a document that shall be prepared and prescribed by the Federal Government, which has no set parameters or heads under which it shall be formulated. National Electricity Policy (NEP) provides detailed features of a competitive market and give detailed features of a Competitive Trading and Bilateral Contract Market (CTBCM).

4. Tariff Regimes

4.1 Generation Tariff Regimes

Cost- Plus Tariff

- Under cost-plus tariff, the generation facility is paid its actual cost plus an agreed profit. In this mode, a generation facility is required to submit ~~a~~ tariff petition to NEPRA for award of tariff for a particular project along with the tariff proposed for the project and supporting documents evidencing the cost. In the recent past, NEPRA determined Internal Rate of Return (IRR) for different technologies under the Cost plus tariff mechanism.

Upfront Tariff:

- Tariff developed, declared, determined, or approved by the Authority on a petition filed by any relevant agency or in exercise of suo moto powers by the Authority. Upfront Tariff is one which is determined and announced by the Regulator based on its own scrutiny and calculations with certain terms and conditions. The project sponsors may accept the Upfront Tariff based on its viability for their project. For Independent Power Producers (IPPs), the up-front tariff regime under Up-front Tariff (Approval & Procedure) Regulations, 2011, is generally applied by NEPRA.

Competitive Bidding Tariff

- Competitive bidding is a common procurement practice that involves inviting multiple developers to submit offers against the Request for Proposal (RFP) issued by the Relevant Agency. The Competitive Bidding is governed under NEPRA Competitive Bidding Tariff (Approval Procedure) regulations 2017 to lay down the procedure for approval of tariff arrived at through a competitive bidding process. The purpose of Competitive bidding was to allow transparency, equality of opportunity and the ability to demonstrate that the outcomes represent the best value. In line with the regulations, Competitive Bidding is conducted by the Relevant Agency keeping in view the demand forecasted by national grid

company in accordance with the least cost generation plan of each distribution company.

- It is important to highlight that the federal government has decided that henceforth, power procurement will be essentially on least cost basis and only through competitive bidding mode. National Electricity Policy and Alternative and Renewable Energy Policy state that procurement of power from generation power plants will be based on competitive bidding mode.

Transmission Tariff

- Transmission Tariff is determined by NEPRA, as per the Guidelines contained in the Methodology & Process for Determination of Revenue Requirement and Use of System Charges (UoSC) for Transmission License. The objective is to establish a transparent methodology for the determination of transmission revenues and UoSC that is predictable and certain in its operation and is consistent with the requirements under Nepra Act. The UoSC are calculated in Rs./kW/h and is paid only if the transmission line is available for dispatch of energy.

Distribution Tariff

- NEPRA determines consumer-end tariffs to recover the entire supply chain costs. In deciding the average sale price, NEPRA considers the annual revenue requirement of DISCOs, which includes all the costs involved. The main factors in the annual revenue requirements include power purchase price, net distribution margin, transmission and distribution (T&D) losses, and prior-year adjustments.
- Under the Amended Act, 2018, NEPRA is required to determine a uniform tariff for distribution licensees, wholly owned and controlled by a common shareholder, based on their consolidated accounts. The amended Act also requires that NEPRA will take guidance from National Electricity Policy to determine, modify or revise rates, charges, and terms and conditions for the provision of electricity services. For K-Electric and a number of DISCOs, NEPRA has used performance based multi-year tariff approach.

5. Indigenous Energy Resources in Pakistan

- The power potential through indigenous energy resources in Pakistan is estimated as follows:

  - Hydro Power 60,000 MW
  - Wind Power 346,000 MW
  - Solar Power 2,900,000 MW
  - Bagasse Cogeneration: 2,000 MW
  - Coal Power 100,000 MW

  Hydro resources are mainly located in the northern parts of the country, from which the mighty Indus river starts and other rivers and tributaries join this river. Indigenous coal resources are present in Thar in Sindh Province. The wind and solar resources are mainly located in Balochistan, Sindh and areas in Southern Punjab.

5.1 Hydro Power

The above indicated hydro power may be developed in the Khyber Pakhtunkhwa, Gilgit-Baltistan, Punjab and Azad Jammu & Kashmir (AJ&K). Power potential on different rivers is as follows:

- Indus River 39,717 MW
- Jhelum River 5,624 MW
- Swat River 1,803 MW
- Kunhar River 1,480 MW
- Kandiah River 1,006 MW
- Punch River 462 MW
- Other Rivers 9,704 MW

A **summary** of hydropower projects, which are already operational and are under various stages of development, under private and public sectors, is as follows:

- Projects in Operation

- Public Sector 9,443 MW
- Private Sector 1,051 MW

- Projects under Implementation

- Public Sector 19,539 MW
- Private Sector (PPIB + Provinces) 5,540 MW

- Projects with Feasibility Study Completed 4,345 MW
- Raw Sites 19,725 MW
- Total Hydropower Potential 59,643 MW

The following hydropower projects are operational / under development, under CPEC Framework:

- 720 MW Karot Hydropower Project on River Jhelum in Punjab
- 884 MW Suki Kinari Hydropower Project on River Kunhar in KPK
- 1,124 MW Kohala Hydropower Project on River Jhelum in AJK
- 700 MW Azad Pattan Hydropower Project on River Jhelum in AJK

5.2 Solar Power

Pakistan is among the most fortunate countries that receive plenty of sunshine throughout the year. Considering the country positive solar irradiance profile and availability of area, it has been estimated that Pakistan has the indigenous resources to fulfil all of its current electricity needs by only using Solar Energy. The GoP is envisaging to develop more than 7,000 MW of solar PV projects by 2030.

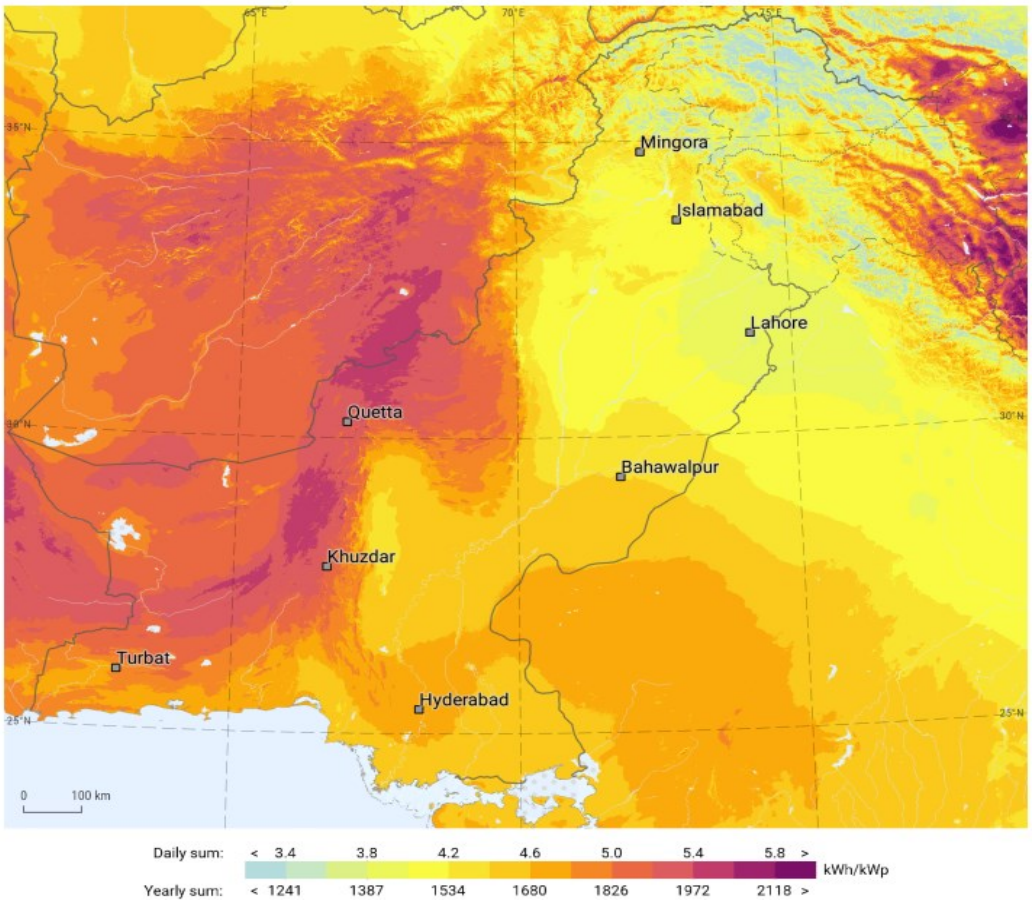
5.3 Solar Radiation in Pakistan

Pakistan receives good sun radiation, with higher levels of irradiation in the south and southwest than in the north. The upfront rates for solar PV power generation, which vary in the northern and southern regions of the country, take this into account.

AEDB in collaboration with World Bank under its Energy Sector Management Assistance Program (ESMAP) initiated Renewable Energy mapping through the installation of wind and solar measurement stations throughout the country.

For solar resource mapping, a total of nine (09) ground based solar measurement stations were installed. The geographical locations of these sites are distributed all over Pakistan, which cover different solar and climatic regimes.

Following is the Solar Energy Resource Map of Pakistan showing PV electricity output from an open space fixed-mounted PV system taken from Solar Resource Report of Pakistan dated March 2017 by the World Bank:



Map showing PV electricity output from an open space fixed-mounted PV system

The country's largest annual global horizontal irradiance is found in Baluchistan in the southwest, where it is little over 2,300 kWh per square meter (m^2). A study obtained from 58 meteorological stations, spread all over Pakistan, has been carried out to estimate the global solar radiation. The study indicates that more than 70% of the 0.8 million km^2 area of the country receives an annual average solar radiation energy of 5.0– 5.5 kW h/m^2 /day. There are sizeable pockets near Quetta, Qalat, Khuzdar and Zhob in the province of Baluchistan and Larkana in the province of Sindh, which receive 5.5–6.0 kW h/m^2 /day.

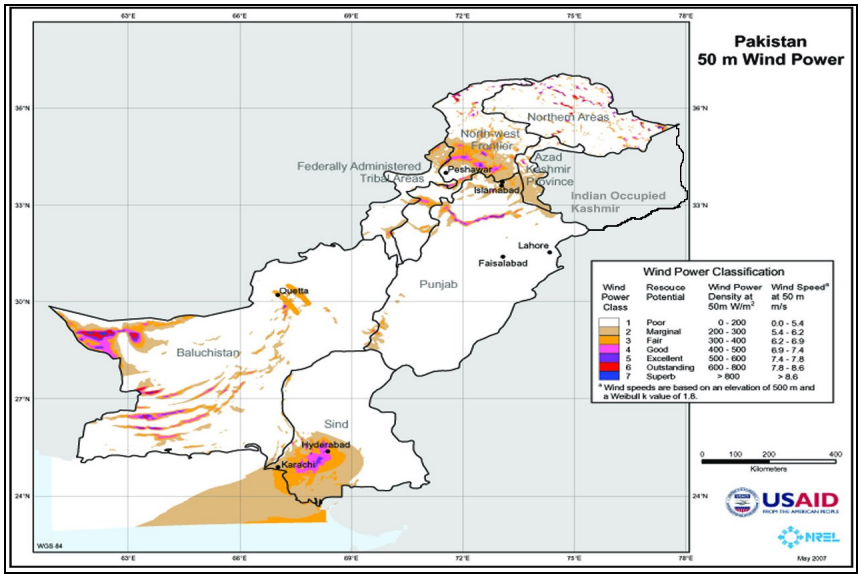
5.4 Wind Power

Wind Resource Potential in Pakistan

The potential of wind power in Pakistan is estimated to be around 346,000 MW. Pakistan Meteorological Department (PMD), Alternative Energy Development Board (AEDB), and National Renewable Energy Laboratory (NREL) are three of Pakistan's primary sources of wind data.

Wind Map of Pakistan

In 2007, NREL, as part of the U.S. Agency for International Development (USAID) aid programme, carried out wind resource assessments of Pakistan, which produced a mesoscale map of Pakistan that displays the possible wind speed at a height of 50 m. In addition to numerous relatively isolated wind corridors in central and western Punjab, central and southern Balochistan, and Gilgit-Baltistan, a remote region of Pakistan's north, this wind map of the country reveals significant wind corridors in southern Sindh, northwestern locations in Balochistan, and central areas of KPK.



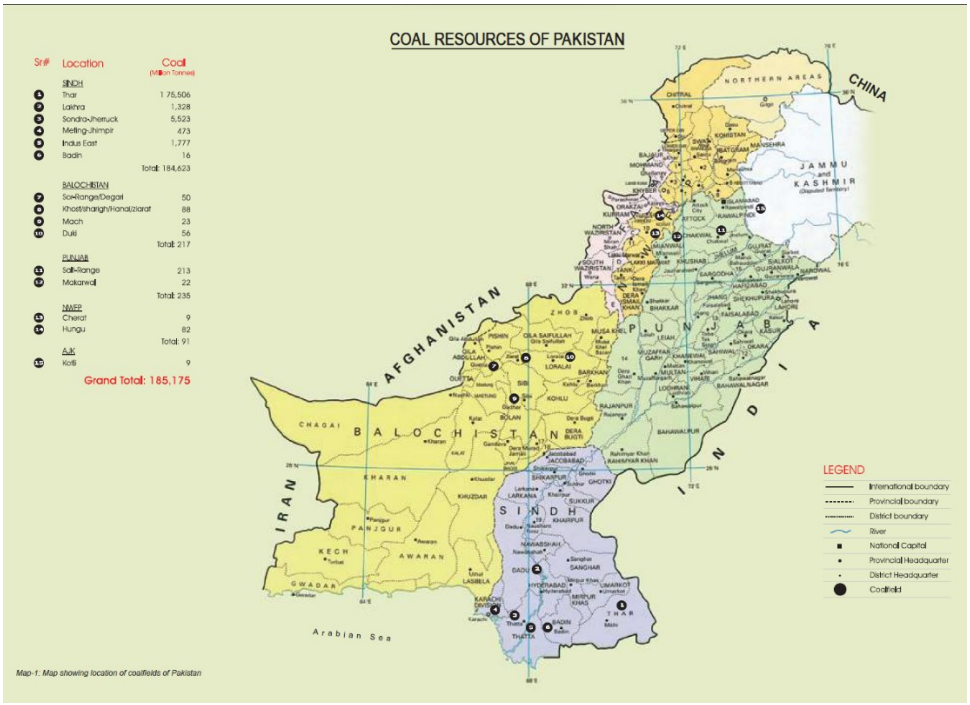
Wind Map of Pakistan

5.5 Indigenous Coal Power

The Federal Government and Provincial Governments, however, are continuously trying to facilitate private investors in developing and promoting indigenous coal for power generation. There are vast resources of coal in all four of Pakistan's provinces and in Azad Jammu & Kashmir. Thar Coal reserves are estimated at 175.5 billion tonnes which are sufficient to meet energy requirement of the country in the long term.

It is anticipated that, if properly exploited, Pakistan's coal resources may generate more than 100,000 MW of electricity over the next 30 years.

The following map shows locations and names of major coalfields and coal deposits of Pakistan. According to rough estimates, the total coal resources of Pakistan are more than 185 billion tonnes.



Locations and names of major coal resources of Pakistan

6. CPEC Portfolio of Power Projects and its major Achievements

6.1 The plans for an economic corridor between Pakistan and China preceded China's Belt and Road Initiative (BRI).

The project was first announced in the summer of 2013, when then-Prime Minister of Pakistan met with Chinese Prime Minister in Beijing. The focus was on connecting China with the Chinese-invested Pakistani port of Gwadar through highway, rail and pipeline infrastructure. Project plans had a five-year horizon for implementation, and the sums involved – ranging between ten and twenty billion USD – were moderate compared to China's current ambitions in Pakistan. In 2014, both countries decided to install 17,045 MW new generation capacity mix of hydro, wind, solar and coal clubbed with two High Voltage Direct Current (HVDC) transmission lines from South to North and North to South.

Honorable Chinese President Xi Jinping kicked off CPEC with his October 2015 visit to Islamabad. Agreements and Memoranda of Understanding (MoUs) initially signed under CPEC totaled nearly $46 billion with investments in Pakistan's energy (power) and infrastructure. The project is considered an integral part of the BRI, virtually connecting China's Kashgar city in Xinjiang with the Gwadar port in Balochistan province.

6.2 Energy Cooperation (22 Projects, 33 Billion USD)

In the energy mix of CPEC power projects (17,045MW), coal is leading with 8,220 MW (48%) followed by the balance part of 3,997 MW (23%), Hydel 3,428 MW (21%), Solar 1,000 MW (6%) and Wind 400 MW (2%).

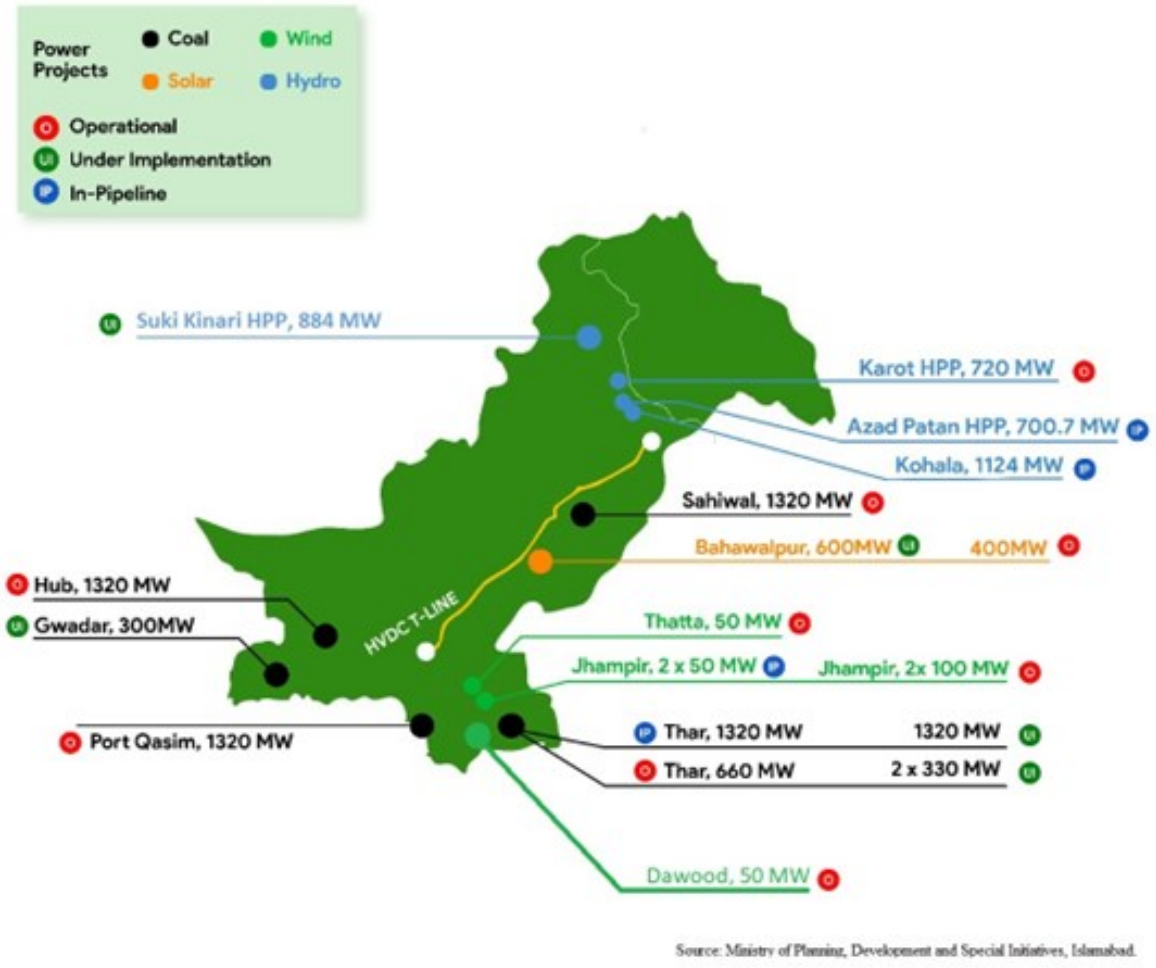
The details of power projects under CPEC are as follows:

Sr. No.	Name of Project	Capacity (MW)	Actual / Expected COD
Projects already commissioned			
1	Sahiwal Coal Power	1,320	Oct-17
2	Port Qasim Coal Power	1,320	Apr-18
3	China-HUB Coal Power	1,320	Aug-19
4	Engro Thar Power & Mine	660	Jun-19
5	Quaid-e-Azam Solar Park	400	Aug-16
6	Hydro China Dawood Wind	50	Apr-17
7	UEP Wind Farm	100	Jun-17
8	Sachal Wind Farm	50	Apr-17
9	Three Gorges Wind Power Projects	99	Jun-18
10	±660KV Dual Pole HVDC Lahore-Matiari Transmission Line	-	Sep-21
11	Karot HPP	720	Jun-22
	Total (MW)	**6,039**	
Projects under construction / under development			
1	Shanghai Electric (TCB-1) & Mine	1,320	2023
2	HUBCO Thar Power	330	2022

3	ThalNova Thar Power	330	2022
4	Suki Kinari HPP	884	2022
5	Azad Pattan HPP	700.7	2026
6	Kohala HPP	1,124	2029
7	Gwadar Coal / Solar Power Plant	300	2023
8	Thar (Oracle) Coal Plant	1,320	2026
9	Quaid-e-Azam Solar Park	600	2024
10	Cacho Wind Power Project	50	2026
11	Western Energy (Pvt.) Ltd.	50	2026
	Total (MW)	**7,009**	
Potential Projects (expected be included in CPEC in Future)			
1	Mahl HPP	640	-
2	Taunsa HPP	135	-
3	Toren More HPP	350	-
4	Jameshill More HPP	260	-
5	Phander HPP	80	-
6	Port Qasim-Faisalabad HVDC Transmission Line	-	-
	Total (MW)	**1,465**	

Details of power projects under CPEC

A map highlighting location of CPEC power projects in Pakistan is as follows:



Map highlighting location of CPEC power projects in Pakistan

6.3 Achievements of CPEC Projects:

- Improving macroeconomic conditions in Pakistan
- Alleviating Pakistan's energy shortage through addition of more than 6,000 MW of Generation Capacity
- Addition of Pakistan's first ever HVDC Transmission Line in National Grid.
- Addition of Clean and Green Energy in the National Grid
- CPEC Projects provided immense Employment Opportunities in Pakistan
- Foreign Direct Investment in Pakistan
- Technology and Skill Transfer to Pakistan
- Fast track development of Power Projects in Pakistan
- CPEC Projects providing electricity in Pakistan at Competitive Rates
- CPEC Projects bringing prosperity to the local community
- Improving infrastructure connectivity in Pakistan
- Cross-border fibre optic project completed and opened

7. IGCEP 2021-30 and Power Demand / Supply Analysis

Future opportunities in the sector depend on the growth of power sector in terms of demand requirements, objectives of the federal government and corresponding investment needs. As per the Planning Code (PC4) of the NEPRA Grid Code, NTDC is required to prepare and submit the following plans to NEPRA for approval:

- Load Forecast
    - For at least next 20 years
- Generation Expansion Plan
    - Ten year Indicative Generation Capacity Expansion Plan (IGCEP)
- Transmission Expansion Plan
    - Comprehensive Transmission Line plan

The development of the least cost generation capacity expansion plan is the process of optimizing i) existing and committed generation facilities and ii) addition of generation from available supply technologies/options, which would balance the projected demand while satisfying the specified reliability criteria. NTDC prepared the first IGCEP (for the period 2021-30) on April 20, 2020, which was approved by NEPRA, on Sep 24, 2021 after various meetings and public hearings. NTDC is required to prepare such plan every year which would be used for capacity planning in view of system demand forecast and technical, economic and financial parameters. It is to be noted that IGCEP has been prepared to meet the electricity demand of the whole country except the areas served by K-Electric (KE).

NTDC used the following demand forecast for the next ten years as shown below. By 2025, the demand is expected to be 29,389 MW, which would increase to 37,129 MW by year 2030.

Year	Power Demand	
	Generation (GWh)	**Peak Demand (MW)**
2020-21*	130,652	23,792
2021-22	136,151	24,574
2022-23	142,563	25,779
2023-24	159,319	28,027
2024-25	166,550	29,389
ACGR 2021-25	**6.26%**	**5.42%**
2025-26	174,102	30,814
2026-27	181,834	32,276
2027-28	190,037	33,829
2028-29	198,622	35,457
2029-30	207,418	37,129
ACGR 2025-30	**4.47%**	**4.77%**
ACGR 2021-30	**5.27%**	**5.07%**

Yearly demand forecast from 2020-21 to 2029-30

*Actual Demand (MW) and Energy Generation (GWh) used by NTDC for preparation of IGCEP

7.1 Requirement of Generation by 2030 based on IGCEP simulation

In order to meet the demand of 37,129 MW in year 2030, a capacity generation of 61,112 will be made available. The share of each source of energy generation available in year 2030 is mentioned in below table along with available capacity. The data shows

that the share from variable renewable energy (VRE) resources stands out to be 7,932 MW, 5,005 MW and 749 MW of Solar, Wind and Bagasse, respectively by 2030. Moreover, inclusion of renewable energy projects, hydro and Thar coal will also help in lowering the basket price of the overall system, which would help in giving relief to the end consumers. The share of gas fired power plants would also be decrease significantly from 15% to just 6% in the next five years, this would further aide in reducing the cost of energy generation.

Moreover, the addition of generation through local coal based projects will be increased to 15%. Due to this fact, the share of RLNG based plants will be decreased from 18% to 2% in 2025 and then eventually falling nearly to 0% in 2030. Same is the case for imported coal-based plants, whose contribution in the overall generation mix falls from 21 % in 2021 to only 9% by the year 2030. Moreover, the share of solar and wind in the overall energy mix increases from 3% to 16% by 2030. The summary of the total expected Installed Capacity (MW) & Energy Generation (GWh) respectively by year 2030 is as follows:

Technology	Installed Capacity (MW)	Energy Generation (GWh)
Solar	7,932	15,916
Wind	5,005	17,225
Bagasse	748.6	3,380
Hydro	23,653	94,649
Imported Coal	4,920	18,448
Local Coal	3,630	23,145
RLNG	6,786	686
Gas	2,582	5,623
Nuclear	3,635	24,910
Cross Border	1,000	3,436
RFO	1,220	-
Total	61,112 MW	207,418

Summary of Installed Capacity and Energy Generation by 2030

8. Competitive Market Frame Work

The development of the wholesale competitive electricity market in Pakistan was envisioned at the outset of power market reforms of the 1990s. Generation companies were allowed to sell directly to Bulk Power Consumers (BPC- consumers with a load of 1 MW or above) under the Regulation of Generation, Transmission, and Distribution of

Electric Power Act, 1997. Later on Transmission License granted by Nepra to NTDC contained an elaborate blueprint for a competitive market by identifying a number of entities to be created for moving to competitive market. The concept of 'single- buyer-plus' model was also introduced which was planned to lead to multiple seller and buyer market. Nepra Amendment Act (Amendment Act) introduced material changes in the Nepra Act 1997 by identifying new players in the sector like market operator, system operator, trader, and supplier. Amendment Act also stipulated salient features of National Electricity Policy (NEP) in respect of development of future competitive market model.

In November 2020, NEPRA approved CTBCM model that provided a roadmap for opening the Wholesale Electricity Market of Pakistan. , aiming to provide choice to the bulk power consumers. CTBCM is not a standalone mechanism, rather it complements the framework as provided under Amendment Act, 2018.

8.1 Roles of Institutions in implementing CTBCM

System Operator (SO)

SO, a separate licensed entity will be entrusted with following roles:

- Real time operations and system balancing within security and reliability constraints

Transmission Line Companies

- Provide reliable and stable transmission infrastructure to enable the trade
- NTDC as the National Grid Company (NGC) to coordinate with other transmission licensees for adequate design and construction of network

Independent Auction Administrator (IAA)

PPIB/AEDB will be merged to assume the role of Independent Auction Administrator (IAA), which will perform the auctioneer function for procuring generation capacity against the incremental demand, primarily for DISCOs. In order to undertake this function, PPIB/AEDB would need to get themselves registered with NEPRA as IAA. The functions of IAA will be as follows:

- To Prepare the Capacity Procurement Plan based on IGCEP prepared by NTDC, Energy Gap by DISCOs and energy policies of the government.
- To conduct the competitive auctions for the new power procurement.
- To prepare the standard bidding documents and submit to NEPRA for review.
- To prepare and obtain the regulatory approval of PPAs / EPAs templates for the centralized auctions.
- To assist the DISCOs in finalizing the bilateral PPAs/ EPAs with each generator that has been awarded in the auction.
- To arrange Guarantees for low performing DISCOs through GoP.

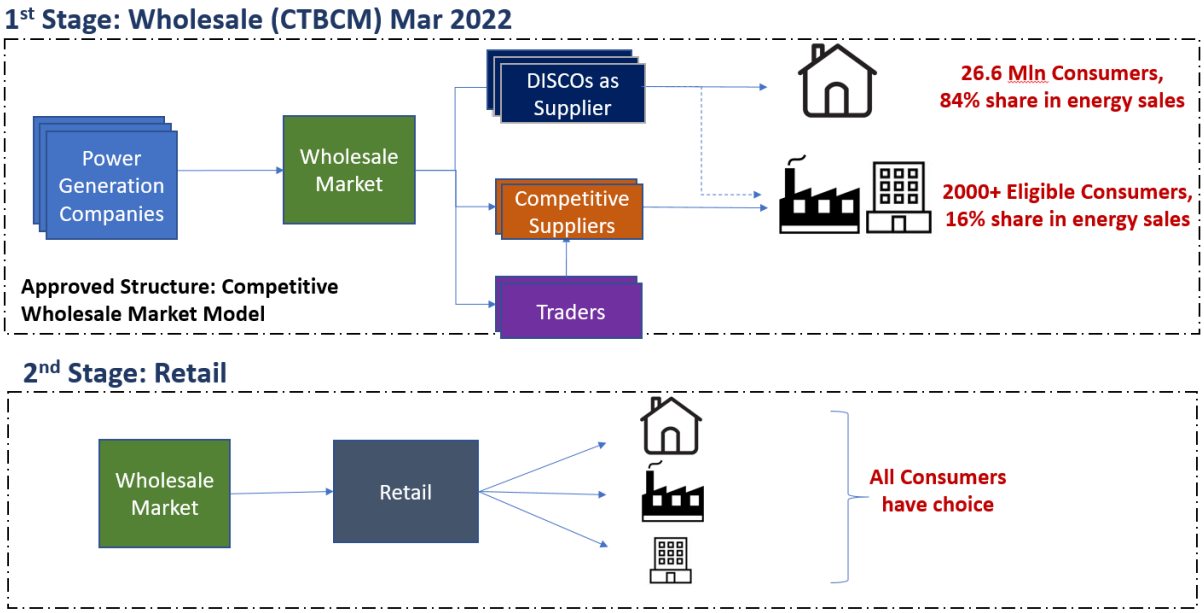
8.2 Special Purpose Trader (SPT)

- SPT will perform the same functions as CPPA-G does in its agency role today.

8.3 Market Operator (MO)

- **Contract Registrar** (Admission, suspension and cancellation of Participants)
- Registration of Common Delivery Points (CDPs)
- Sign a **Market Participation Agreement** (MPA) with Participants establishing rights, responsibilities and obligations, including the obligation of the Participant to provide credit cover
- Calculate **energy and capacity imbalance quantities** for each Participant;
- Calculate **hourly imbalance prices** for energy
- Calculate monthly **transmission use of system charges and market fee**
- **Balancing Mechanism for Energy (BME) Settlement** on a weekly (provisional) and monthly (final) basis
- **Balancing Mechanism for Capacity (BMC) settlement** on annual basis

Different stages of CTBCM are shown in the following diagram;



CTBCM: Competitive Wholesale and Retail Markets

8.4 Participation of Private Sector in Competitive market

The CTBCM provides for a number of major changes in the institutional set up as new organizations have been identified to play their role in the operation of the market. At the same time however, CTBCM is foreseen to open doors for the private sector participation as well.

8.5 Privatization of DISCOs as Network Operator

The Amendment Act 2018 has separated distribution into wire and supply functions. Henceforth, DISCOs will only perform the duties of network operator pursuant to NEPRA Act. The new role, which excludes the sale function will certainly be more conducive for placing DISCOs for privatization. It is expected that a simplified model with minimum involvement of end consumers will draw lesser resistance from lower level employees relative to earlier such initiatives.

8.6 Competitive Suppliers

The Amendment Act allows the DISCOs to continue for five year (2018-23) to act as Supplier of the Last Resort (SOLR). However, in addition to that any person can be engaged in supply of electricity subject to license granted by NEPRA under Section 23E of the Act. Therefore, generation companies and others as a 'supplier' will be able to supply to BPC in the territory specified in their license. Accordingly, large-scale induction of RE based power generation plants under GOP Policy, also established through IGCEP, may also participate in the competitive market as 'competitive suppliers'. Similarly, 'Captive Power Generation' will have opportunities to participate in the Competitive Market

8.7 IPPs after Expiry of Legacy Agreements

A number of IPPs established under earlier policies are expected to complete their contracts with NTDC/CPPA-G in near future. Depending on the useful life of such power generation plants, they may participate in the market as a merchant plant, which will create additional opportunity for the private sector as SPT (CPPA-G) will not procure power from those IPP under the competitive market framework.

8.8 Traders

Trading under the Amendment Act means a facilitator of bilateral trading of electricity by entering mutual contracts between parties. Any person can engage in trading of electricity, subject to NEPRA License under Section 23C of the Act.

8.8 Present Status of CTBCM:

In May 2022, NEPRA granted market operator license to CPPA-G and approved **Market Commercial Code (MCC)**. As per the approved MCC:

a) the single buyer regime will end and DISCOs will be procuring power through centrally organized auctions run through the Independent Auction Administrator (IAA),
b) bulk power consumers (more than 1 MW load) will be given choice to procure power either from distribution company (DISCO) or it's competitive supplier and

c) market sales on merchant basis will also be allowed to interested generation plants including those retiring from legacy generation fleet or connected with the national grid as captive generating plants.

9. Electric Vehicles

While the thrust of all major energy policies in the country up till 2019 has been in the industrial and consumer sectors, the fact remains that transport is a large, untargeted sector, consuming almost one-third of all energy. The paucity of a unified approach towards the transport sector leads not only to poor availability of low-carbon, efficient public transport in all major cities of the countries, but also to heavy reliance on expensive imported fuel, and constantly deteriorating air quality in urban centers. While numerous initiatives have been taken by the automakers and governments globally to reduce sectoral and country-specific carbon footprints, reducing unsustainable reliance on fossil fuels, Pakistan has only recently joined the conversation through its first-ever national Electric Vehicles (EV) policy 2019. The policy targets 30% of its road vehicles to be EVs by 2030. This means that a window of opportunity has opened to allow global car manufacturers investing in EVs such as Tesla, Volkswagen, Ford, BMW, Mercedes, Toyota, and Nissan among other large Chinese manufacturers, to see Pakistan as a viable market.

- **Indigenization and Development of Infrastructure for EVs**

  This automotive transition to EVs will not only help the country in combating climate change in large urban centers but also provide a useful avenue for improved utilization of excess electricity, whenever available, especially in Pakistan. This benefit can be further enhanced by indigenously developing manufacturing, R&D, and testing facilities for EV components. As EVs take off in Pakistan, indigenization of key components will not only reduce reliance on imported technology but also make the transition economically viable. Local component supply chains could be developed leading to local capacity development and sectoral growth. With enough support, Pakistan could well become the regional hub of selected low-cost EV components (along with testing facilities).

- **Pakistan's National Electric Vehicle Policy an Overview**

  Pakistan's National Electric Vehicle Policy 2019 (EV Policy) sets EV adoption targets and includes incentives for buyers and manufacturers. It also focuses on the development of a nationwide charging infrastructure to ease the adoption of electric vehicles. The salient points of the EV Policy are as follows:

- **Goals**

  (a) Passenger Vehicles: EV sales to constitute 30% of new sales by 2030 and 90% of new sales by 2040.

  (b) 2 & 3 wheelers: EV sales to constitute 50% of new sales by 2030 and 90% of new sales by 2040.

(c) Buses: EV sales to constitute 50% of new sales by 2030 and 90% of new sales by 2040.
(d) Trucks: EV sales to constitute 30% of new sales by 2030 and 90% of new sales by 2040.

10. Key Power sector Challenges

The Report identifies the following major challenges to an efficient power sector and future participation by Private Sector;

- Circular Debt
- Inconsistent Power Policies
- High Transmission and Distribution losses
- Failure in Privatization efforts for Discos
- Inefficient Public Sector Power generation Plants
- Delay in timely completion of Transmission line projects
- Security Issues
- Difficulties in Land Acquisition
- Rapid Changes in Tax regime
- Lack of Coordination between federal and provincial/AJK institutions

11. Way Forward

The report also provides a way forward for overcoming major challenges and issues as discussed above;

- New Power Policy for attraction of investors
- Utilization existing and upcoming power projects
- Retirement of Old plants in Public and private sector
- Feasibility Study about Pumped Storage projects
- Policy for large scale induction of Electric Vehicles (EV)
- Reforms in Power sector and Privatization of Discos
- Fully involve private sector in CTBCM development

The Report also includes three Case Studies about different projects under the umbrella of CPEC as listed here;

- Karot hydropower Project
- Matiari-Lahore HVDC transmission Line Project
- The China Three Gorges Second (TGS) and China Three Gorges Third (TGT) wind power projects

CHAPTER 1

PAKISTAN ECONOMY AT A GLANCE AND KEY MACRO ECONOMIC STATISTICS

1.1 Pakistan's Economy at Glance

Pakistan is geographically located at the crossroads of the world's most populous, economic strongholds and conflict zones. China surrounds the country from the northeast, India from the east and southeast, Afghanistan from the north and northwest, and Iran from the west. As per the National Institute of Population Studies (NIPS), Pakistan, with an estimated population of 228.78 million, is the fifth most populous country in the world and second in South Asia after India. More than half of the population falls in the age group of 15-64 years, making it an asset and liability simultaneously (Pakistan Bureau of Statistics, 2021).

Pakistan also has one of the larger workforces in the world, which stood at 71.76 million during the fiscal year of 2021. With a 6.3% unemployment rate, total employment stood at 67.25 million during the same period. The employment to population ratio is higher in men (64.1%) than in women (19.4%) (Economic Survey of Pakistan, 2022).

According to the Labour Force Survey 2021, the share of agriculture in overall employment generation is decreasing while the share of the services sector is increasing in Pakistan. The government needs to explore more avenues for training and educating the youth to capitalize on the available demographic dividend. Existing educational facilities have remained short of accelerating the current literacy rate of 62.8%.

The economy of Pakistan has remained volatile for quite some time. It has not been sustainable over the past several decades but has shown unpredictable high and low growth periods. In recent years, at the outset of the China-Pakistan Economic Corridor (CPEC), the economic growth, which was predicted to pick up momentum, remained shaky after showing promising growth of above 5% in 2017 and 2018.

Political instability and the COVID-19 pandemic has affected the trail of economic growth during 2019 and 2020, which picked up again during FY 2021 by catching up with the pre-pandemic growth rate. As per various resources, including the Ministry of Finance and the State Bank of Pakistan, the real GDP growth rate has remained at 5.74 and 5.97 % during FY 2021 and FY 2022, respectively. During FY 2022, the country's total GDP was US$ 383 billion, while the GDP per capita was US$ 1798.

The recent global upsurge in commodity prices has negatively impacted the Pakistani markets. The rising fuel prices and ongoing global conflicts have increased pressure on the prices of food and non-food items. As per the Pakistan Bureau of Statistics, the general Consumer Price Index

(CPI) at the national level has risen from 7% in Dec 2020 to 25% in July 2022, with a massive increase of 12 points from May July 2022. The rural areas have been more affected in food inflation, where the inflation touched 30% in July 2022. The Government of Pakistan (GOP) has managed to minimize the impacts of high commodities prices on the masses by alleviating the petroleum levies and sales tax on all petroleum products and subsidizing the electricity prices. This, in return, has contributed to increasing the serious fiscal imbalances, which stood at 3.8% during March-May 2022 than 3% in the previous period.

Pakistan has borrowed from the domestic capital market and international development partners to fulfill the budgetary requirements. By March 20,22, the total public debt stood at PKR 44,366 billion, of which PKR 28,076 was domestic and PKR 16,290 billion, or US$ 88.8 billion, was foreign (Economic Survey of Pakistan, 2022).

As a member of various tradeorganizations such as the General Agreement on Tariffs and Trade (GATT) and the World Trade Organization (WTO), Pakistan is well-connected with international markets. Various Pakistani governments have engaged with major international markets such as the European Union (EU), North America, China, the Association of Southeast Asian Nations (ASEAN), and the GULF to gain maximum access for domestic goods.

In recent years, exports of various goods and services have picked up. The exports of goods and services have grown by 27.6% and 18.2%, respectively, from July-April 2022. During that period, the exports of goods reached an all-time high at US$ 28.6 billion, whereaservices exportses touched US$ 5.8 billion. While the exports have shown promising growth, the growth in imports has outshined the exports' revenue by creating a net trade deficit of 49.6% or US% 32.9 billion from July-April 2022. This trade deficit was difficult to fill with the all-time high workers' remittances of US$ 26.1 billion (Ministry of Finance, 2022).

Over the years, one of the main sectors that has contributed to increasing the import bill of the country is the energy sector in general and thermal power plants in particular. Throughout July 2021 to April 2022, the import bill had increased by 95%, making it US$ 17.03 billion more than the preceding year, when it was US$ 8.69 billion. Among the import of Petroleum, Oil, and Lubricants (POL) products, the import of crude oil increased by 75% in value and about 1% in quantity. LNG imports increased by 85% (Economic Survey of Pakistan, 2022).

Pakistan's total electricity installed capacity stood at 39,772 MW in June 2021, of which 25,098 MW capacity was thermal based, 9,915 MW hydroelectric, 2,612 nuclear, 1,248 MW Wind, 430 MW Solar, and 369 MW was based on Bagasse (NEPRA, 2021). Installed capacity in the public sector remained at 20,822 MW, which is 18,952 MW in the private sector.

To lessen the continuous financial pressure, Pakistan needs to develop and capitalize on the indigenous energy resources. Recent climate change events have also necessitated the need for the energy transition in Pakistan based on clean and indigenous energy resources. Recent energy dialogues and policies have also echoed a need for the such an energy transition to ensure the country's sustainable and secure energy future.

The latest political map of Pakistan is as follows:

1.2 Key Macroeconomic Indicators

Population (2021)	224.78 M* (82.83 million urban & 141.96 million rural)
Labor Force (2021)	71.76 M, 10th Largest in the World
Mean Size of Household (2021)	6.3
Employment/population ratio (2021):	42.1% (In Male: 64.1% and in Female: 19.45)
Avg. Population Growth Rate per year	1.9%*
Area	796,095 Square KMs
Inflation (2022)	11.3%**
GDP (current USD)	383.34 Billion*
GDP Growth Rate (2022)	5.97**
Employment in Sectors (2021)	37.4% Agri, 9.5% Construction, 14.4% Services
Total Public Debt	Rs 44,366 Billion
Domestic Debt	Rs 28,076 Billion

External Debt	US$ 88.8 Billion
Central government debt, total	66.8% of GDP
Per Capita Income (2022)	1798 US$**
Agriculture Sector Growth (2022)	4.40 %**
Industrial Sector Growth (2022)	7.19 %**
Manufacturing Sector Growth (2022)	9.80 %**
Services Sector Growth (2022)	6.19 %**
Monetary Policy Rate	13.75%
Total Exports (July-April FY 2022)	US$ 33.4 Billion
Trade Deficit (July-April FY 2022)	US$ 32.9 Billion
Remittances (July-April FY 2022)	US$ 26.1 Billion
Current Account Deficit (Same Period)	US$ 13.3 Billion
Foreign Exchange Reserves	Around US$ 11 Billion**
PKR-USD exchange rate	225 PKR
Major Donors	China, IMF,KSA, UAE, ADB, WB, USA
Fiscal Deficit to GDP Ratio (2022)	3.8% (447.2 Billion PKR)
Import Bill of Fuel (2022)	US$ 17.03 Billion
Electricity Generation Capacity	41 GW
Peak Demand of Electricity (2022)	27 GW
Major Export Destinations	USA, China, Europe (UK), Germany, Afghanistan
Major Import Origins	China, UAE, USA, Indonesia, KSA,
Major Exports	Textile, Leather, Surgical, Sports, Fruits
Major Imports	Fuel, Electrical Machinery, Vehicle Parts, Steel, Pharma
Major Crops	Wheat, Cotton, Corn, Olive, Maze
CO_2 emissions	0.9 metric tons per capita
Access to electricity	75.4% of population

CHAPTER 2:

OVERVIEW OF PAKISTAN POWER SECTOR

At the time of independence of Pakistan in 1947, Pakistan inherited a generation capacity of only 60 MW from the British government, which was increased to 636 MW by 1970. However, due to a relatively higher pace of the power sector development, especially after the 1970s, the installed generation capacity (all of that in the public sector) reached more than 9,000 MW by 1990-91. At that time, two vertically integrated public sector utilities, i.e., **Water and Power Development Authority (WAPDA) and Karachi Electric Supply Company (KESC),** were responsible for the operation and management of the overall power sector of the country.

WAPDA and KESC performed satisfactorily till the mid of 1980s; however, after that, capital availability constraints led to inadequate generation capacity and deterioration in transmission and distribution infrastructure. The increase in the supply of electricity was insufficient to keep pace with the demand, which was growing consistently at 9 to 10 percent per annum in that period. Consequently, in the early 1990s, a n excessive electricity shortage, especially for industrial and commercial consumers, was experienced.

Heavy financial losses were incurred because of undue political interference and mismanagement of limited capital resources, overstaffing, and bureaucratic delays in handling routine matters in these public utilities. In addition, inappropriate and costly investments, poor quality of services, high system losses, and poor collection of bills from the customers; all negatively affected the financial health of the power sector.

The overall operational inefficiencies in the power sector created the need for its restructuring. Accordingly, in **1992** the "Strategic Plan for Restructuring the Pakistan Power Sector" was approved by the Government of Pakistan (GOP) / Council of Common Interests (CCI) and was followed by Power Policies of 1994 to 2002.

The government intended to move towards the creation of a competitive power market in Pakistan by taking the following initiatives:

- Restructuring and privatizing the then-existing thermal power generation, power transmission, and distribution functions and assets of existing public sector utilities, i.e., WAPDA and KESC;
- Creation of a fully autonomous regulatory authority, the National Electric Power Regulatory Authority (NEPRA); and
- Induction of private sector in power generation.

2.1 Restructuring of WAPDA

In December 1998, the WAPDA Act was amended to bifurcate WAPDA into two separate entities responsible for Water and Power. Water Wing was tasked to look after hydel power generation and mega hydel projects, whereas Power Wing was responsible for thermal power generation, transmission, and electricity distribution. The power sector was further unbundled to have separate generation, transmission, and distribution functions through the creation of the following public limited companies:

- Public sector thermal power generation plants were grouped into four companies, namely;

1.	**Jamshoro Power Generation Company Limited (JPCL)**	**(GENCO-1)**
2.	Central Power Generation Company Limited (CPGCL)	**(GENCO-2)**
3.	Northern Power Generation Company Limited NPGCL)	**(GENCO-3)**
4.	**Lakhra Power Generation Company Limited (LPGCL)**	**(GENCO-4)**

- **National Transmission & Power Despatch Company Limited** (NTDC) to look after the transmission and dispatch of power functions of the country, and
- Eight distribution companies were mainly the successors of the earlier Area Electricity Boards (AEBs). The AEBs were departments within WAPDA to administer the distribution system's supply and distribution, construction, expansion, maintenance and operation. Out of the eight incorporated companies, later on HESCO was bifurcated into two companies by creating Sukkur Electric Power Company (SEPCO). Tribal Area Supply Company (TESCO) was subsequently formed to make ten distribution companies for the country, excluding Karachi. These companies are listed as follows, which have been structured in line with modern management practices:

1.	**Lahore Electric Supply Company**	**(LESCO)**
2.	Gujranwala Electric Power Company	**(GEPCO)**
3.	Faisalabad Electric Supply Company	**(FESCO)**
4.	Islamabad Electric Supply Company	**(IESCO)**
5.	Multan Electric Power Company	**(MEPCO)**
6.	Peshawar Electric Supply Company	**(PESCO)**
7.	Hyderabad Electric Supply Company	**(HESCO)**

8.	Quetta Electric Supply Company	**(QESCO)**
9.	Sukkur Electric Power Company	**(SEPCO)**
10.	**Tribal Area Electric Supply Company**	**(TESCO)**

KESC was retained as a separate vertical integrated entity for ultimate privatization to provide generation, transmission, and distribution functions to Karachi City and certain adjoining areas of the Baluchistan Province.

2.2 Creation of PEPCO

Pakistan Electric Power Company (Private) Limited (PEPCO) is a Private limited management company owned by the Government of Pakistan (GOP), whose Memorandum and Articles of Association, signed on 12th May 1998, was introduced as the Managing Company to steer, manage and oversee the corporatization/ commercialization reforms program of the government.

2.3 Creation of NEPRA

National Electric Power Regulatory Authority (NEPRA) was established through an Act of parliament in December 1997. NEPRA is exclusively responsible for regulating the generation, transmission and distribution sectors in Pakistan. NEPRA Act provides a framework for the regulatory regime under which NEPRA grants licenses, determines tariffs, sets performance standards, and other rules and regulations incidental to the power sector. NEPRA Act 1997 was amended in 2018 (Amendment Act 2018), bringing significant changes to the regulatory regime, including separation of wire and supply functions, cessation of 'exclusivity' by DISCOs, and the concept of 'suppliers' selling directly to bulk power consumers (BPC).' Amendment Act 2018 also allowed the creation of provincial grid companies and the concept of captive power generation.

2.4 Privatization Efforts

2.4.1 Privatization of KESC

Although KESC was retained as a vertically integrated utility, its financial performance deteriorated. By 1996, its net profits stood at minus 2.87%, which continued over subsequent years. As a result, KESC became financially unviable to operate as a company. In order to arrest its deteriorating performance, in December 2005, the GOP privatized KESC and sold 73 percent of its shares to Hassan Associates, Saudi Al-Jomaih Group of Companies, and Kuwait's NIG. The conglomerate guaranteed better services via professional management, new investment, technology, and employment benefits.

2.4.2 Privatization of other Entities

The privatization of KESC (now K-Electric) was the first in a broader privatization program, which included public sector thermal power generation plants and distribution companies. In this respect, several initiatives were taken by the government, and the Jamshoro Power generation project and three distribution companies, namely IESCO, FESCO, and GEPCO, were identified for their total privatization. Detailed analysis and due diligence of the relevant companies were also carried out; however due to multiple reasons such as resistance by the labour union and the officers of distribution companies, the exercise was shelved. Successive

governments also initiated the privatization of distribution companies based on different strategies, including partial privatization, management control, franchising, etc.. However, all such attempts have remained unsuccessful so far. It is important to highlight that privatization of DISCOs to bring efficiency in distribution companies' performance has been considered a key component to overcoming circular debt issues. Privatization of DISCOs was one of the main elements in the Circular Debt Management Plan 2015. The plan envisaged using the revenue generated through privatization for clearing circular debt; however, it could not be materialized yet again.

The Government of Pakistan is all set to roll out DISCOs' privatization. For that, new boards of directors have been appointed. As per the information available on the website of the Privatization Commission, all state-owned distribution companies (excluding TESCO), irrespective of their financial and commercial performance, are potential candidates for privatization.

2.5 Existing Situation of Overall Power Sector

2.5.1 Generation

As per latest NEPRA State of Industry Report 2021, the country's total installed capacity by June 30, 2021, was about 39,772 MW, which was further bifurcated into 36,934 MW installed capacity at the CPPA-G/NTDC system and 2,838 MW installed capacity at Karachi Electric (KE) system. The installed capacity of CPPA-G/NTDC system during 2021 further comprised of WAPDA hydel 9,443 MW, IPPs hydel 472 MW, GENCOs thermal 4,881 MW, IPPs thermals 17,276 MW, captive power plants 340 MW, nuclear power 2,475 MW, wind plants 1,248MW, solar plants 430MW and Bagasse plants 369 MW. Similarly, the installed capacity of the K-Electric system during 2021 comprised KE's plants 2,084 MW, IPPs 366 MW, Captive plants 151 MW, KANUPP 137 MW, and RE plants 100 MW.

Details of the total installed capacity of Pakistan as of 30th June 2021 is as follows:

Sr. No.	Generation Source	Capacity (MW)
1	WAPDA Hydel	9,443
2	IPPs Hydel	472
	Total Hydel	9,915
3	GENCOs connected with PEPCO	4,881
4	IPPs Connected with PEPCO	17,276
5	SPPs/CPPs Connected with PEPCO	340
6	Nuclear	2,475
	Total Thermal including Nuclear	24,972
7	Wind	1,248
8	Solar	430
9	Bagasse/Biomass	369

	Total CPPA-G/NTDC System	36,934
10	KE Own	2,084
11	IPPs Connected with KE	366
12	SPPs/CPPs connected with KE	151
13	Nuclear	137
14	Solar	100
	Total KE	2,838
	Total Installed Capacity of the Country	39,772

Details of the total installed capacity of Pakistan

Source :NEPRA State of industry Report 2021

The total electricity generated in Pakistan's power system during FY 2020-21 was 143,588.60 GWh. Out of the total electricity generated, 129,722.05 GWh was generated in power plants connected to the CPPA-G/NTDC system, and 13,368.59 GWh was generated in power plants connected to the KE system. While 498.37 GWh of electricity was imported from Iran during the same financial year. The energy generated in CPPA-G/NTDC connected plants is from various sources, including thermal, hydel, renewable, etc. Details of the total energy generation in Pakistan as of 30th June 2022 are as follows:

Sr. No.	As of 30th June	Energy Generation (GWh)
	HYDEL	
1	WAPDA Hydel	36,982.53
2	IPPs Hydel	1,818.01
	Sub-Total	38,800.54
	% Share (Hydel Electricity Generation)	27.02
	THERMAL	
3	GENCOs: CPPA-G System	6,802.93
4	KE Own	10,186.00
5	IPPs: CPPA-G System	68,708.63
6	IPPs Connected with KE	2,184.57
7	SPPs/CPPs/N-CPPs: CPPA-G	216.8
	System	
8	SPPs/CPPs/N-CPPs connected with KE	579.02
	Sub-Total	88,677.95

	% Share (Thermal Electricity Generation)	61.76
	NUCLEAR	
9	CHASNUPP (I, II, III and IV)	9,172.09
10	KANUPP (I and II)	1,917.96
	Sub-Total	11,090.05
	% Share (Nuclear Electricity Generation)	7.72
	IMPORT	
11	Import from Iran	498.37
	Sub-Total	498.37
	% Share (Imported Electricity Generation)	0.35
	RENEWABLE ENERGY (RE / WIND, SOLAR AND BAGASSE)	
12	RE Power Plants: CPPA-G System	4,322.13
13	RE Power Plants connected with KE	199.56
	Sub-Total	4,521.69
	% Share (RE Electricity Generation)	3.15
	Total Electricity Generation of the Country	143,588.60

Details of the total Energy Generation in Pakistan

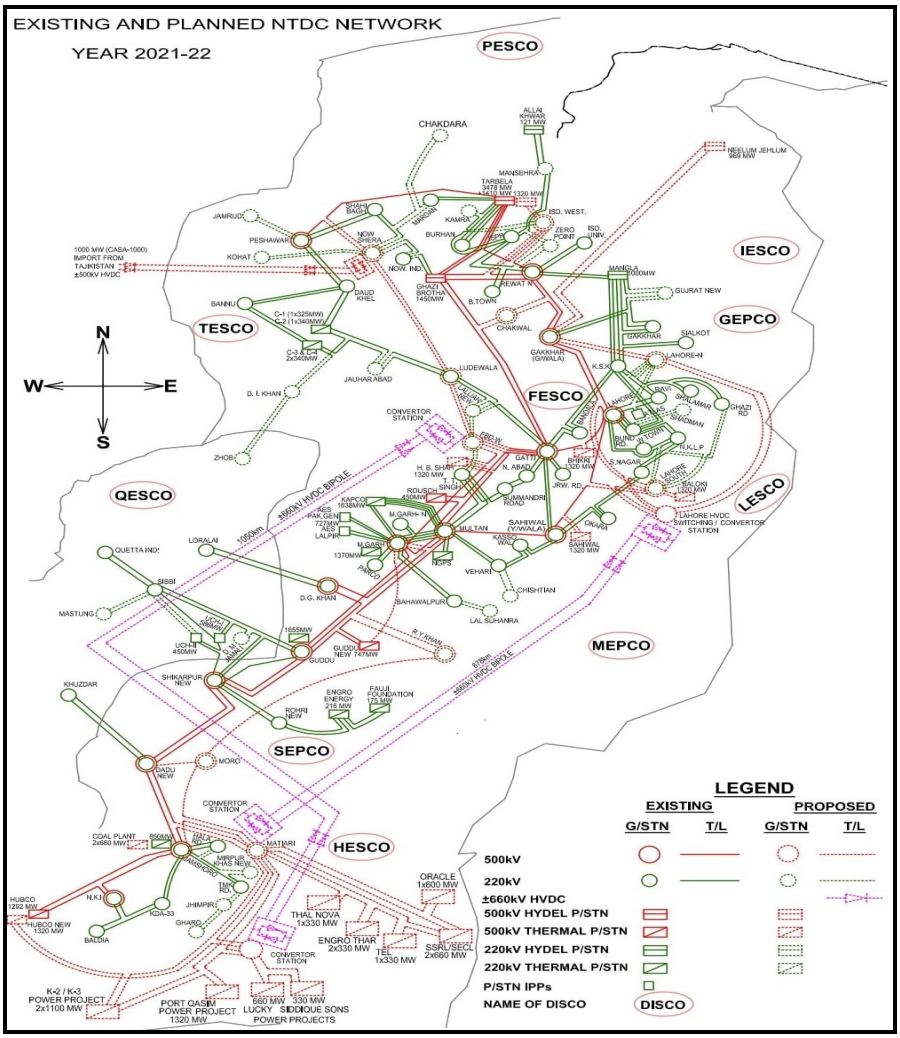
Source: NEPRA State of Industry Report 2021

2.5.2 Transmission System

The transmission System in Pakistan is owned and operated by NTDC. NTDC was incorporated under the Companies Ordinance 1984 on November 6, 1998, due to structural reforms introduced by the Government of Pakistan in the Power Sector. The principal business of NTDC is to own, operate, and build infrastructure for transmission system of 220 kV, 500 kV and above transmission Lines and associated Sub-stations.

NTDC is one of the better-operated power sectors corporatized companies in Pakistan. It operates and maintains Pakistan's high-voltage electric power transmission system (approximately 19,497 km of high voltage lines).

Following is the map showing the existing and planned network of the NTDC transmission system:



Map of existing and planned network of NTDC transmission system

The details of NTDC Grid Stations and Transmission lines are as follows:

Description		Details
No. of Grid Stations	500 kV	**16**
	220 kV	**45**
	Total	**61**
Length of Transmission Line (Circuit km)	500 kV	**8,059**
	220 kV	**11,438**
	Total	**19,497**
Transformation Capacity (MVA)	500 kV	**30,610**
	220 kV	**25,770**
	Total	**56,380**

Details of the NTDC Grid Stations and Transmission lines

Source: NEPRA State of Industry Report 2021

2.5.3 Distribution System

The distribution of electric power in Pakistan is licensed under the NEPRA Act. Currently, ten (10) Distribution companies wholly owned by the Federal Government are performing the function of electric power distribution in their respective territories under the license granted by NEPRA. Before amendments in NEPRA Act in April 2018, the distribution of electricity included the wire business, and sale of electricity to the end consumers. However, after the promulgation of NEPRA (Amendment) Act, 2018, the sale of electricity has been excluded from the distribution, while for the sale of electricity, the "Electric Power Supply License" is required. Under NEPRA (Amendment) Act, 2018, the existing distribution licensees shall be deemed to hold a license for the supply of electric power for five years from the coming into effect of the NEPRA (Amendment) Act, 2018.

Besides DISCOs, KE has also been granted a Distribution License for electricity distribution in its specified territory.

The number of consumers and peak demand in Distribution companies in PEPCO and KE systems is as follows:

Name of DISCO	Total No. of consumers in DISCO in 2020-21	Peak Demand (MW) in the Year 2020-21
PESCO	3,484,150	3,307
IESCO	3,261,112	2,406
GEPCO	3,816,224	2,948
FESCO	4,341,618	3,342
LESCO	5,527,859	4,835
MEPCO	6,518,207	4,635
QESCO	640,530	1,429
SEPCO	805,769	1,191
HESCO	1,173,063	1,399
K-Electric	3,184,342	3,604
Total	32,752,874	29,096

Number of Consumers and Peak Demand in various DISCOs and KE

Source: NEPRA Performance Evaluation Report for Distribution Companies 2021

The key statistics of the Transmission and Distribution Infrastructure in Distribution companies in PEPCO and KE systems are as follows:

DISCO	T/Lines 132 kV (km)	G/ Stations 132 kV (Nos.)	Power Transformers		11 kV Feeders		Distribution Transformers	
			No.	MVA	No.	km	No.	MVA
PESCO	2,967	95	221	6,658.50	1,138	37,177	79,437	6,264.35
TESCO	441	11	34	711.3	275	10,567	18,827	2,093.40
IESCO	3,482	111	260	6,609.00	1,211	26,237	51,988	4,279.00
GEPCO	2,611	59	172	5,084.80	910	24,659	76,125	4,745.00
LESCO	3,051	167	427	12,916.00	2,011	30,055	122,124	9,245.10
FESCO	2,337	102	217	5,778.00	1,185	45,690	120,446	7,628.00
MEPCO	4,072	134	301	8,602.00	1,652	79,837	187,791	9,102.17
HESCO	2,771	70	106	2,654.40	570	28,471	43,873	2,680.59
SEPCO	2,262	60	111	2,782.10	548	25,682	39,076	2,178.31

QESCO	5,500	73	135	3,267.00	688	40,822	64,119	3,339.40
Total CPPA-G	29,495	882	1,984	55,063.10	10,188	349,197	803,882	51,555.30
KE	833	69	168	6,457.00	1,937	10,283	29,702	8,153.34
Grand Total	30,328	951.00	2,152.00	61,520.10	12,125	359,480	833,584	59,708.64

Key statistics of the Transmission and Distribution Infrastructure in various DISCOs and KE

Source: NEPRA State of Industry Report 2021

The performance parameters of the Distribution companies in PEPCO and KE systems are as follows:

DISCO	Actual Losses 2020-21 (%age)	Actual Recovery 2020-21 (%age)
PESCO	38.18	101.87 *
TESCO	9.58	83.27
IESCO	8.54	116.87 *
GEPCO	9.23	105.1 *
LESCO	11.96	98.72
FESCO	9.28	97.2
MEPCO	14.93	102.15 *
HESCO	38.55	75.63
SEPCO	35.27	64.48
QESCO	27.92	39.8
KE	17.54	94.87

Performance parameters of the various DISCOs and KE

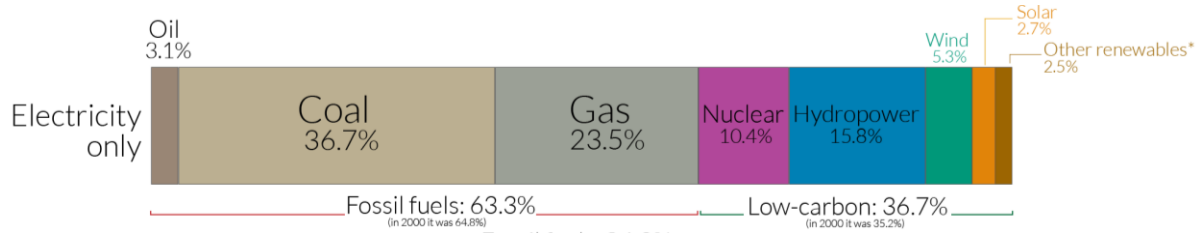
Source: NEPRA Performance Evaluation Report for Distribution Companies 2021

*Note: The recovery ratios are more than 100%, as the collection also includes receivables of previous years.

2.6 Global Energy Mix in Power Generation

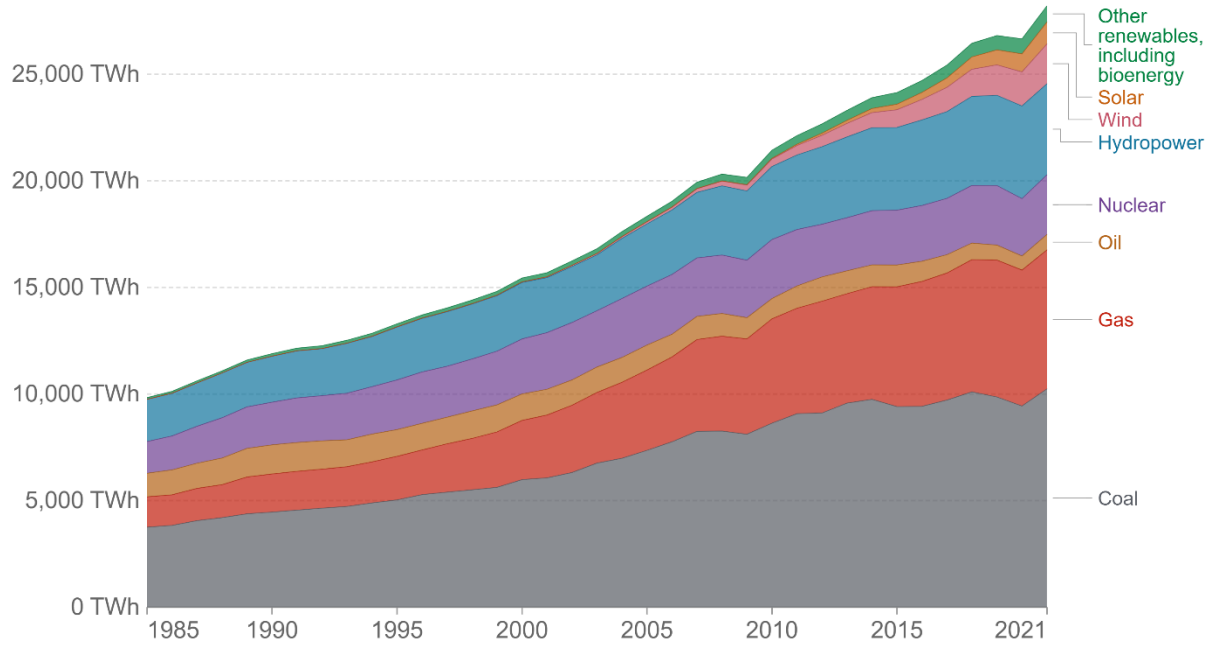
The energy is produced mainly through fossil fuels; however, the production of energy by using renewable energy resources has been increasing in recent years. In 2019, around 16% of global primary energy came from low-carbon resources. Low-carbon resources are the sum of nuclear

energy and renewable, including hydropower, wind, solar, bioenergy, geothermal, and wave and tidal energy.



Global Energy Mix in Power Generation (2020)

Despite producing more and more energy from renewables each year, the global energy mix is still dominated by coal, oil, and gas, about 84% of the total energy consumption. However, demand for renewables grew by 3% in 2020 and is set to increase across all key sectors – power, heating, industry, and transport – in coming years. The power sector leads the way, with its demand for renewables on course to expand by more than 8% to reach 8,300 TWh, the largest year-on-year growth on record in absolute terms.

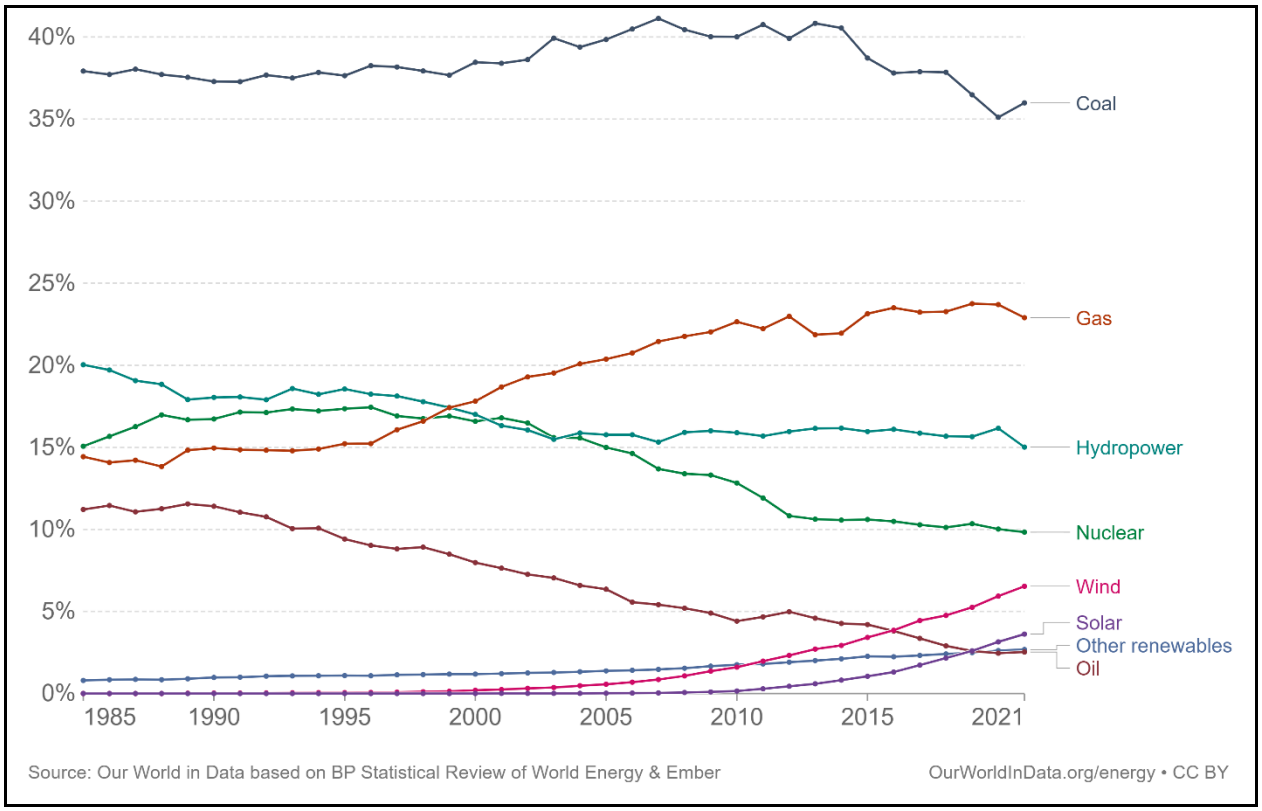


Source: Our World in Data based on BP Statistical Review of World Energy (2022) ; Our World in Data based on Ember's Global Electricity Review (2022). ; Our World in Data based on Ember's European Electricity Review (2022).
Note: 'Other renewables' includes biomass and waste, geothermal, wave and tidal.
OurWorldInData.org/energy • CC BY

World Electricity Production by Source (Year 1985 - 2021)

Solar PV and wind are expected to contribute two-thirds of renewables' growth. The share of renewables in electricity generation is projected to increase to almost 30% in coming years, the highest share since the beginning of Industrial Revolution and up from less than 27% in 2019. The wind is on track to record the most significant increase in renewable generation, growing by 275 TWh, or around 17%, from 2020. Solar PV electricity generation is expected to rise by 145 TWh or almost 18%, from 2020.

The production of energy by using Renewables increased tremendously in 2021, ; however, the energy produced through fossil fuels is way more than renewable energy resources. The trend is shown in the below chart at the end of the year 2021:

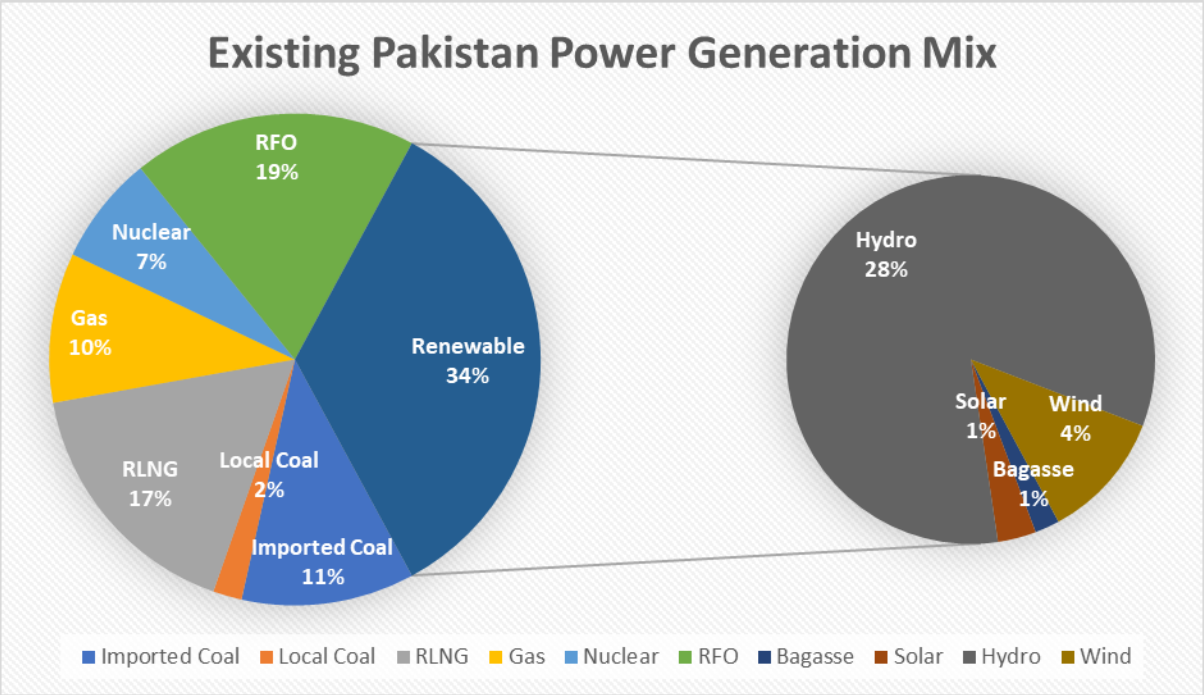


World Electricity Production by Source (1985 to 2021)

2.7 Energy Mix in Power Generation in Pakistan

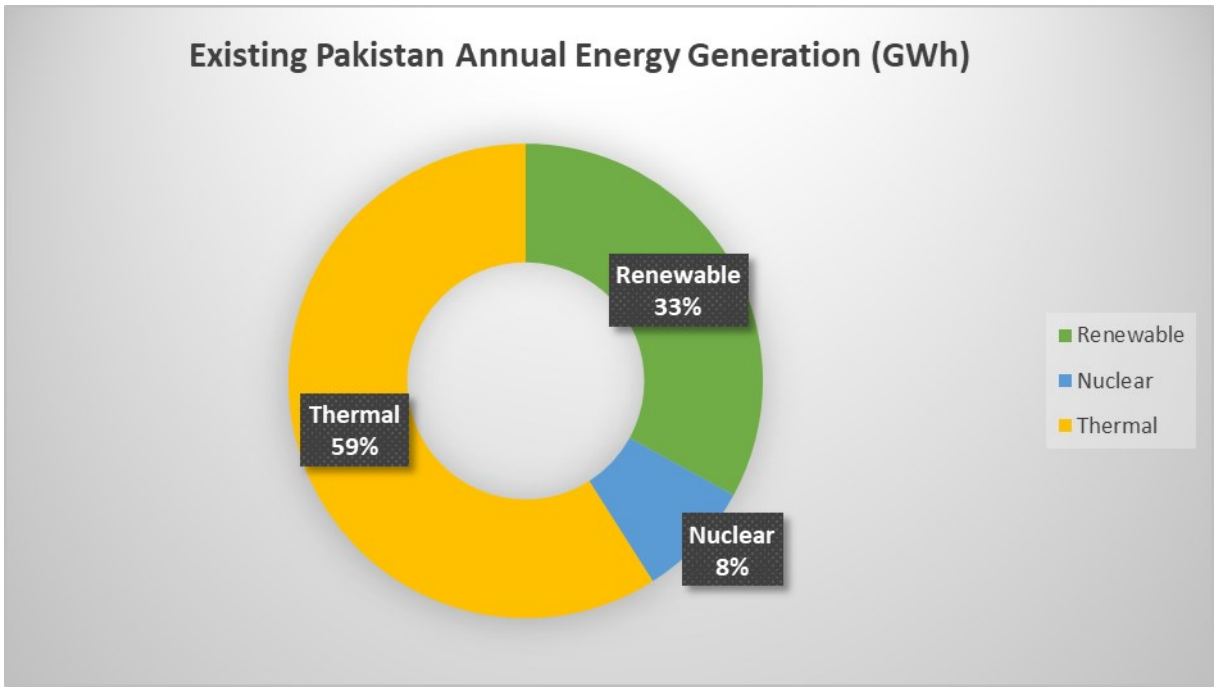
2.7.1 Present Scenario

The existing installed generation capacity of the NTDC system consists of around 34% from Renewable Energy comprising hydro, solar, wind, and bagasse-based technologies, and 66% from thermal plants, which comprised of natural gas, local coal, imported coal, RFO, RLNG, and nuclear-based technologies, as shown in the below Chart:



Existing Pakistan Power Generation Mix

The actual energy produced by power projects during the fiscal year 2020-21 was around 143,588 GWh, which consisted of approximately 33% by renewable energy (30% hydroelectric plants and 3% by solar, wind, and bagasse-based technologies), 59% by thermal plants (containing natural gas, local coal, imported coal, RFO, and RLNG based technologies), and 8% by nuclear plants as shown in the below chart:

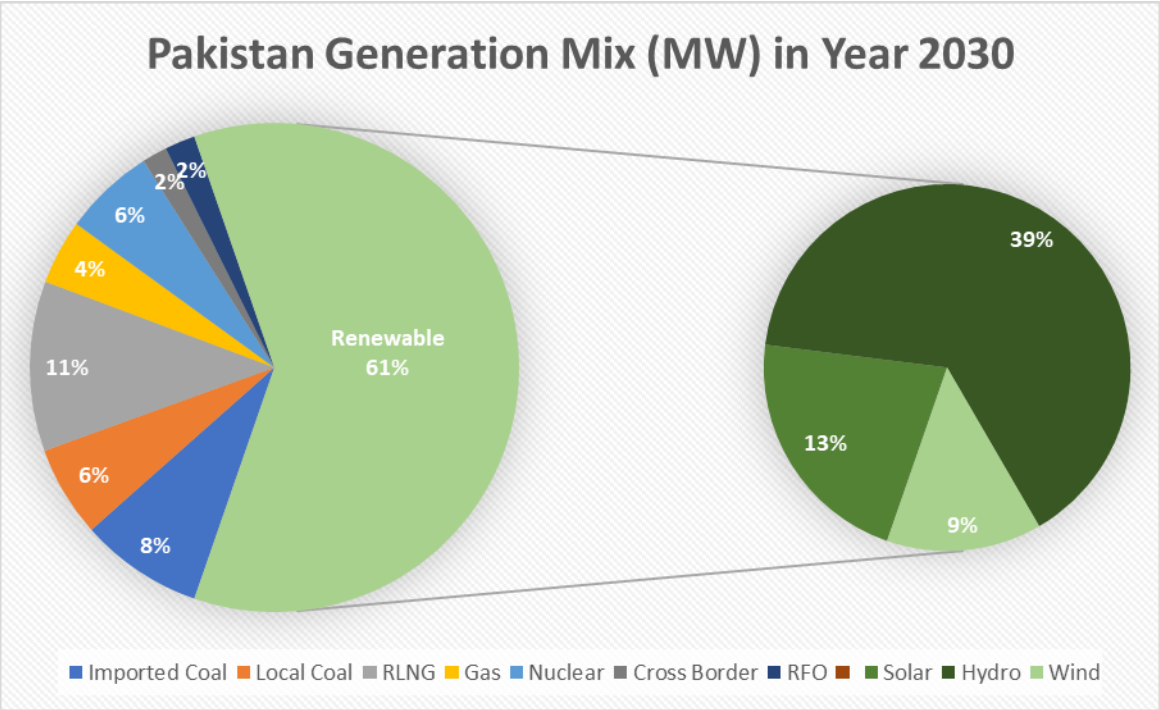


Existing Pakistan Annual Energy Generation (GWh)

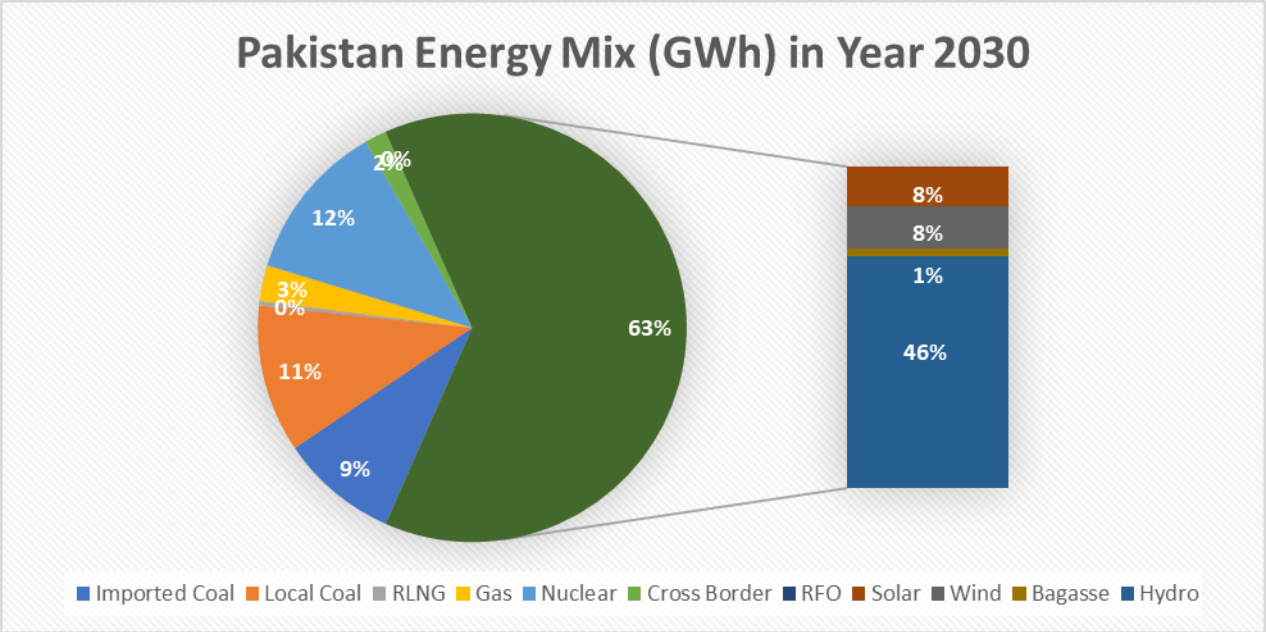
The energy was produced from fossil fuels (Oil, Gas, Coal) and hydropower till the year 2000; however, in the year 2000, a nuclear resource was added to the energy generation. For the last 6-8 years, the government of Pakistan has focused more on generating energy through renewable energy. Therefore, they started utilizing renewable energy resources.

2.7.2 Future Energy Mix:

As per IGCEP, to meet the demand of 37,129 MW in 2030, a capacity generation of 61,112 MW will be required. The share of energy generation through renewable energy resources will increase to about 61% in the year 2030 (39% hydro, 9% Wind, and 13% Solar). The capacity generation mix expected in the year 2030, as per IGCEP, is shown in the below chart:



The capacity share from renewable energy resources stands out to be 23,653 MW, 7,932 MW, 5,005 MW, and 749 MW of Hydro, Solar, Wind, and Bagasse, respectively, by 2030. The overall energy mix in GWh in the year 2030 would be more towards generatng renewable energy resources and over 60% of energy would be produced utilizing renewable resources.



2.8 Future Scenario

2.8.1 Generation

It is envisaged that opportunities in the generation sector will mainly be regulated through the Indicative Generation Capacity Expansion Plans (IGCEPs) prepared by NTDC and later by National Power Control Centre (NPCC) for the medium to long term scenarios, strictly on least cost basis. It is important to note the Policy Objectives of the Federal Government, which has set goals for the induction of renewable energy as 20% of total installed capacity by the year 2025 and 30% by the year 2030. Only a competitive bidding mode will be used to induce future renewable energy projects.

The generation function will be delicensed, and the investors will be required to weigh their risks for entering the sector as no sovereign guarantees will be provided as available through earlier power generation policies; however, opportunities will increase with the introduction of 'suppliers' who would be able to sell directly to Bulk power Consumers (BPC).

Some of the existing thermal power generation projects in public sectors would be retired or offered for privatization. Similarly, several private sector thermal power generation plants would complete their terms under NEPRA License. These plants may be able to participate in the market by supplying to BPCs at their evaluation of risks.

2.8.2 Transmission

NTDC will continue to provide transmission services all over the country, and it would be possible to construct transmission networks through public, private, and public-private modes. Additionally, given the provisions under the Constitution of Pakistan, the Provinces have been allowed to own and construct transmission lines for transmission services within the provincial boundary as allowed under the Amendment Act 2018. The Act also allows the construction of transmission lines in the private sector under the 'Special Purpose Transmission Licensee' regime.

2.8.3 Distribution

The distribution sector would not only offer construction of networks but opportunities will also be abundant in the shape of other players like suppliers and traders.

2.8.4 Competitive Market

NEPRA has already approved a competitive market plan for the sector subject to certain enabling conditions. As discussed above, the market is expected to generate new opportunities in the generation, distribution, and supply functions.

CHAPTER 3:

INSTITUTIONAL FRAMEWORK IN PAKISTAN POWER SECTOR

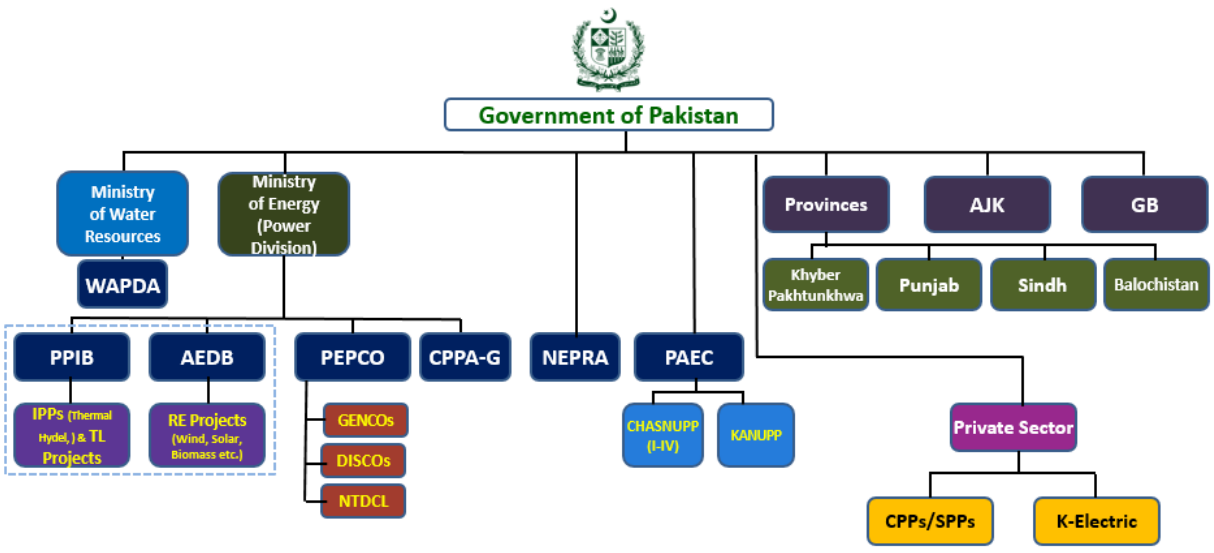
3.1 Introduction

Both public and private sectors have conspicuous shares in developing generation, transmission, and distribution infrastructure in Pakistan Power Sector. Out of the total installed capacity of 39,775 MW in 2020-21, the public sector represents 52.35% share, whereas the private sector makes up 47.65%. Similarly, out of the total energy generation of 143,588 GWh during 2020-21, the public sector contributed 52.84%, whereas the rest of the 47.16% was provided by the private sector.

As the sector grew through a number of investor-friendly power policies by successive governments, a robust structure was also put into place to manage and govern relevant entities for the provision of reliable electricity supply to consumers.

Currently, there are about 29 institutions under GOP and provincial / AJK governments, which oversee the working of the sector, as provided through their respective mandates.

Following is a schematic diagram of the institutional framework in the Power Sector of Pakistan:



Schematic diagram of institutional framework in Power Sector of Pakistan

3.2 Ministry of Energy (Power Division)

The Ministry of Energy was created on August 4, 2017, after merging the Ministry of Petroleum and Natural Resources with the Power Division of the Ministry of Water and Power (now renamed Ministry of Water Resources). The Ministry has two Divisions - Petroleum and Power. The Power Division oversees the overall power sector of Pakistan.

The Ministry of Energy (Power Division) is responsible for the following:

i. Matters relating to the development of power resources of the country.
ii. Matters relating to electric utilities.
iii. Liaison with international engineering organizations in the power sector.
iv. Federal agencies and institutions for the promotion of special studies in the power sector.
v. Electricity Sector.
vi. Karachi Electric Supply Corporation and Pakistan Electric Agencies Limited.
vii. National Engineering (Services) Pakistan Limited.
viii. Private Power & Infrastructure Board.
ix. Administrative Control of Alternative Energy Development Board.
x. National Energy Efficiency and Conservation Authority.

3.3 Water and Power Development Authority (WAPDA)

WAPDA was established in February 1958 for integrated and rapid development and maintenance of the country's water and power resources. WAPDA was assigned the duties of planning and executing projects and schemes for:

i. Generation, Transmission, and Distribution of Power,
ii. Irrigation, Water Supply, and Drainage,
iii. Prevention of Water Logging and Reclamation of Saline Land,
iv. Flood Control and
v. Inland Navigation.

Subsequently, in the late 1990s, thermal power generation projects were shifted to the private sector. Similarly, because of the restructuring of the Power Wing, the utility part was corporatized into independent companies. This gave birth to 14 entities operating in different zones. These are NTDC, four Thermal Power Generation Companies (GENCOs), and nine Distribution Companies (DISCOs). The present status of these companies is corporate public limited entities under the residual Power Wing is responsible for the development, operation, and maintenance of Mega Multi-purpose Hydropower Projects in the public sector, involving irrigation, power generation, flood control, and navigation.

Presently, the total installed capacity of 24 No. WAPDA Hydel Power Stations is 9,443 MW, which includes Tarbela, Mangla, Ghazi Brotha, Neelum Jehlum, and Warsak Hydropower Projects, which is about 25% of the total system capacity of 36,166 MW from all sources. The list of these projects is at **Annex-I**. The Net Electrical Output is about 32,000 GWh per annum. WAPDA is developing and constructing the following Mega Multi-purpose Hydropower Projects in the public sector:

Sr. No.	Name of Project	Capacity (MW)
1	Dasu Hydropower Project	4,320
2	Keyal Khwar Hydropower Project	128
3	Tarbela 5th Extension Project	1,410
4	Mohmand Dam Project	800
5	Diamer Basha Dam	4,500
6	Kurram Tangi Dam	83.4
Total (MW)		11,241.4

3.4 Pakistan Atomic Energy Commission (PAEC)

Nuclear Power Projects in Pakistan are developed and operated by the PAEC. PAEC was the established in 1956. The PAEC has developed several nuclear power projects to support the economic uplift of Pakistan. The total installed capacity of nuclear power plants connected with the NTDC System is 3,530 MW, which includes 1,330 MW Chashma Nuclear Power Project and 2,200 MW Karachi Nuclear Power Project.

3.5 National Electric Power Regulatory Authority (NEPRA)

NEPRA was established under the Regulation of Generation, Transmission, and Distribution of Electric Power Act, 1997. It is exclusively responsible for the regulation of the power sector in Pakistan. The powers and functions of NEPRA, as delineated in the Act, include:

i. Grant of licenses Generation, Transmission, and Distribution licenses under this Act
ii. determination of Tariffs/electricity rates of Generation, Transmission and Distribution Companies including IPPs
iii. to specify procedures and standards for investment programs by generation companies and persons licensed or registered under this Act,

iv. to specify and enforce performance standards for generation companies and persons licensed or registered under this Act,
v. to specify accounting standards and establish a uniform system of the account by generation companies and persons licensed or registered under this Act and;
vi. perform any other function which is incidental or consequential to any of the previously mentioned functions.

NEPRA Act 1997 was amended in 2018 (Amendment Act, 2018), introducing material changes in the existing regulatory regime.

3.6 National Transmission and Dispatch Company (NTDC)

NTDC was incorporated as a Public Limited Company on Nov 06, 1998. After receiving the Certificate for Commencement of Business, NTDC started its commercial operations on March 01, 1999. NEPRA granted a Transmission License to NTDC in December 2002 to exclusively engage in the transmission business for thirty (30) years.

NTDC links Power Generation Projects with Load Centers spread all over the country (including Karachi). NTDC is responsible for the evacuation of Power from the Hydroelectric Power Plants (in the North), the Thermal Units of Public (GENCOs) and Private Sectors (IPPs) (in the South) to the Power Distribution Companies through primary Extra High Voltage (EHV) Network.

The functions of NTDC are as follows:

i. Transmission Network Operator (TNO)
   - Operation and Maintenance of 500/220kV Network Planning, Design, and Construction of the new 500/220kV System and strengthening/upgrading the existing one.
ii. System Operator (SO)
   - Arranging Non-Discriminatory, Non-Preferential Economic Dispatch Ensuring Safe, Secure, and Reliable Supply.
iii. Wire Business
   - Transmission Planning
   - Design and Engineering
   - Project Development and Execution
   - Operation and Maintenance of Transmission Assets
iv. System Operation & Dispatch
   - Generation Dispatch
   - Power System Operation and Control

The transmission line network of NTDC includes 8,059 km long transmission lines operating at 500 kV level and 11,438 km long 220 kV lines. The country's first ±660 kV High Voltage Direct Current (HVDC), 886 km long transmission line from Matiari (Sindh) to Lahore (Punjab), with a bipolar transmission capacity of 4,000 MW, has been constructed and

completed by the private sector for evacuation of electric power from power plants in the South region and its transmission to the load centers.

3.7 Central Power Purchasing Agency Guarantee Limited (CPPA-G)

CPPA-G was formed to act as a power purchaser under the single-buyer model on behalf of DISCOs. The framework for a competitive market was provided through the transmission license granted by NEPRA to NTDC in 2003. As per the framework's provisions, a single-buyer model was introduced under which CPPA-G was required to procure power from hydel, public sector GENCOs and IPPs under the 1994 Policy. Pursuant to NEPRA Act, generation facilities were also allowed to sell to BPCs to be considered as a Single-Buyer-Plus model. It was expected that the market would be opened to a multi-buyer/multi-seller model over nine years; however, the scheduled milestones were missed due to various constraints.

Amendment Act 2018 provided for the introduction of a market operator. CPPA-G was first registered in 2015 as a market operator and was later granted a license by NEPRA as a Market Operator. CPPA-G, as the market operator in Pakistan, is facilitating the power market transition from the current single buyer to a competitive market. The market operator performs eight major functions segregated into six core and two support functions.

The core functions of CPPA-G include:

i. settlement,
ii. power procurement on behalf of DISCOs,
iii. finance,
iv. legal and corporate affairs,
v. strategy and market development,
vi. monitoring and coordination.

CPPA-G has been performing two roles, i.e., of a power purchaser and market operator. However, given the conflict of interest between these roles, the GOP has decided to separate the two functions. In the future, CPPA-G will only be responsible for the purchase of power, whereas a new entity will be formed to perform the functions of Market Operator under NEPRA Act.

3.8 Distribution Companies (DISCOs)

In Pakistan, electricity is supplied to the end consumers through various Distribution Companies (DISCOs). The distribution of electricity is a licensed activity and an important function for providing electricity to the end consumers. As of 30-06-2021 there were ten public sector DISCOs and K-Electric responsible for electricity supply in their respective areas.

These DISCOs are performing distribution functions under licenses granted by NEPRA. In addition, KE also possesses the Distribution license to supply the electricity in its designated area.

3.9 Private Power & Infrastructure Board (PPIB)

PPIB was established in 1994 to provide a one-window facility to private sector investors. PPIB is responsible for implementing the GOP's policies on private power generation and transmission. PPIB has been authorized by the Honorable President of Pakistan to issue the Sovereign Guarantee to IPPs for payment obligations by the Power Purchaser and the performance obligations of the Provinces and the AJK. PPIB is a repository of the IPP knowledge. Hence, it provides full support in matters related to the IPPs to the Ministry of Energy (Power Division), NTDC, CPPA-G, Provinces / AJK, NEPRA, and other departments of the GOP.

Following is the brief mandate of PPIB:

i. Function as One-Window facilitator on behalf of GOP, and its Ministries/ Departments.
ii. Execute IA and provide GOP guarantees on behalf of the President of Pakistan.
iii. Monitor and facilitate IPPs in executing PPA, and WUL with relevant GOP agencies.
iv. Provide technical, financial, and legal support to the then Ministry of Water & Power (now Power Division), Provinces and AJ&K.
v. Coordinate/ consult with local and multilateral development Finance Institutions.
vi. Handle power projects in the public sector and implement and operate them as independent and efficient corporate entities.

Since its inception in 1994, PPIB has a track record of attracting around US$23 billion of investment with the establishment of forty IPPs totaling 18,211 MW and an Extra High-Voltage Direct Current (HVDC) transmission line project in the country. This constitutes around 50 percent of installed power generation capacity in the country.

Following is the PPIB's portfolio of the commissioned IPPs (with capacities in MWs):

Total	Hydro	Thar Coal	Natural/Low BTU Gas	RLNG	Imported Coal	Oil
18,931	1,053	1,320	5,372	3,633	3,960	3,593

PPIB's portfolio of the commissioned IPPs

3.10 Alternative Energy Development Board (AEDB)

AEDB was established in May 2003 with the main objective to facilitate, promote and encourage the development of Renewable Energy in Pakistan and with a mission to introduce Alternative and Renewable Energies (AREs) at an accelerated rate. AEDB is responsible for implementing GOP's ARE Policies as announced from time to time. AEDB has been authorized

by the Honorable President of Pakistan to issue the Sovereign Guarantee to IPPs for payment obligations by the Power Purchaser and the performance obligations of the Provinces / AJK.

The Government of Pakistan has mandated AEDB to:

i. Implement policies, programs, and projects through the private sector in the field of ARE
ii. Assist and facilitate the development and generation of ARE to achieve sustainable economic growth
iii. Encourage transfer of technology and develop an indigenous manufacturing base for ARE Technology
iv. Promote the provision of energy services that are based on ARE resources; and
v. Undertake ARE projects on a commercial scale.

Following is the AEDB's portfolio of the commissioned IPPs (with capacities in MWs):

Total	Solar Power Projects	Wind Power Projects	Bagasse / Biomass based Cogeneration Power Projects
2,134	430	1,335	369

AEDB's portfolio of the commissioned IPPs

3.11 Merger of PPIB and AEDB

From the administrative perspective, the AEDB has been tasked with the similar functions as that of PPIB's, except that its scope is limited to the development of ARE projects, resulting in duplication of functions, resources, and efforts. Therefore, it has been decided by the Government of Pakistan that the mandate of AEDB may be merged with PPIB. This will also dovetail with the Competitive Trading Bilateral Contract Market (CTBCM), which envisions an Independent Auction Agent (IAA) that will be assigned the task of conducting the auctions/biddings on behalf of DISCOs, where PPIB as a single entity will function as IAA. In this regard, the Private Power & Infrastructure Board (Amendment) Bill 2022 is being processed at the National Assembly of Pakistan after due process.

3.12 Pakistan Electric Power Company (PEPCO)

Pepco was incorporated in 1998 in pursuance of the "Strategic Plan for Restructuring of Pakistan Power Sector" to facilitate the transition process in the WAPDA power wing and effective corporatization of new entities after unbundling WAPDA. PEPCO is responsible for assisting the Power Division, Ministry of Energy, and Government of Pakistan, in effectively

monitoring and overseeing Distribution Companies (DISCOs). The following companies come under PEPCO:

i. Distribution companies (DISCOs)
ii. Power Information Technology Company (PITC)

3.13 Provincial and Regional Power Sector Entitles

3.14 Provincial / Regional Implementing Agencies

3.15 Punjab Power Development Board (PPDB), Government of Punjab

PPDB was created in 2011 by the Government of Punjab to:

i. Facilitate the private investors in matters relating to the setting up of power projects per the policy of the Government.
ii. Implement the government's policy relating to power generation and coordinate with various departments and agencies of the Government in the field of power generation.
iii. Negotiate and finalize, with the prospective private investors in the power sector, the implementation plans, feasibility studies, and operational plans.
iv. Correspond with the local or international agencies in the performance of its functions.
v. Issue no objection certificate, permission, or license for the use of canal or river water or land of the Government for power generation.
vi. Explore potential sites for hydel and coal power generation and develop non-conventional sources of energy, including solar, wind, biomass, biogas, and solid waste.
vii. Examine energy policies of the Federal Government and advise the Government on the effect of the policies of the Federal Government.
viii. Co-ordinate with the Federal Government or any authority or agency of the Federal Government for the installation of power houses, grid stations, and transmission lines according to the needs of the Province.
ix. Encourage and ensure the exploitation of indigenous resources for the development of thermal or hydel power projects in the Province.
x. Encourage the local and foreign entities to form joint ventures to participate in the development of the power projects.
xi. Advise the Government on bulk power supply from the national grid for transmission and distribution within the province, levy of tax onelectricity consumption, laying of transmission lines, and determination of power tariff for distribution of electricity within the Province.
xii. Acquire, where necessary, land for power projects; and
xiii. Perform such other functions as prescribed to promote power generation in the province.

So far, PPDB has contributed to adding 1,720 MW into the National Grid. PPDB, a provincial facilitator, also maintains a constant liaison with the Federal and Provincial entities in achieving its goals and objectives.

The government of Punjab is pursuing the establishment of a Provincial Grid Company (PGC) to reap the advantage of wheeling regulations and optimally utilize spare generation capacities of IPPs plants after the completion of their PPA term(s). In addition, the indigenous generation made available in captive/PPP/public mode will be transmitted to potential consumers. The establishment of PGC is in the final stages of government approval. After that, the company will be registered with SECP and will proceed with the acquisition of a license from NEPRA.

3.16 Energy Department, Government of Sindh

Energy Department (ED), Government of Sindh (GOS) is providing one window facility for investors in the energy sector on the provincial level. Following are the key functions of ED GOS:

i. Development of Power Generation by exploiting oil, gas, coal, wind, solar and hydel resources.
ii. Development of power policy in consultation with other allied Departments.
iii. Development of Coal Resources.
iv. Grant of Licenses, Permits, Leases for Coal Mining.
v. Negotiations/Consultations with Private Investors.
vi. Serves as Secretariat of Thar Coal & Energy Board.
vii. All matter relating to Alternate of Renewable Energy.
viii. Implementation of Alternate Energy Policy framed by the Government of Pakistan.

So far, the ED GOS has issued:

- 35 Nos. of LOIs for the development of Wind Power Projects having a cumulative capacity of 2,485 MW, which are at various stages of development.
- 25 Nos. of LOIs for the development of Solar Power Projects having a cumulative capacity of 1,550 MW which are at different stage of development.
- 1 LOI to Nara Hydropower Limited for development of Hydel Power Project capacity of 15 MW which is at tariff determination stage.

Besides, Sindh Solar Energy Project has been initiated with the financial support of US$ 100 million by the World Bank.

The Sindh Coal Authority (SCA) was established through an act passed by Sindh Assembly in 1993. It is managed by a Board headed by the Minister of Energy, Government of Sindh. In order to fast track, the development of coal, especially the largest coal resources of Thar, the Thar Coal and Energy Board (TCEB) has been established by the Government of Sindh with representation from Federal and Provincial Governments as well. TCEB acts as one-stop organization on behalf of all Ministries, Departments, and agencies of the GOP and GOS in the matters relating to approval of the Projects for Coal Mining in Thar and coal-fired Power generation plants or other uses of Thar Coal.

Sindh Transmission and Dispatch Company (STDC) was incorporated on 7th January 2015, to provide extra high voltage electric power infrastructure. It is a subsidiary Company of Sindh Energy Holding Company (Pvt.) Limited. NEPRA also awarded the 1st ever Provincial Grid Company (PGC) License to STDC.

3.17 Pakhtunkhwa Energy Development Organization (PEDO), Govt. of Khyber Pakhtunkhwa

PEDO was created in 2014 through an amendment to PEDO Act 2014. It is an autonomous body of the Government of Khyber Pakhtunkhwa and is responsible for fast-track development of the province's energy sector. As the province of Khyber Pakhtunkhwa has immense potential for the development of hydro power, this area is being given the top priority, and private sector investment is being encouraged. Thermal power generation based on natural gas or coal also comes within the purview of PEDO.

The major functions of PEDO are as follows:

i. Approve and undertake the power projects of any financial value.
ii. Construct, maintain, own, operate and control the power houses, grids, and micro grids, generation stations, transmission, and distribution lines through itself, contractors, private parties etc.
iii. Conduct feasibility studies, surveys, detailed designs, detailed engineering, and research.
iv. Determine and prescribe procedures and standards, through rules and regulations, for determination, modification or revision of licenses, rates, charges, and terms and conditions for generation of electric power, transmission, interconnection, distribution services, and power sales to consumers by licensees.
v. Acquire by purchase, lease, exchange, or otherwise and dispose of by sale, lease, exchange, or otherwise any immovable or movable property or any interest in such property.
vi. Establish thermal, solar, wind, hydro, waste to energy or other alternate renewable energy based powerhouses, erect test masts, collect wind and solar data for power generation, lay or cause to be laid, pipelines for supply of fuel, establish fuel supply means, engage in transmission, trading, distribution, and sale of energy to industries and domestic consumers, manage demand, issue licenses, cause setting of tariff, recover and collect charges and fees;
vii. Perform any other function or exercise any other power as may be incidental or consequential for the performance of any of its functions or the exercise of any of its powers or as may be entrusted by Government to meet the objects of this Act.

PEDO is working to explore all energy avenues, including renewables like hydro, solar, and wind energy. So far, PEDO has completed the following projects:

Sr. No.	Name of Project	Capacity (MW)
1	Malakand-III Hydropower Project	81
2	Pehur Hydropower Project	18
3	Reshun Hydropower Project	4.2
4	Shishi Hydropower Project	1.7
5	Ranolia Hydropower Project	17
6	Machai Hydropower Project	2.6
7	Daral Khwar Hydropower Project	36.6
Total (MW)		**161.1**

3.18 Energy Department, Government of Baluchistan

The mandate of the Energy Department, Government of Baluchistan (ED, GOB) is to electrify villages through QESCO. Moreover, the ED, GOB executes solar energy projects in various areas of the province to utilize available renewable energy sources. Baluchistan Energy Company Limited (BECL) has also been established to promote investment through the private sector for the generation of electricity from indigenous resources.

The mandate of BECL is as follows:

i. To execute the Business of planning, promoting, Organizing, and implementing programs for the exploration and development of oil, gas, renewable, and alternate energy resources in Baluchistan.
ii. To conduct geological, geophysical, and other surveys to explore oil, gas, renewable energy, alternate energy, and conventional/non-renewable energy.
iii. To acquire shares of companies or interests of the Government of Baluchistan and the Government of Pakistan in the existing and new petroleum, renewable energy, and alternate energy joint ventures or corporations.

3.19 Azad State of Jammu & Kashmir, Power Development Organization (AJK PDO)

The Government of AJ&K established Power Development Organization (previously Hydro Electric Board) in 1989 to plan & undertake the development of identified hydro potential. It has completed 23 Projects having a total installed capacity of 79.12 MW so far. The details of these projects are at **Annex-VIII**.

3.20 Azad State of Jammu & Kashmir, Private Power Cell (AJK PPC)

AJK PPC was created in 1995. It acts as a one-window facility for implementing power projects up to 50 MW capacity in the Private Sector in AJK. In addition, the AJK PPC also undertakes evaluation /Pre-qualification of bids of submitted by the Sponsors.

Other responsibilities of AJK PPC include:

i. Issuance of Letters of Intent (LOIs) and Letters of Support (LOSs),
ii. Coordination and Monitoring of feasibility studies, as well as
iii. Coordination and execution of Implementation Agreement (IA), Power Purchase Agreement (PPA), Water Use Agreement (WUA), Land Lease Agreements and Direct Agreements.

For projects above 50 MW in AJK, PPC is the main driver and catalyst for marketing and negotiating/signing Security Documents with the IPPs. So far AJK PPC has facilitated the following projects in private sector:

Sr. No.	Name of Project	Capacity (MW)
1	Khari Hydropower Project	3.5
2	New Bong Escape Hydropower Project	84
3	Patrind Hydropower Project	147
4	Gulpur Hydropower Project	100.98
Total (MW)		335.48

3.21 Generation Companies (GENCOs)

After restructuring of power sector in 90s, the following four (04) Public Sector Power Generation Companies (GENCOs) have been formed. The list of projects of GENCOs is as follows:

Sr. No.	Name of Generator	Capacity	Fuel Type
1	GENCO-I Jamshoro 1 Block-I	250 MW	**RFO**
2	GENCO-I Jamshoro 2 Block-II	210 MW	**Gas/RFO**
3	GENCO-I Jamshoro 3 Block-II	210 MW	**Gas/RFO**
4	GENCO-I Jamshoro 4 Block-II	210 MW	**Gas/RFO**
5	GENCO-I Jamshoro Block-III	144 MW	**Gas/HSD**
6	GENCO-II TPS Guddu Block -I	415 MW	**Gas**
7	GENCO-II TPS Guddu Block -II	600 MW	**Gas**
8	GENCO-II TPS Guddu Block -III	420 MW	**Gas/RFO**
9	GENCO-II TPS Guddu Block -IV	220 MW	**Gas**
10	GENCO-III TPS Muzaffargarh Block -I	630 MW	**Gas/RFO**
11	GENCO-III TPS Muzaffargarh Block -II	320 MW	**Gas/RFO**
12	GENCO-III TPS Muzaffargarh Block -III	400 MW	**Gas/RFO**
13	GENCO-III GTPS Faisalabad Block -IV	144 MW	**Gas/HSD**
14	GENCO-III SPS Faisalabad Block -V	132 MW	**Gas/RFO**
15	GENCO-III GTPS Faisalabad Block -VI	100 MW	**Gas**
16	Nandipur	425 MW	**RFO**
17	GENCO-IV Lakhra Coal	150 MW	**Lakhra Coal**
	Total	**4,980 MW**	

*List taken from CPPA-G Website

3.22 Independent Power Producers (IPPs)

IPPs are private power projects, which are developed under various GOP's Power Policies, and which sell power to CPPA-G / NTDC at an electricity tariff approved by NEPRA. In Pakistan, 20,881 MW of private power projects are in operation based on coal (imported / local), RLNG, oil, gas, Hydro, Wind, Solar, Bagasse, etc., the breakup of which is as follows:

Sr. No.	Type of IPPs	Capacity (MW)
1	IPPs Hydel	1,192
2	IPPs	17,276
3	Wind	1,248
4	Solar	430
5	Bagasse	369
6	KE IPPs	366
Total		**20,881**

3.23 Captive and Small-Scale Power Producers (CPPs / SPPs)

CPPs are captive power projects, which are owned and operated by various industries in Pakistan. They consume power within the industry. The SPPs are small power producers, who are the companies which either generate and consume power by themselves or supply power to the neighboring industries. In Pakistan, 340 MW of CPPs / SPPs are currently in operation.

CHAPTER 4:

GOP POWER POLICIES, REGULATORY FRAMEWORK AND TARIFF REGIME

A. GOP Private Power Policies

4.1 Private Power Generation Policies

The performance of Pakistan's public Sector Utilities (WAPDA/KESC) was commendable till 70s. Subsequently, however, deterioration began to creep into their work, and after the 1980s, power shortfalls started to appear. After the mid-eighties, budget constraints and mismanagement coupled with inherent inefficiencies in public sector utilities led the government to seek Private Sector investment for power generation.

It was anticipated that the Private Sector participation (local and foreign) in Power Sector would bring additional Financial Resources, help in meeting growing energy demand through enhanced reliability and efficiency, and reduce and transfer Government risks to the private sector (e.g., construction, completion, operational and financial risks etc.). It was also envisaged that foreign direct investment would not only stimulate the development of local capital markets but induction of foreign expertise would also help transfer knowledge, ameliorate management skills, and overall capacity building of human resources. GOP, therefore, over a period from 1985 to the early nineties published several documents about the opportunities for the private sector in the development of Pakistan power generation sector. Subsequently, several Policies for other sectors in addition to the generation sector were framed by successive governments to attract private sector investment

Following are the details of various measures and Policies announced by successive Governments from time to time to encourage private investment in developing Power Generation and Transmission Line Projects:

1. ECC Decision on "Private Sector Induction in Power Generation (1985)"
2. Opportunities for the Private Sector in Power Generation Projects in Pakistan (June 1989)
3. Investment Opportunities in Private Sector in Power Generation Projects in Pakistan (July 1991)
4. Investment Opportunities in Private Sector in Power Generation Projects in Pakistan (August 1991)
5. Investment Opportunities in Private Sector in Power Generation Projects in Pakistan (February 1992)

6. Investment Opportunities in Private Sector in Power Generation Projects in Pakistan (February 1993)
7. Policy Framework and Package of Incentives for Private Sector Power Generation Projects in Pakistan (March 1994)
8. Private Power Investment Opportunities in the Power Sector in Pakistan (November 1994)
9. Policy Framework and Package of Incentives for Private Sector Transmission Line Projects in Pakistan (March 1995)
10. Policy Framework and Package of Incentives for Private Sector Hydel Power Generation Projects in Pakistan (May 1995)
11. Policy for New Private Independent Power Projects (July 1998)
12. Policy for Power Generation Projects (2002)
13. Policy for Development of Renewable Energy for Power Generation, 2006
14. National Policy for Power Co-Generation by Sugar Industry and Guidelines for Investors (January 2008)
15. Policy for Captive Power Producers (CPPs)
16. Policy for New Captive Power Producers (N-CPPs)
17. Policy for Small Independent Power Producers (SIPPs)
18. Frame Work for Power Co-Generation 2013 (Bagasse / Biomass)
19. Transmission Line Policy 2015
20. Power Generation Policy 2015
21. Alternative and Renewable Energy Policy 2019

Some of the Private Power Policies announced by the GOP from time to time were a great success, while others could not achieve the desired result. The key Private Power Policies under which several Independent Power Projects (IPPs) have been established are:

4.1.1 Policy Framework and Package of Incentives for Private Sector Power Generation Projects in Pakistan (Power Policy 1994)

Following incentives were offered to investors through the Power Policy 1994:

- Investors were free to select fuel, technology and site
- Upfront Bulk Power tariff was 6.5 cents / kWh
- Projects to be on BOO (Build Own Operate) Model
- Fuel price to be treated as "Pass through"
- Minimum equity requirement of 20%
- GOP Guarantee for payment obligations of public sector power utilities (WAPDA/KESC) and fuel supplier (PSO/OGDC)
- Standardized Security Package was developed to avoid protracted negotiations
- PPIB was created to provide one-window facility to private investors

The Power Policy 1994 received an overwhelming response, and a total of Eighty one (81) Letters of Interest (LOIs) and Thirty-six (36) Letters of Support (LOSs) were issued by PPIB. Policy attracted world renowned key players like International Power, AES, El-Paso, General Electric, ABB, Tenaga, Mitsui (Japan), Xenel (KSA), Coastal Technologies,

Siemens, Wartsila, etc. as sponsors and reputable commercial lenders such as IFC, ADB, IDB, US Exim Bank, CDC UK, EDC UK, PROPARCO (France), SWEDFUND (Sweden), etc.

As a result, fourteen (14) IPPs having a cumulative capacity of 3,113 MW were commissioned (list is at **Annex-II**). Policy attracted Foreign Direct Investment (FDI) of about US$ 3.5 Billion in three years. The Policy successfully established new institutions like PPIB, which provided one window facility to private sector investors, a major reason for successful implementation of the policy. The Policy attracted development and implementation of thermal power projects on a fast-track basis.

4.1.2 Policy Framework and Package of Incentives for Private Sector Hydel Power Generation Projects in Pakistan (Hydel Policy 1995)

To address the peculiarities of Hydro Power Projects, the Government of Pakistan (GOP) developed and announced the Hydel Policy 1995. Following are some of the Features of the Hydel Policy 1995:

- Run-of-river hydel projects with size up to 300 MW
- Up-front levelized tariff of US Cents 5.57/kWh
- 'Take or pay' for energy up to 95%
- A nominal price for the use of water at a rate of 0.233 US cents/ kWh to be paid to the provincial governments
- Processing of LOI / LOS at Provincial level
- Standardized security agreements
- Private sector to carry out feasibility studies to determine technical and economic feasibility of the proposed project

Under Hydel Policy 1995, PPIB issued 41 LOIs with a total capacity of 1,856 MW and 13 LOSs with a capacity of 354 MW to various Private power companies to develop Hydro Power Projects.

Although, only one hydropower project was completed under this Policy i.e. 84 MW New Bong Escape Hydropower Project, which achieved financial closing and Commercial Operation Date (COD) in 2009 and 2013 respectively, the Power Policy 1994 however, generated a lot of interest in development of hydro power projects in private sector and created awareness about the peculiarities of hydro power projects. It also helped in creation of the institutions similar to that of PPIB in Provinces /AJK as well.

4.1.3 Policy for Power Generation Projects (Power Policy 2002)

Keeping in view the growing power demand and the experiences gained from the implementation of Power Policy 1994, the GOP announced a Power Policy in 2002, which encouraged local and international investors to develop Private Power Projects. The Key Features of the Policy 2002 were:

- Exemption from Corporate Income Tax, Turnover Tax and Withholding Tax, no Sales Tax, only 5% concessionary Import Duty on plant & equipment not manufactured locally
- GOP Guaranteed obligations of power purchaser and provinces
- GOP provided protection against Political Force Majeure, change in law, and change in duties & taxes
- Power Purchaser to bear the hydrological risk for hydropower projects
- GOP allowed 20% Return on Equity (ROE) for indigenous coal-based power projects and 17% ROE on Hydro Power Projects

The Power Policy 2002 received a very encouraging response from local investors. Nearly all the leading business houses in Pakistan, such as Nishat Group, Sapphire Textile Ltd., Attock Refinery Ltd., Engro Chemical, Shirazi Investment, Fauji Foundation, Saif Group, Liberty Mills and Descon Group, etc. developed projects under this policy. Nearly all of these projects were financed by local Banks, such as the National Bank of Pakistan, Habib Bank Ltd, United Bank Ltd, Muslim Commercial Bank, Allied Bank Ltd, Askari Bank Ltd, Faysal Bank Ltd, Meezan Bank Ltd, Bank Al Habib, etc.

Under Power Policy 2002, PPIB issued 33 LOIs and 24 LOSs. Out of those, 16 projects with a cumulative capacity of 3,903 MW have been commissioned (list of projects is at **Annex-III**). The Power Policy 2002 attracted investment of about US$ 3 Billion. One of the major factors for the success of the his policy was the provision of one window facility at the Federal level through PPIB for IPP projects above 50 MW. The policy successfully generated interest and know-how in local investors and lenders relating to private infrastructure (power) projects and was instrumental in developing 969 MW of private sector hydel power projects.

4.1.4 Frame Work for Power Co-Generation 2013 (Bagasse / Biomass)

In order to incentivize the power generation from Bagasse / Biomass, the GoP announced the Frame Work for Power Co-Generation 2013 (Bagasse / Biomass). The salient features of the policy are as follows:

- The scope of the Renewable Energy Policy 2006 shall include Bagasse/biomass / Waste-to-Energy, Bioenergy.
- Upfront tariff for bagasse / biomass based cogeneration projects to be determined by NEPRA.
- Power Producers shall have the option to offer energy to the respective DISCOs at 11 kV or 132 kV, or to the CPPA at 132 kV, provided that the cost of interconnection, grid station upgrades, etc. for power evacuation shall be incurred by the respective DISCOs.
- It shall be mandatory for the Power Purchaser to evacuate all the energy offered to it by the Power Producer.
- Standard bankable EPA & IA documents will be prepared and provided to the Power Producer by AEDB.
- Wheeling shall be an option for Power Producers as allowed in the Renewable Energy Policy of 2006.

As a result, nine (09) IPPs having a cumulative capacity of 369 MW have been commissioned (list is at **Annex-VII**).

4.1.5 Power Policy 2015

Based on the useful experience gained on developing and implementing the private power projects under Power Policy 1994 and 2002, the GOP prepared and announced the Power Policy 2015. Following are the Key Features of the Power Policy 2015;

- Tripartite Letter of Support (LOS) Regime
- GOP Guaranteed obligations of power purchaser & provinces
- Protection against Political Force Majeure and Change in Law
- Hydro Projects - Hydrological risk on Power Purchaser & Water Usage Charges (WUC) to be paid to the concerned province
- Attractive ROE provided by the Regulator – Imported Coal: 27.3%; Local Coal: 29.5%; Thar Coal: 34.5%; Hydro: 17% IRR (23% ROE); Gas/LNG: 15% IRR (18% ROE)
- Tariff re-openers for Hydropower Projects were allowed for the following:
  (i) Cost Escalation in Civil and E&M works
  (ii) Resettlement Cost
  (iii) Cost variation due to Geological Conditions in Tunnels

The Policy was successful mainly in attracting investment for mega imported / local coal and R-LNG Projects. Under Power Policy 2015, eight projects with a total capacity of 8,913 MW have been commissioned (the list of projects is at **Annex-IV**). The Policy provided attractive ROE to the coal-based projects. Hence, a number of investors showed interest in the development of Coal based Projects. A total of five (05) Coal fired Projects with a capacity of 5,280 MW have been commissioned under Power Policy 2015. It is important to highlight that all of these projects are under CPEC Framework, financed by Chinese and local Sponsors and Chinese lenders. The completion of the 660 MW project in Thar will prove to be the beginning of a new era in Pakistan's power sector as coal mining at Thar at this scale was successfully done for the first time for use in power generation

4.1.6 Renewable Energy (RE) Policies (ARE Policy 2006, Power Co-generation Policy 2013, and ARE Policy 2019)

To help reduce environmental degradation through reduced emissions of Carbon Dioxide, and Sulfur, encouraging and implementing renewable energy based projects has been adopted at policy levels all over the world. Initially RE based projects could not get the needed assent at higher levels in Pakistan including Nepra, due to not only their exuberant cost of production relative to other generation sources, but also technical limitations including intermittency and response to system faults were considered negatively by the decision makers. Lately with the rapid reduction in costs and technological advancement GOP has fully embraced induction of RE through its various policies including National Electricity Policy 2021.

In order to promote RE Projects, the GOP created Alternative Energy Development Board (AEDB) in the year 2003. The AEDB was mandated by the GOP to implement policies,

programs and projects through the private sector in the field of Alternative Energy, and to assist and facilitate development and generation of Alternative Energy to achieve sustainable economic growth.

Following are the Key features of the ARE Policy 2006:

- Wind Risk / Hydro Risk borne by the Power Purchaser
- Mandatory purchase of electricity by Power Purchaser
- Grid provision is the responsibility of the Power Purchaser
- Attractive Tariff (Cost plus and bulk / upfront tariff)
- No Income Tax / withholding tax/turnover tax

ARE Policy 2006 received a good response. Twenty-Six (26) wind power projects of 1335 MW and Six Solar PV Power Projects with a cumulative capacity of 430 MW have achieved Commercial Operation and are supplying electricity to National Grid (Refer to **Annex-V** and **VI**).

Although the RE Policy 2006 had been instrumental in kicking off the alternative and renewable energy sector developments, the main focus had been limited to the development of wind, solar and biomass-based power generation on solicited mode through cost-plus and upfront tariff settings, whereas by year 2019, the world had shifted to competitive bidding mode for developments.

In order to further realize the full potential of alternative and renewable energy in the country while promoting competitive pricing, the government has announced Alternative & Renewable Energy Policy 2019 (ARE Policy 2019).

Following are the Key features of the ARE Policy 2019:

- Three Modes of Procurement of Power allowed i.e. (i) Competitive Bidding, (ii) Government to Government (G2G) and (iii) Unsolicited Projects.
- The GOP under the policy set the target of at least 20% on-grid RE generation by capacity by the year 2025 and at least 30% by 2030 (20X25 and 30X30 target).
- Procurement of AREPs will be done through auctions, preferably on annual basis.
- IGCEP outputs will form the basis of all on-grid capacity procurements (except net-metering).
- Upfront or cost-plus tariffs for mature technologies will be discontinued.
- Tariffs will be comprised of energy purchase price only (no capacity payments), coupled with a mandatory-purchase obligation for the duration determined in accordance with the prescribed clause of the policy.

AEDB is currently in the process of preparing and finalizing Request for Proposal (RFP) documents for conducting the bidding for RE projects under this policy.

4.1.7 Net Metering Regulations for Solar Projects 2015

NEPRA, in September 2015, issued Net-Metering Regulations that allow the DISCOs to purchase excess units of electricity produced by the consumers and net them off against the units consumed from the grid. Renewable Energy is a long-term power solution. The Solar PV Technology gives access to affordable electricity supply during system life. Residential and commercial customers can switch their electricity load to Renewable Energy (RE) and can slash their power bills. Subsequently, AEDB issued "Net-Metering Reference Guide for Electricity Consumers".

In Pakistan, as of today, more than 20,000 domestic, commercial and industrial net metering customers have successfully availed the opportunity all over the country with approximately 400 MW i.e. added to the national grid through this concept. The demand of net metering customers is increasing day by day. Solar energy would have the maximum prospects and would see its maximum market share with net metering.

In addition to above, the GoP is also encouraging the utilization of Solar Water Heaters.

4.2 Private Transmission Line Policy

4.2.1 GOP Policy Framework for Private Sector Transmission Line Projects, 2015 (Transmission Line Policy 2015)

The large scale capacity additions in the Pakistan Power Sector required the corresponding augmentation in the transmission network. Due to the encouraging response of the private sector for investments in imported and local coal, LNG, hydropower, gas-based and oil-based projects and the constraints on public sector resources, the GOP decided to announce the Policy Framework for Private Sector Transmission Line Projects, 2015 (Transmission Line Policy 2015) for investment in AC and DC EHV Overhead Power Transmission Lines and Substations (SS) / Grid Stations (GS) or Convertor Stations (CS).

Salient Features of Transmission Line Policy 2015 are as follows:

- Award of Projects - Through ICB and Upfront Tariff
- EHV Transmission Lines - 220 kV and above (HVAC & HVDC)
- Acquisition of Land & Right of way to be provided by NTDC
- Project Term: 25 years on BOOT basis
- Transmission Service Charge - NTDC to pay a fixed Transmission Service Charge, regardless of the quantum of energy
- Exemption for first 10 Years - Exemption from corporate income tax including minimum turnover rate tax and withholding tax on imports for the period of 10 years from date of establishment of Independent Transmission Company or from the date of commencement of business whichever is earlier
- Only 5% concessionary Import Duty - Plant and Equipment not manufactured locally

For large volumes of power to be generated through mainly coal-based power projects, a stable transmission corridor was required to provide maximum capacity utilization of the transmission

network. Based on detailed deliberations, the GOP decided to develop a ±660 kV HVDC Transmission Line from Matiari to Lahore for which NEPRA determined the tariff. The Project has been completed in Sept 2021 under the CPEC framework.

B. Regulatory Framework

4.3 Historical background

Historically, in Pakistan, electricity sector policymaking, regulation, and service provision were all under Government's control. Creating an independent regulatory authority was one of the key components of the GOP approved, Strategic Plan for Power Sector Restructuring 1992 to bring transparency and efficiency in the power sector's decision-making.

Accordingly, NEPRA was established in 1997 through NEPRA Act No. XL 1997 to regulate the provision of electric power services in Pakistan.

One of the main objectives of NEPRA is to improve the efficiency and availability of electric power services while protecting the interests of consumers and investors and encouraging competition through its tariff determinations. Nepra Act provided a broad framework for development of the Pakistan Power Sector; unbundled following the 1992 power sector Reform Process. NEPRA Act contains a number of provisions and obligations for regulating generation, transmission and distribution entities.

In order to provide a framework to move toward a competitive market, the federal government amended the existing Act in 2018 (Amendment Act 2018). The amendment in 2018, brought major changes to Nepra Act, like opening of the sector and wholesale competition in the market. A separate section has been included to define the role of provinces, specifically in the transmission of electric power. The following sections provide an overview of the amendment Act 2018.

4.4 NEPRA Amendment Act, 2018

The Regulation of Generation, Transmission and Distribution of Electric Power (Amendment) Act, 2018 was passed by the Government of Pakistan on 27th April 2018. The Amendment Act has restructured and evolved the power sector in material respects and completely reformed the role and responsibilities of the Nepra and other stakeholders in the sector.

Separation of Network and Supply Functions: The Amendment Act has separated network and supply functions, which were earlier bundled in distribution business. The Amendment Act defines 'distribution' as related to network ownership and operation, whereas 'supply' is for sales to end consumers. Segregation of distribution and supply functions is expected to bring more transparency and efficiency in the overall regulations of distribution sector.

No Exclusivity for Distribution Companies: The Amendment Act has also ended the exclusivity of distribution companies, earlier allowed in their licenses under Nepra Act 1997. Therefore,

under the revised scheme of things, other supply license holders, may also supply to consumers in the service territory of another supplier.

Cessation of Generation Licenses: The Amendment Act has provided a mechanism that shall implement a gradual cessation of generation licenses in the forthcoming years, with the Generation license requirement to be gradually abolished under a mechanism formulated by the Federal Government after consultation with the Authority. Licensing is currently a core function of NEPRA, and cessation of a licensing regime for generation companies will effectively remove a significant portion of the regulator's function and work. This has been done for liberalizing the sector by removal of barriers for new entrants.

Steps for liberalization pf markets: Alongside cessation of generation licenses, a number of additional licenses and entity classes were introduced in the Amendment Act, which are envisioned to fundamentally shift the entire power sector towards a more competition-based regime. NEPRA will now grant System Operator and Market Operator licenses, who will be tasked with overseeing transmission systems and dispatch and market transactions respectively. The Authority will also be granting Provincial Transmission licenses where required. The Amendment Act further introduces 2 new class of licensees, namely the Electric Power Trader and Electric Power Supply. The Electric Power Supply license will be authorized to sell electric power to end consumers.

The National Electricity Policy and Plan: The Amendment Act has introduced the concepts of the National Electricity Policy and the National Electricity Plan under Section 14A. The National Electricity Policy is a policy document that shall be prepared by the Federal Government, with the approval of the Council of Common Interests (CCI). The Policy's scope shall be focused *inter alia* on development of power markets, energy sustainability, transmission systems and optimal utilization of resources. The National Electricity Plan, however, is a document that shall be prepared and prescribed by the Federal Government, which has no set parameters or heads under which it shall be formulated. The Plan has unrestricted freedom to address and cover any subject matter deemed relevant by the Federal Government.

4.5 Market Concept

The Amendment Act, while providing a framework for a market through a number of steps for liberalization, like allowing new players and allowing BPCs to have choice of their supplier, has not mentioned the specific type of competitive market to be evolved.

Section 14A of the Amendment Act provides a broad guideline about market design. Section 14 A(1) provides that the Federal Government shall, from time to time, with the approval of the Council of Common Interests, prepare and prescribe a national electricity policy for development of the power markets. Section 14A (2) (b) stipulates that the policies to be prescribed by the federal government shall provide for, inter alia–development of efficient and liquid power market design.

4.6 National Electricity Policy

National Electricity Policy (NEP) provides detailed features of a competitive market. Sections 5.5.1 and 5.5.2 give detailed features of a Competitive Trading and Bilateral Contract Market (CTBCM).

Sections 5.5.1 reads: "The efficient and liquid power market design, as approved by the Regulator (CTBCM), will contribute to attaining the policy goals. The approved wholesale market design ensures the following objectives:

a. providing open access to all market participants on a non-discriminatory basis;
b. creating an environment to attract investment;
c. contribute in improving power sector security of supply;
d. ensuring further evolution of wholesale market to advanced phases;
e. promoting competitive arrangements, both for and in the market;
f. promoting payment discipline among market participants;
g. eliminating sovereign guarantees for purchase of power over time through improvement in market conditions;
h. ensuring compatibility of wholesale market design for operation of retail market in the future;
i. ensuring transparency, predictability and accountability in the market; and
j. creating an environment for compatibility / participation in regional electricity market."

Section 5.5.2 reads as follows;

"The approved wholesale market design, its implementation and subsequent development takes into account the following:

a. enabling the choice of changing supplier of electricity, initially only for large or Bulk Power Consumers, followed by gradual liberalization of the retail market;
b. creating incentives to promote entry and sustainability of the most efficient generation in the system;
c. no anomalies shall be created that allow any participant to take undue advantage of market conditions;
d. creating minimum burden for the government in the form of subsidies through liberalization of the market;
e. maintaining investor confidence by honoring the existing contracts (Energy / Power Purchase Agreements) and / or seamless transition of such contracts in the market design by mutual consent;
f. providing a level playing field to all market participants through uniform application of cross-subsidization and other grid charges to consumers of all suppliers;
g. the Government shall take a decision on the recovery of costs that arise due to advent of the open access and market liberalization;
h. ensuring open access to information and undertaking other transparency measures in the market especially providing for credible and independent service providers in the market;

i. standardizing trading instruments to enhance liquidity;
j. commercialization of strategic projects;
k. ensuring proper settlement mechanisms for the imbalances resulting from trade among different market participants;
l. ensuring accountability of market participants to bring discipline in the market;
m. building on experiences of international market development and local market conditions;
n. allowing, through simple regulatory adjustments, the future evolution towards increasing competition for and/or in the market; and
o. fair allocation of risks amongst market participants."

4.7 Development of Rules and Regulations under Nepra Act 1997

NEPRA has developed the Rules, Regulations, Codes, Guidelines, manuals, and Standard Operating Procedures (SOPs) under Nepra Act 1997 to regulate the power sector of Pakistan.

The important instruments of Nepra regulatory regime under 1997 Act are summarized as under:

- **Regulation of Generation, Transmission and Distribution of Electric Power Act 1997:** to regulate generation, transmission and distribution of electric power
- **Tariff Standards Procedure Rules-1998:** to highlight the procedure of tariff determination and standards to be adopted
- **Application Modification Procedure Regulations-1999:** to standardize the manner for submitting applications and filing petitions to NEPRA
- **National Electric Power Regulatory Authority Licensing (Distribution) Rules-1999 & Eligibility Criteria for Consumers of (Distribution) Companies, 2003:** to regulate the process of acquiring licenses by distribution companies.
- **Licensing Generation Rules-2000:** to streamline the process for becoming a licensee under NEPRA Act
- **NEPRA (Fees) Rules, 2002 :** to prescribe fee applicable in various scenarios
- **NEPRA (Fines) Rules, 2002:** to prescribe fines in respect of violations
- **Interim Power Procurement (Procedures and Standards) Regulation – 2005:** to streamline the manner for acquiring permission for the sale of power to transmission and distribution companies.
- **Performance Standards (Generation) Rules-2009, (Transmission) Rules-2005, (Distribution) Rules-2005:** to provide standards of performance for licensees in three sub-sectors.

The Regulation of Generation, Transmission and Distribution of Electric Power (Amendment) Act (2018) has increased Nepra's responsibilities. Its additional responsibilities include the following:

- to guarantee high standards of transparent, clear, and effective regulation of the electric power markets of Pakistan;

- specification of the legal framework within which a competitive electric power market can develop and sustain; and
- to manage conflict of interest between the state and the development of the electric power markets.

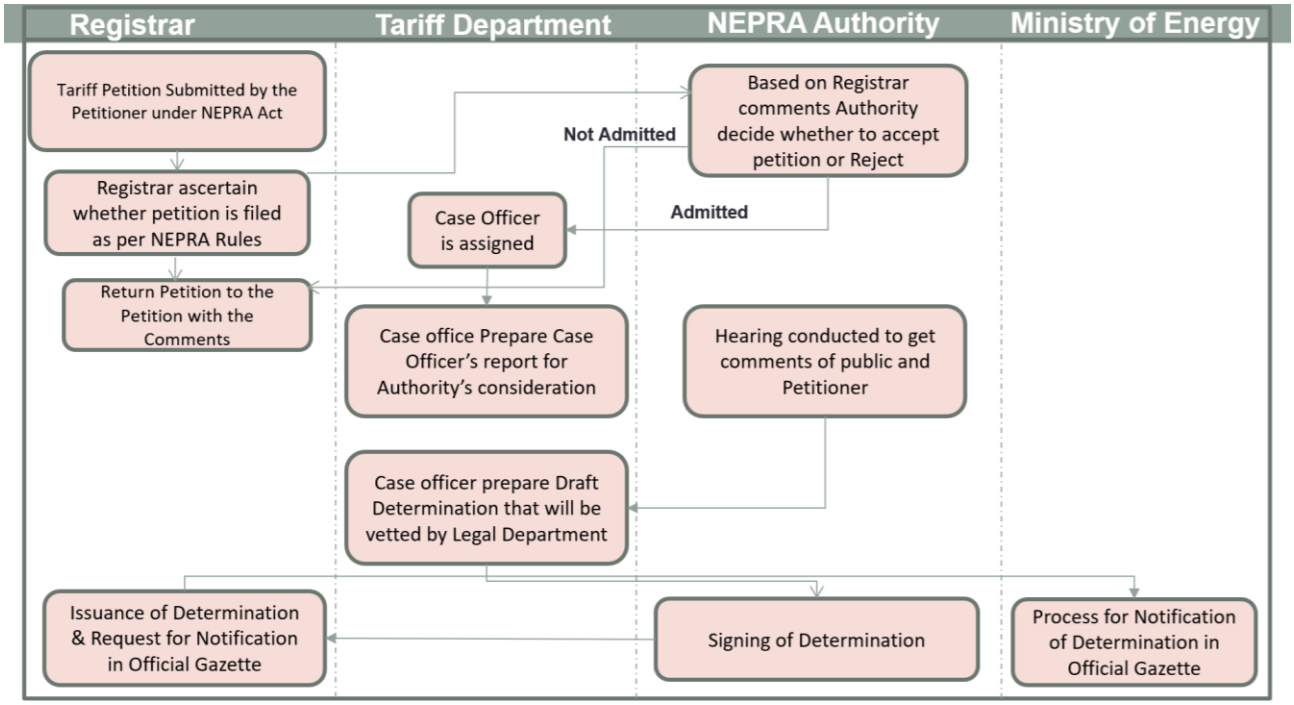
In addition to grant licenses and tariff determination, NEPRA is given authority to do the following:

- Specification of procedures & standards for registration of persons providing electric power services.
- Advisory to the Federal Government in the formulation of electricity plan, policy, and public sector projects.
- Specification and enforcement of performance standards for generation companies and persons licensed or registered under the Act.
- Specification of procedures & standards for investment programs by generation companies and persons licensed or registered under the Act.
- Specification of accounting standards and establish a uniform system of account by generation companies and persons licensed or registered under the Act.
- Ensuring efficient tariff structures and market design for sufficient liquidity in the markets.
- Specifying fees.
- Review of its own decisions.
- Settle dispute between licenses in accordance with the specified procedure.
- Issue guidelines and operating procedure to promote market development, including trading in accordance with national electricity plan and policy.

The Amendment Act allowed the Authority to make 'regulations' for the functioning of the sector, whereas the federal government can prescribe 'rules'.

C. Tariff Structure Regime

NEPRA Tariff Standards and Procedure Rules (1998) provide guidelines for the process and parameters for setting tariffs. Licensee, consumer, or person interested in the tariff may file a petition with the NEPRA by submitting it before the Registrar along with such fee as may be determined by the Authority. Upon receipt of the tariff petition by NEPRA, the process to be followed is elaborated below:



Tariff Determination process by NEPRA

Tariff determined by NEPRA is forwarded to the Federal Government under Section 31(4) of the NEPRA Act for notification in the Official Gazette.

The NEPRA (Amendment) Act, 2018 also requires to determine a uniform tariff for distribution licensees wholly owned and controlled by a common shareholder based on their consolidated accounts; NEPRA determines the tariff through a consultative process in transparent manners as provided in law.

The tariff is determined on reference values, which are subject to adjustment at different intervals, i.e. monthly, quarterly, biannually, etc.

4.8 Tariff Structure & Components

The tariff components are different for each category i.e., Generation, Transmission, and Distribution.

4.8.1 Generation:

The tariff is broadly divided into two parts Capacity Price and Energy Price, and depending upon the technology, the sub-components include O&M, Insurance, Return on Equity, Debt service, etc.

4.8.2 Transmission:

The Tariff Components include Use of System Charges (fixed cost) determined annually, Pool generation cost (fixed and variable cost), and transfer pricing mechanism for DISCOs, including K-Electric (KE) to the extent of 650 MW (Power Purchase Charge for DISCOs).

4.8.3 Market Operator:

The Market Operator shall charge the Market Operator Fee payable by relevant Market Participants, in accordance with the determination of the Authority.

4.8.4 Distribution Tariff

4.8.4.1 Power Purchaser Price (PPP):

This is the cost at which a DISCO is projected to purchase power. This cost consists of the generation cost and the cost of transmission by NTDC of the total power that a DISCO is projected to purchase during the year.

4.8.4.2 Net distribution margin:

This margin is the difference between the gross distribution margin and the 'other income' of DISCOs. Gross margin consists of O&M cost, depreciation, and return on an asset base of DISCOs. 'Other income' includes amortization of deferred credit, meter and rental income, late payment surcharge, profit on bank deposit, sale of scrap, income from non-utility operations and commission on PTV fees and miscellaneous.

4.8.4.3 Tariff Regimes

The tariff regimes in Generation sector include cost plus, up front, competitive bidding and multi-year tariffs. Tariffs in Transmission sector have been determined using cost plus and up-front modes. Similarly, NEPRA has used cost plus and Performance-based Multi-year tariffs for the distribution companies.

4.9 Generation Tariff Regimes

4.9.1 Cost Plus Tariff

Under a cost-plus tariff, the generation facility is paid its actual cost plus an agreed profit. In this mode, a generation facility is required to submit ~~a~~ tariff petition to NEPRA for the award of tariff for a particular project along with the tariff proposed for the project and supporting documents evidencing the cost. In the recent past, NEPRA determined the Internal Rate of Return (IRR) for different technologies under the Cost plus tariff mechanism.

4.9.2 Upfront Tariff:

Tariff developed, declared, determined, or approved by the Authority on a petition moved by any relevant agency or in the exercise of suo moto powers by the Authority. Upfront Tariff is one which is determined and announced by the Regulator based on its own scrutiny and calculations with certain terms and conditions. The project sponsors may accept the Upfront Tariff based on its viability for their project. For Independent Power Producers (IPPs), the up-front tariff regime under Up-front Tariff (Approval & Procedure) Regulations, 2011, is generally applied by NEPRA.

4.9.3 Competitive Bidding Tariff

Competitive bidding is a common procurement practice that involves inviting multiple developers to submit offers against the Request for Proposal (RFP) issued by the Relevant Agency. The Competitive Bidding is governed under NEPRA Competitive Bidding Tariff (Approval Procedure) regulations 2017 to lay down the procedure for approval of tariff arrived at through a competitive bidding process. The purpose of Competitive bidding was to allows

transparency, equality of opportunity and the ability to demonstrate that the outcomes represent the best value. In line with the regulations, Competitive Bidding is conducted by the Relevant Agency keeping in view the demand forecasted by national grid company in accordance with the least cost generation plan of each distribution company.

It is important to highlight that the federal government has decided that power procurement will be essentially on least cost basis and only through competitive bidding mode. National Electricity Policy and Alternative and Renewable Energy Policy state that procurement of power from generation power plants will be based on competitive bidding mode.

4.9.4 Transmission Tariff

Transmission Tariff is determined by NEPRA, as per the Guidelines contained in the Methodology & Process for Determination of Revenue Requirement and Use of System Charges (UoSC) for Transmission License. The objective is to establish a transparent methodology for determining transmission revenues and UoSC that is predictable and certain in its operation and consistent with the requirements under Nepra Act. The UoSC are calculated in Rs./kW/h and is paid only if the transmission line is available for dispatch of energy.

4.9.5 Distribution Tariff

NEPRA determines consumer-end tariffs to recover the entire supply chain costs. In deciding the average sale price, NEPRA considers the annual revenue requirement of DISCOs, which includes all the costs involved. The main factors in the annual revenue requirements include power purchase price, net distribution margin, Transmission and Distribution (T&D) losses, and prior-year adjustments.

Under the Amended Act of 2018, NEPRA is required to determine a uniform tariff for distribution licensees, wholly owned and controlled by a common shareholder, based on their consolidated accounts. The amended Act also requires NEPRA to take guidance from the National Electricity Policy to determine, modify or revise rates, charges, and terms and conditions for the provision of electricity services. For K-Electric and several DISCOs, NEPRA has used a performance based multi-year tariff approach.

CHAPTER 5:

INDIGENOUS ENERGY RESOURCES IN PAKISTAN

Pakistan is blessed with a tremendous amount of Indigenous Energy Resources, which could be utilized for power generation in Pakistan. The power potential through indigenous energy resources in Pakistan is estimated as follows:

Hydro Power	60,000 MW
Wind Power	346,000 MW
Solar Power	2,900,000 MW
Bagasse Cogeneration:	2,000 MW
Coal Power	100,000 MW

Hydro resources are mainly located in the country's northern parts, from which the mighty Indus river starts and other rivers and tributaries join this river. Indigenous coal resources are present in Thar in Sindh Province. The wind and solar resources are mainly located in Balochistan, Sindh and areas in Southern Punjab.

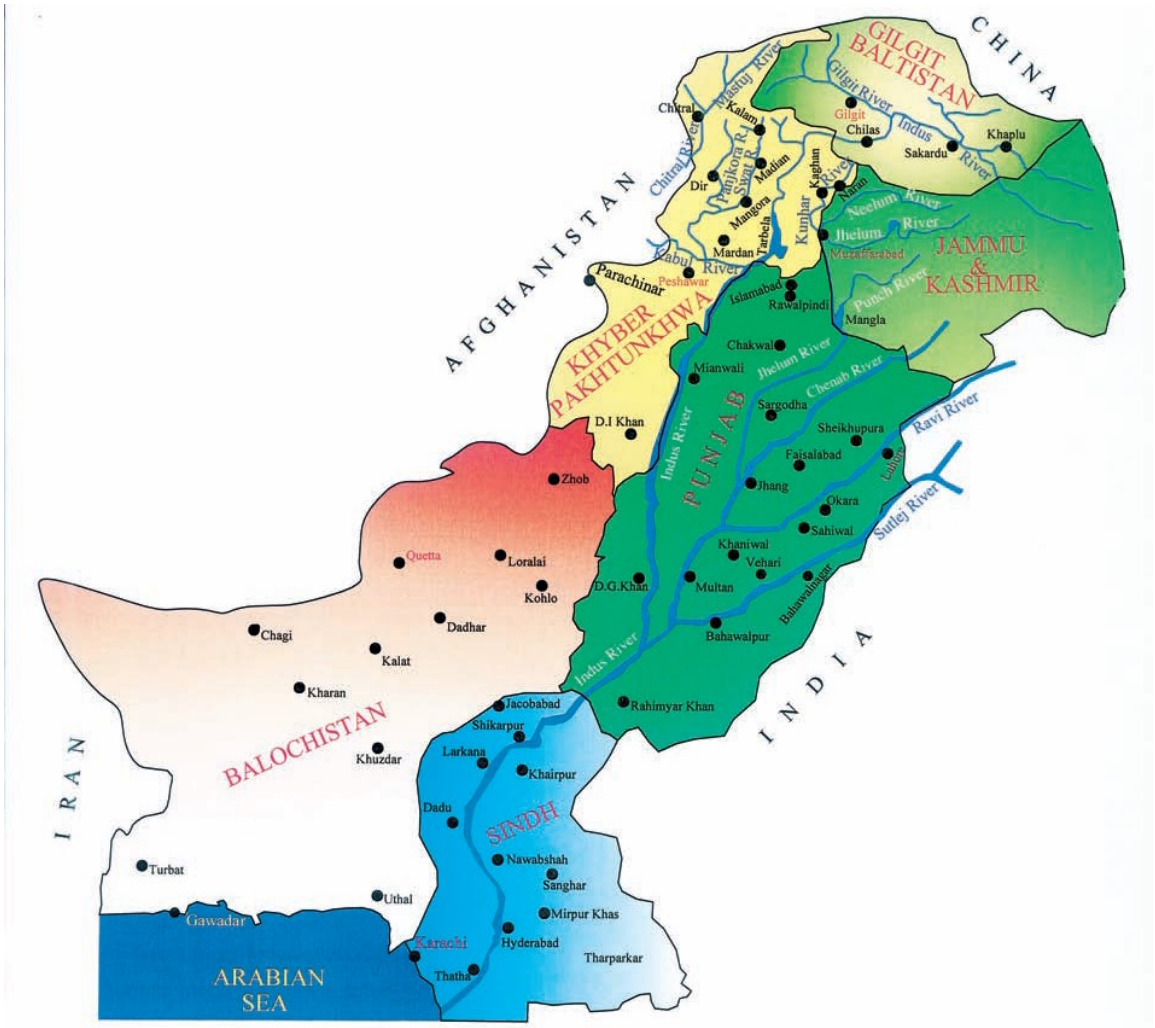
The following sections provide a detailed account in respect of power potential through various energy resources:

5.1 Hydro Power

Pakistan has abundant hydropower resources and the Government is keen to develop hydropower generation in the Country. Pakistan is endowed with hydropower resources of about 60,000 MW, almost all of which lie in the Khyber Pakhtunkhwa, Gilgit-Baltistan, Punjab and Azad Jammu & Kashmir (AJ&K). Power potential on different rivers is as follows:

Indus River	39,717 MW
Jhelum River	5,624 MW
Swat River	1,803 MW
Kunhar River	1,480 MW
Kandiah River	1,006 MW
Punch River	462 MW
Other Rivers	9,704 MW

A map of Pakistan showing major rivers is as follows:



Map of Pakistan showing major rivers

5.1.1 Efforts by GOP for development of hydro resources of Pakistan

The Government has always prioritized developing hydro resources in Pakistan for power generation. In this respect, mega Hydel Power Projects, which include irrigation, navigation, flood control are being developed by WAPDA in the public sector and the run of river projects, are being developed mainly by PPIB, AEDB and provinces in the public and private sector. The GoP had taken a number of initiatives for the development of Hydro Power Projects in Pakistan including:

Comprehensive brochure on Pakistan Hydel Power Potential

Ranking (prioritization) of Hydel Power Projects (50-1000 MW)

Preparation of Standardized Terms of Reference for a Bankable Feasibility Study

Cascade Study for Swat River and Jhelum River Hydropower Projects

Mechanism for Determination of Tariff for Hydropower Projects by NEPRA provides three stage tariff determination

To encourage private sector in private power generation, specific incentives have been provided to investors such as GoP to bear hydrological risks and reopeners have been allowed in the EPC Contract; Standardized Security Documents i.e. IA, PPA and WUA for hydropower projects have been prepared with active participation of all stakeholders

Dedicated institutions in the federal and provincial government have been established to facilitate investors for hydropower project development, such as PPIB, AEDB, PPDB, PPDCL, PPC AJK, PEDO, etc.

To mitigate high underground geological risk, long construction period and environmental sensitivities, the following tariff Re-openers are allowed by NEPRA:

Cost escalation in Civil and cost variation for E&M works

Resettlement cost

Cost variation due to Geological conditions limited to tunnel area

A summary of hydropower projects, which are already operational and are under various stages of development in private and public sectors, is as follows:

Projects in Operation	
Public Sector	9,443 MW
Private Sector	1,051 MW
Projects under Implementation	
Public Sector	19,539 MW
Private Sector (PPIB + Provinces)	5,540 MW
Projects with Feasibility Study Completed	4,345 MW
Raw Sites	19,725 MW
Total Hydropower Potential	59,643 MW

The following hydropower projects are operational / under development under CPEC Framework:

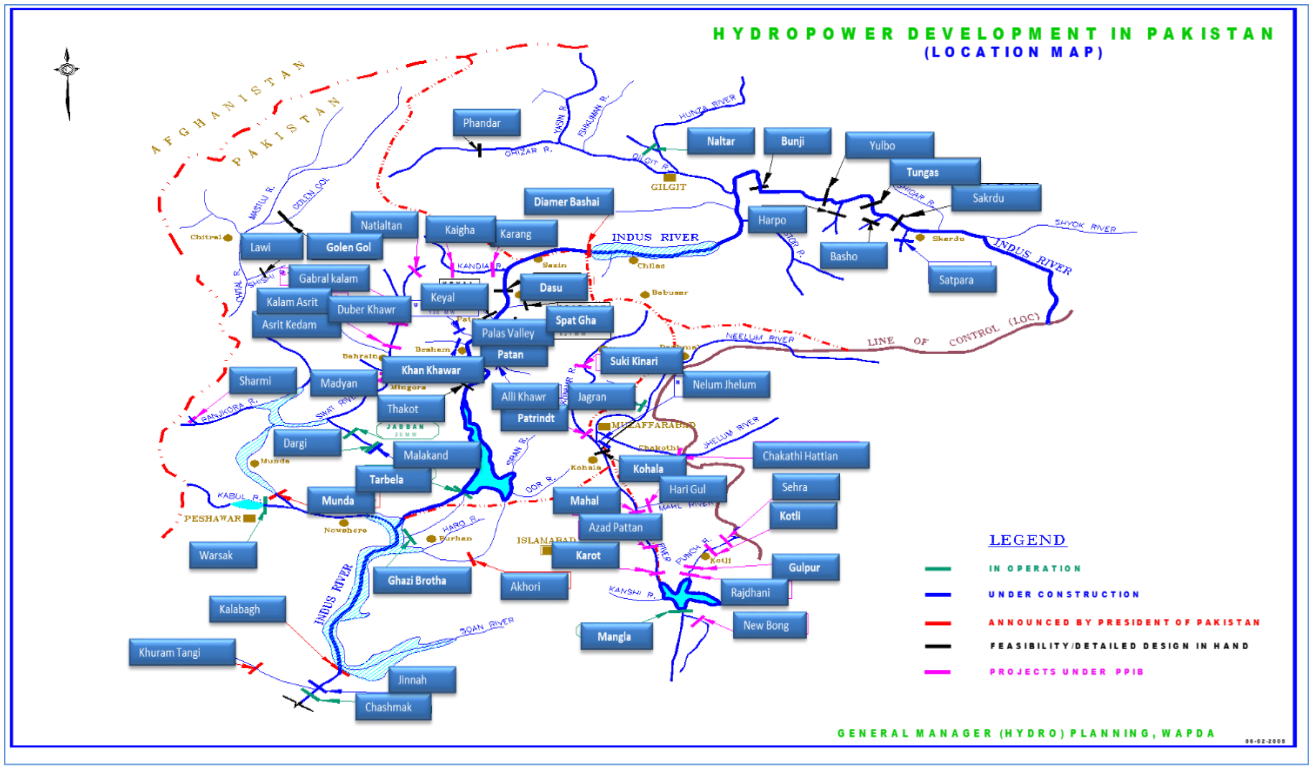
720 MW Karot Hydropower Project on River Jhelum in Punjab

884 MW Suki Kinari Hydropower Project on River Kunhar in KPK

1,124 MW Kohala Hydropower Project on River Jhelum in AJK

700 MW Azad Pattan Hydropower Project on River Jhelum in AJK

A map showing location of various hydropower projects in Pakistan is as follows:



Map showing location of various hydropower projects in Pakistan

5.2 Solar Power

Solar energy is the energy received by the earth from sun. This energy is in the form of solar radiation, which produces solar electricity.

5.2.1 Factors contributing to the development of large-scale Solar Power Projects

Due to the high cost of solar PV Projects, large-scale generation from Solar PV Projects was not economically feasible. Hence, no large-scale solar power project could be developed in Pakistan. However, the recent advancement in the solar PV technology and cost reduction has made solar PV the most economical option for electricity generation among different renewable energy technologies. The utilization of Solar Energy in Pakistan has started gaining momentum due to the following reasons:

- Clean – No pollution or emission
- Very silent
- Low maintenance cost
- Provides power where Grid not available
- Short construction time
- Can be expanded easily
- Technological improvements – cost reducing

- No siting problem
- High quality power

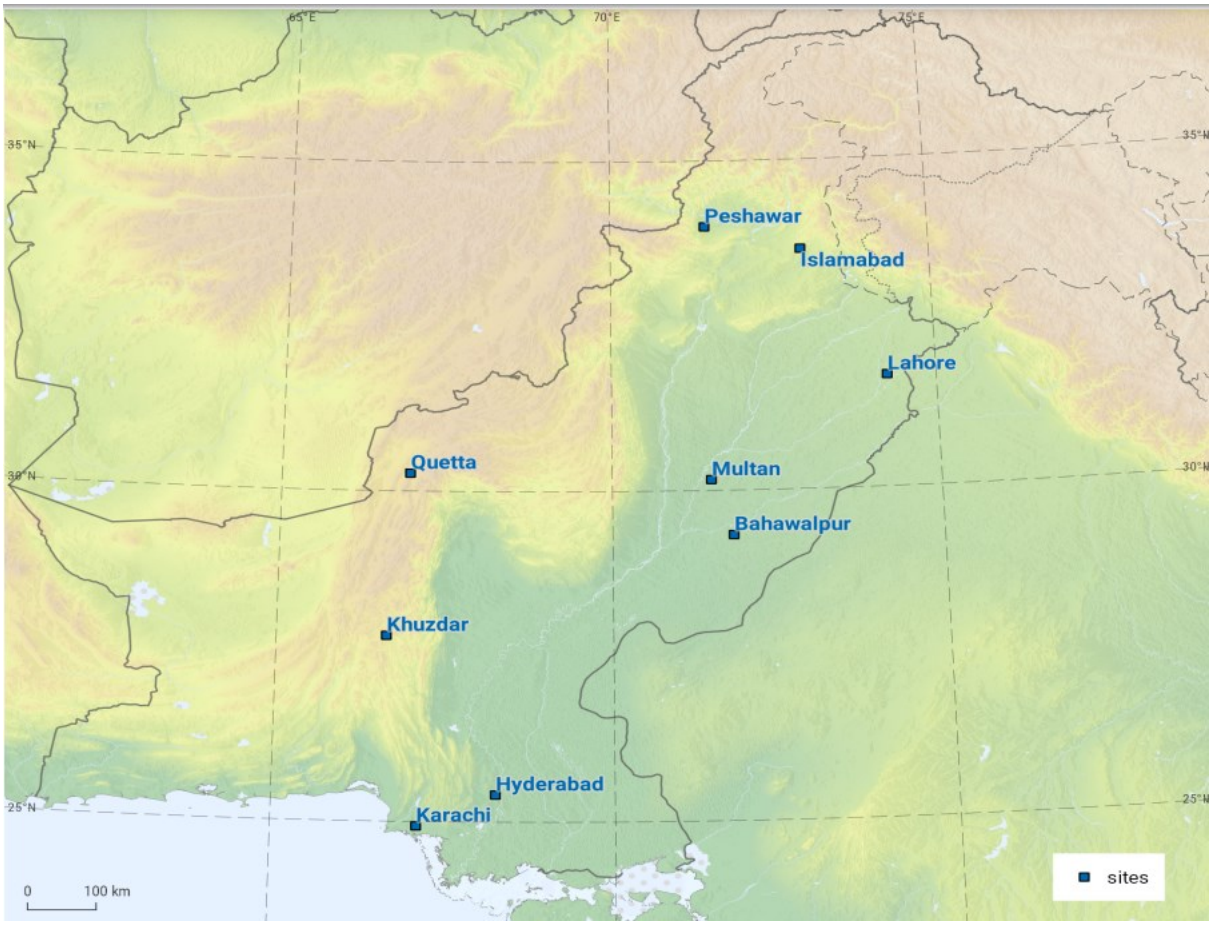
Pakistan is among the most fortunate countries that receive plenty of sunshine throughout the year. Considering the country's positive solar irradiance profile and availability of area, it has been estimated that Pakistan has the indigenous resources to fulfil all of its current electricity needs by only using Solar Energy. The GoP envisages developing more than 7,000 MW of solar PV projects by 2030.

5.3 Solar Radiation in Pakistan

Pakistan receives good sun radiation, with higher irradiation levels in the south and southwest than in the north. The upfront rates for solar PV power generation, which vary in the northern and southern regions of the country, take this into account.

AEDB in collaboration with World Bank under its Energy Sector Management Assistance Program (ESMAP) initiated Renewable Energy mapping through the installation of wind and solar measurement stations throughout the country.

For solar resource mapping, nine (09)ground-based solar measurement stations were installed. The geographical locations of these sites are distributed all over Pakistan, which cover different solar and climatic regimes. The locations of these are shown as follows:

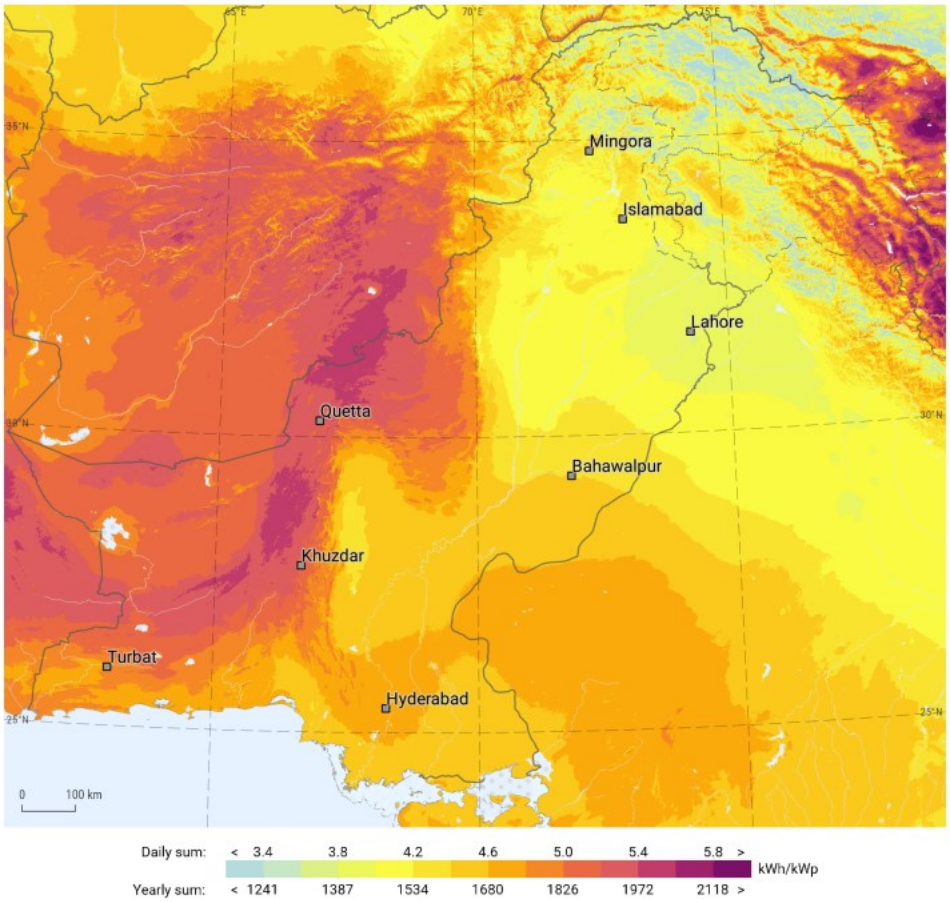


Map showing location of nine (09) ground based solar measurement stations in Pakistan

The data collected from these stations had been used to improve and validate the solar resource model for generating the final, high-resolution solar maps for Pakistan. After the validation, high-resolution solar maps of Pakistan have been published.

These solar maps, and the underlying solar data, can be accessed for free via the Global Solar Atlas, a recently launched tool provided by the World Bank Group covering all countries in the world. In addition, the maps are available in digital format for use in Geographic Information System (GIS) applications and Google Earth.

Following is the Solar Energy Resource Map of Pakistan showing PV electricity output from an open space fixed-mounted PV system taken from the Solar Resource Report of Pakistan dated March 2017 by the World Bank:



Map showing PV electricity output from an open space fixed-mounted PV system

The country's largest annual global horizontal irradiance is found in Baluchistan in the southwest, where it is little over 2,300 kWh per square meter (m^2).

As one proceeds up towards the country's northeast, the predicted values only slightly decline but still surpass 1,500 kWh/m^2 per year across more than 90% of the land area. On arid plateaus or rock deserts, which gather up little to no dust from the surroundings, the direct normal irradiance, a relevant measurement for concentrating solar power, reaches its maximum values. Except for the Himalayan Mountains, high direct normal irradiance is typically available across Pakistan. While 83 percent of the land area still surpasses the threshold of 2,000 kWh/m^2 per year, western Baluchistan is estimated to have peak values surpassing 2,700 kWh/m^2 per year. These maximum values are as good as those around the Sinai Peninsula – one of the top locations for irradiance in the Middle East and North Africa.

A study obtained from 58 meteorological stations, spread all over Pakistan, has been carried out to estimate the global solar radiation. The study indicates that more than 70% of the 0.8 million km^2 area of the country receives an annual average solar radiation energy of 5.0– 5.5 kW h/m^2 /day. There are sizeable pockets near Quetta, Qalat, Khuzdar and Zhob in the province of Baluchistan and Larkana in the province of Sindh, which receive 5.5–6.0 kW h/m^2 /day.

The Alternate Energy Development Board (AEDB) of Pakistan estimates that altogether 2,900 GW of solar resource exists in the country. Each square kilometer area shown in brown color in

the figure above can generate about 60 MW of peak and 15 MW of average power through solar thermal power plants.

The GoP is very interested in developing solar energy projects in the country. Currently, six (06) solar PV power projects with a cumulative capacity of 430 MW are commissioned and are supplying electricity to the national grid.

5.4 Wind Power

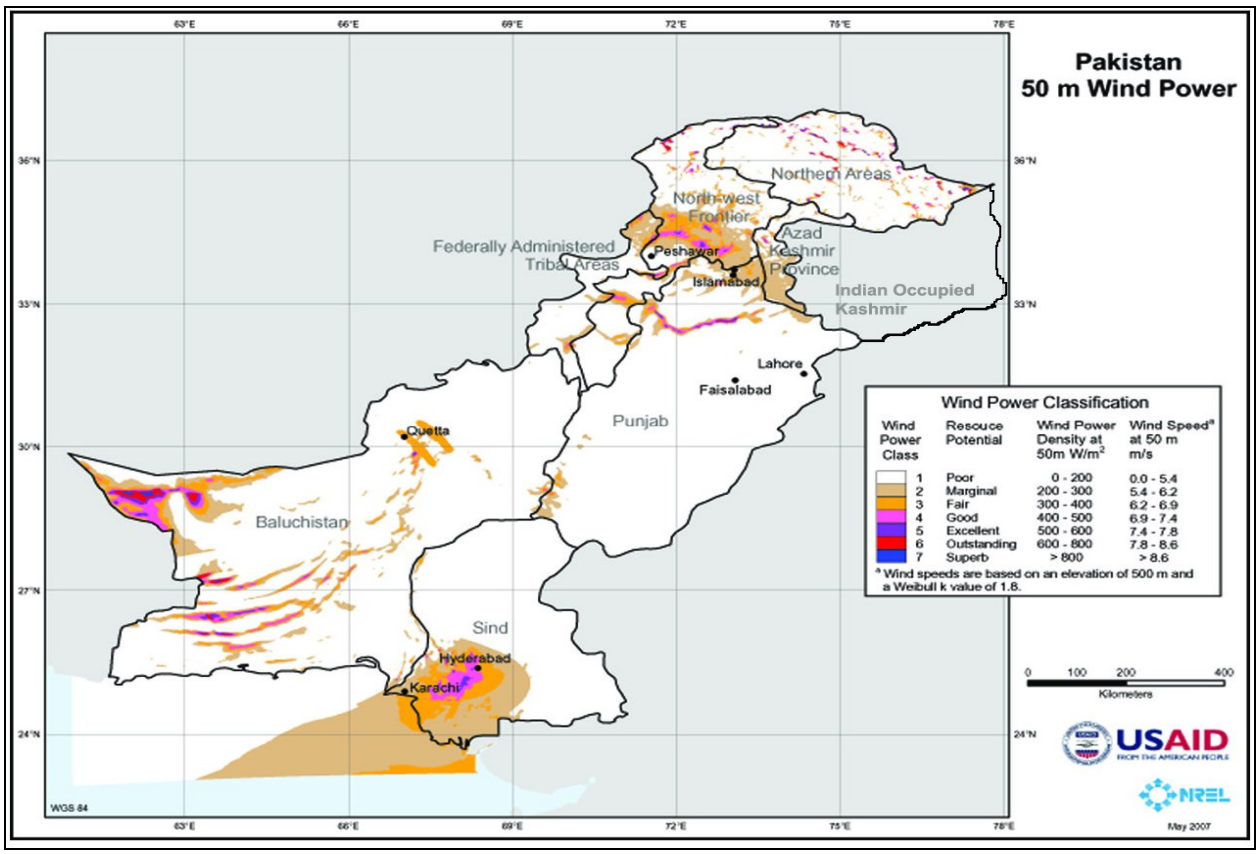
5.4.1 Wind Resource Potential in Pakistan

One big potential source of renewable energy for Pakistan is wind power. Many areas of the country have a high potential for wind energy, which has the potential to be a significant source of power generation and can meet the country's demand for electricity. The potential of wind power in Pakistan is around 346,000 MW.

To find the most promising locations for the installation of wind projects, wind resource assessment was required. The public and commercial sectors can invest in utility-size wind projects more efficiently by identifying the prospective areas. Pakistan Meteorological Department (PMD), Alternative Energy Development Board (AEDB), and National Renewable Energy Laboratory (NREL) are three of Pakistan's primary sources of wind data.

5.4.2 Wind Map of Pakistan

In 2007, NREL, as part of the U.S. Agency for International Development (USAID) aid program, carried out wind resource assessments of Pakistan, which produced a mesoscale map of Pakistan that displays the possible wind speed at the height of 50 m. In addition to numerous relatively isolated wind corridors in central and western Punjab, central and southern Balochistan, and Gilgit-Baltistan, a remote region of Pakistan's north, this wind map of the country reveals significant wind corridors in southern Sindh, northwestern locations in Balochistan, and central areas of KPK.



Wind Map of Pakistan

These wind resource maps are of utmost importance for Pakistan's wind resource evaluation. Major regions of Pakistan have been the subject of a self-conducted wind energy potential survey by the Pakistan Meteorological Department (PMD). For 42 different sites in the northern areas of the nation, including Pakistan's Federally Administered Tribal Areas (FATA), PMD has collected wind data. Data on the average wind speed and direction for ten minutes were gathered at two convenient altitudes (10 m and 0 m). At 20 various locations in Sindh's coastal region, PMD has also gathered data on wind direction and speed. The same measurements were conducted in the coastal areas of Balochistan. It is forecasted that the realization of about 40–70% of Pakistan's wind power potential is expected to be completed by the year 2030.

5.4.3 Classes of Wind Energy

There are seven distinct classes of wind energy. According to NREL, wind power class 2 is ideal for rural applications, while wind power class 3 or higher is suitable for various utility-scale wind turbine installations. The specifications for the classes of wind power defined at 10 m and 50 m height is shown as follows:

Wind power class	Resource potential	10 m		50 m	
		Wind power density (W/m^2)	Speed (m/s)	Wind power density (W/m^2)	Speed (m/s)
1	Poor	0–100	0–4.4	0–200	0–5.4
2	Marginal	100–150	4.4–5.1	200–300	5.4–6.2
3	Moderate	150–200	5.1–5.6	300–400	6.2–6.9
4	Good	200–250	5.6–6.0	400–500	6.9–7.4
5	Excellent	250–300	6.0–6.4	500–600	7.4–7.8
6	Excellent	300–400	6.4–7.0	600–800	7.8–8.6
7	Excellent	> 400	> 7.0	> 800	> 8.6

Wind Power Classes as per NREL

Recording wind data between 6 and 10 meters in height is convenient. The hub height of most medium-sized commercial wind turbines is around 50 m. Therefore, based on the data at lower heights, the wind speed at 50 m is extrapolated. Most utility size wind turbine installations require wind power classes 3 or higher. In order to produce wind energy cheaply, Wind turbines respond well to speeds greater than 5.5 m/s for the efficient production of wind energy.

The wind power classes 4 or higher are necessary for producing wind energy profitably. The current work focuses on wind power classes 3 or higher when evaluating utility-scale wind turbine applications.

Pakistan has a total area of 796,095 km^2, of which 770,875 km^2 is land and only 095 km2 is water. The entire land area is used to calculate the percentage of windy areas. It is assumed (by a conservative estimate) that the total installable capacity per sq. km of windy area is 5 MW to evaluate wind power potential.

Wind energy is a renewable source capable of off-set fossil fuel-based generation and Pakistan has an estimated wind potential of 346 GW in installable capacity. The wind potential in Pakistan is a lucrative economic proposition for investors and concerned stakeholders. The capacity factor of the wind farm represents the energy output from a wind farm on an annual basis as a percentage of the farm's maximum output and is predominantly determined by two factors: 1) the quality of the wind resources where the wind farm is sited and 2) the turbine and balance-of-plant technology used. There is a correlation between capacity factor and estimated wind speed at the site. Indigenous wind energy resources or Wind Power Projects (WPPs) will likely off-set the oil/gas imports and will save a considerable amount of foreign exchange. Moreover, there is a lucrative market for investors to capitalize on better profit margins without interruption of fuel imports subjected to the international market.

5.4.4 Factors contributing to the development of large-scale Wind Power Projects

Due to the high cost of Wind Power Projects, large-scale generation from Wind Power Projects was not economically feasible. Hence, no large-scale solar power project could be developed in Pakistan. Furthermore, reliable wind data was not available. However, the recent technological advancements in the Wind Power technology, cost reduction, and availability of reliable wind data has made Wind Power one of the most economical options for electricity generation among

different renewable energy technologies. The utilization of Wind Energy in Pakistan has started gaining momentum due to the following reasons:

- Clean, zero emissions
  - NOx, SO_2, CO, CO_2
  - Air quality, water quality
  - Climate change
- Reduce fossil fuel dependence
  - Energy independence
  - Domestic energy—national security
- Renewable
  - No fuel-price volatility

5.5 Bagasse Power

5.5.1 Historical Background

Bagasse is an inexpensive indigenous power generation resource. Currently, it has the potential to generate more than 2,000 MW in Pakistan. Sugar mills have sound investment potential, the experience of captive power generation, and basic infrastructure/land for power project is available; therefore, the chances of Co-Generation project materialization are higher.

5.5.2 Merits of Power Generation from Bagasse

The merits of power generation from Bagasse are as follows:

- Mills located near NTDC transmission lines – power evacuation is easy and system losses will be lower
- Bagasse is available near the power plant; therefore, no transportation is required. Besides, it has no sulphur with a very low ash content (4%)
- Waste heat recovery possible from Co-Generation projects for utilization in sugar processing.
- Projects may receive carbon credits under Clean Development Mechanism (CDM).

5.6 Indigenous Coal Power

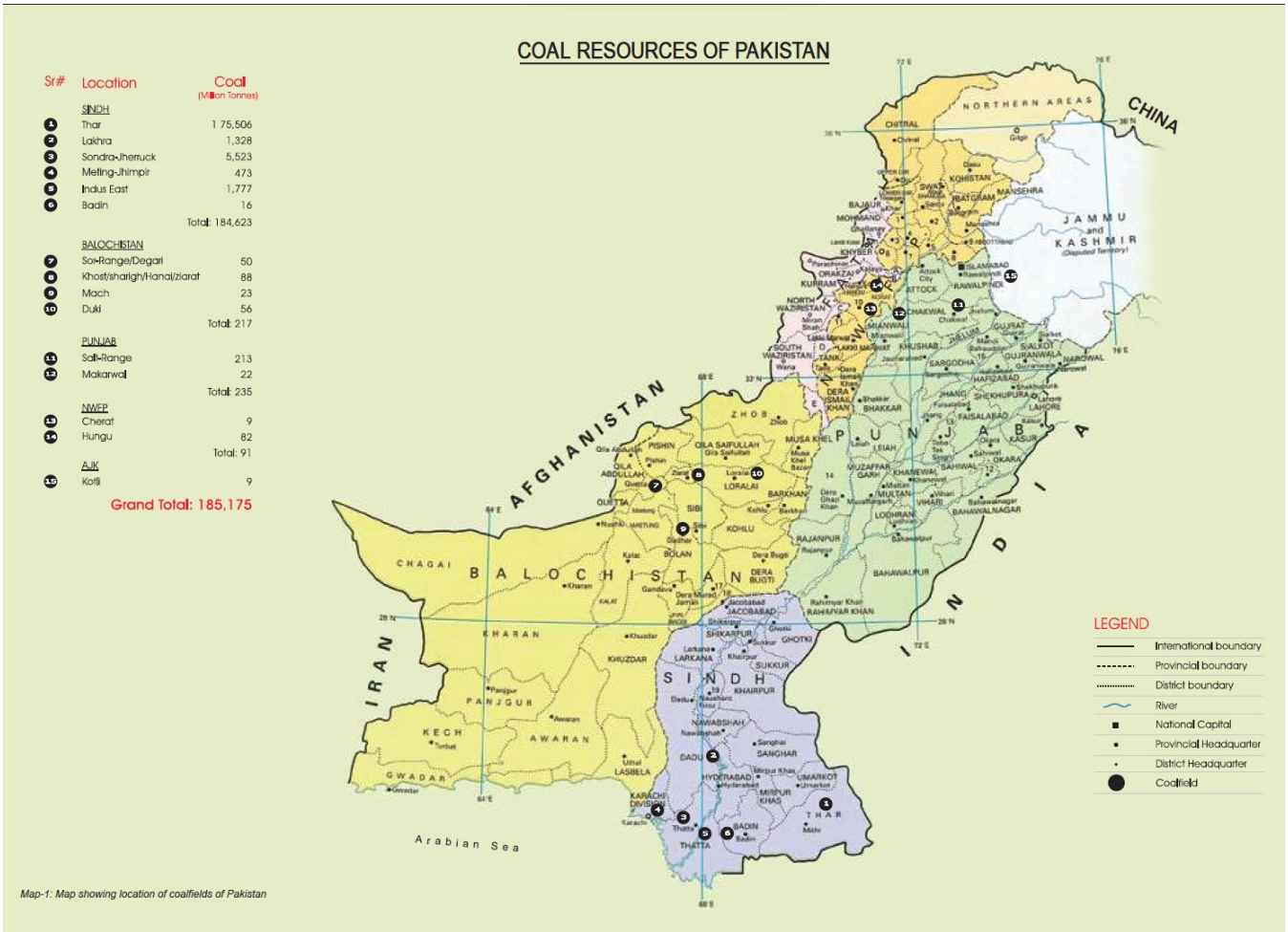
5.6.1 Historical Background

Pakistan is a coal-rich country, but, unfortunately, coal has not been developed for power generation for more than three decades due to lack of infrastructure, insufficient financing and absence of modern coal mining technical expertise. Unavailability of reliable coal is the main obstacle to significant progress in coal power generation. However, the Federal and Provincial governments are continuously trying to facilitate private investors in developing and promoting indigenous coal for power generation.

There are vast resources of coal in all four of Pakistan's provinces and in Azad Jammu & Kashmir. Thar Coal reserves are estimated at 175.5 tonnes, sufficient to meet the country's energy requirement in the long term.

It is anticipated that, if properly exploited, Pakistan's coal resources may generate more than 100,000 MW of electricity over the next 30 years.

The following map shows locations and names of Pakistan's major coalfields and coal deposits. According to rough estimates, the total coal resources of Pakistan are more than 185 billion tonnes.



Locations and names of major coal resources of Pakistan

5.6.2 Characteristics of Indigenous Coal Reserves in Pakistan

Coal reserves, together with heating values (as on a received basis), of all the four Provinces and Azad Kashmir are given here below:

Province	Resources in Million Tonnes	Heating Value (Btu/lb)
Sindh	184,623	5,219 -13,555
Balochistan	217	9,637 -15,499
Punjab	235	9,472 -15,801
NWFP	91	9,386 -14,217
AJK	9	7,336 -12,338
Total	**185,175**	

Source: Geological Survey of Pakistan / Pakistan Energy Year Book 2003

Heating values of province-wise coal resources of Pakistan

Currently, only one (01) power project having a capacity of 660 MW is commissioned in Pakistan, which is based on Thar Coal. Whereas four (04) local coal-based power projects also in Thar, having a cumulative capacity of 3,300 MW, are currently under construction/development.

CHAPTER 6:

CPEC PORTFOLIO OF POWER PROJECTS AND ITS BIG ACHIEVEMENTS

6.1 Background

China-Pakistan Economic Corridor (CPEC) is a framework of regional connectivity. CPEC will not only benefit China and Pakistan but will have positive impact on Iran, Afghanistan, Central Asian Republic, and the region. The enhancement of geographical linkages having improved road, rail and air transportation system with frequent and free exchanges of growth and people to people contact, enhancing understanding through academic, cultural and regional knowledge and culture, activity of higher volume of flow of trade and businesses, producing and moving energy to have more optimal businesses and enhancement of co-operation by win-win model will result in well connected, integrated region of shared destiny, harmony and development.

The plans for an economic corridor between Pakistan and China preceded China's Belt and Road Initiative (BRI). The project was first announced in the summer of 2013 when the then-Prime Minister of Pakistan met with the Chinese Prime Minister in Beijing. The focus was on connecting China with the Chinese-invested Pakistani port of Gwadar through highway, rail, and pipeline infrastructure. Project plans had a five-year horizon for implementation, and the sums involved – ranging between ten and twenty billion USD – were moderate compared to China's current ambitions in Pakistan.

In 2014, both countries decided to install a 17,045 MW new generation capacity mix of hydro, wind, solar, and coal clubbed with two High Voltage Direct Current (HVDC) transmission lines from South to North and North to South.

Honorable Chinese President Xi Jinping kicked off CPEC with his October 2015 visit to Islamabad. Agreements and Memoranda of Understanding (MoUs) initially signed under CPEC totaled nearly $46 billion with investments in Pakistan's energy (power) and infrastructure. The project is considered an integral part of the BRI, virtually connecting China's Kashgar city in Xinjiang with the Gwadar port in Balochistan province.

CPEC is a journey towards economic regionalization in the globalized world. It founded peace, development, and a win-win model for all of them. CPEC hopes for a better future region with peace, development and growth of economy.

6.2 Major components of CPEC

The three major components of CPEC include the investments in:

- Transportation infrastructure (road, optical fibre cable and railway networks),
- Energy (power) sector and
- Special economic zones.

6.2.1 CPEC at a Glance (90 Projects, ~54 Billion USD)

- 10 Joint Cooperation Committee (JCC) Meetings have been clubbed with 11 Joint Working Groups (JWGs), 11th JCC expected to be held in 4th Quarter of 2022.
- 27 projects completed with the investment of 19 Billion USD.
- 27 projects are under implementation stages with the investment of 7.7 Billion USD, will be completed by 2025.
- 36 projects are in pipeline with the approximate investment of 27.5 Billion USD, will be completed by 2030.

The following are the details of capacity, investment and timelines of CPEC Projects:

Areas	Total Projects		Projects completed by June 2022		Projects under Implementation (2025)		Projects in pipeline (2030)	
	No. of Projects	Investment (Bil. USD)	No. of Projects	Investment (Bil. USD)	No. of Projects	Investment (Bil. USD)	No. of Projects	Investment (Bil. USD)
Energy	22	33	11	12	4	6	7	7.4
Infrastructure	25	18	7	6.7	6	0.9	12	10.4
Gwadar	7	0.7	3	0.3	2	0.23	2	0.15
Special Economic Zones	9	1.5			4	0.5	5	1
Socio-economic	27	1	6	0.01	11	0.09	10	0.9
Total	90	54.2	27	19.01	27	7.72	36	19.85
Note: International Cooperation, Agriculture, Science & Technology and Information Technology are newly added, and currently at Planning stage for third party participation.								

Details of capacity, investment and timelines of CPEC Projects

6.3 Stages in the development of CPEC Projects

The stages in the development of CPEC Projects were as follows:

(i) **Early Harvest 2015-2018:** Most of the projects relate to Energy sector which are already completed or expected to be completed by 2018 adding approximately 5,000 MW electricity to national grid and thus easing the energy shortages and load shedding that had crippled the industry and exports

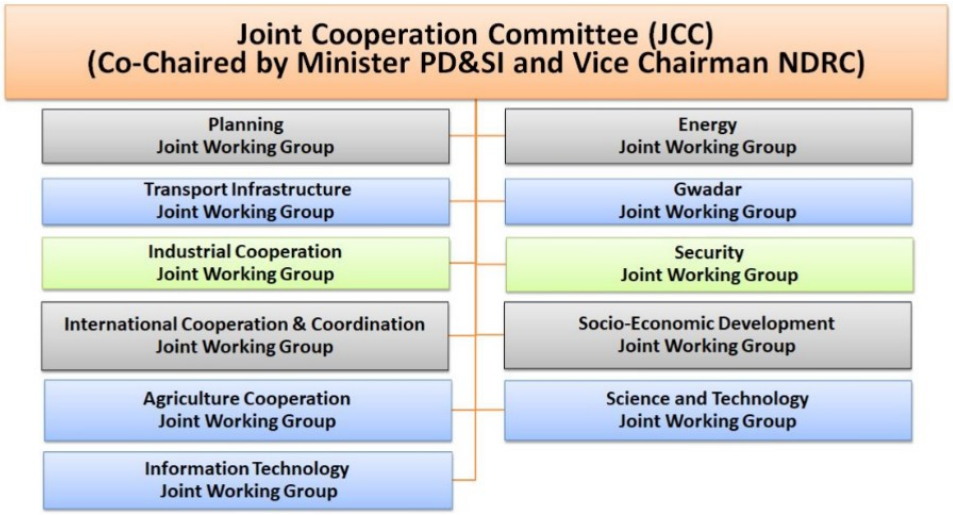
(ii) **Short term projects up to 2020**: mainly Roads, Gwadar Development, Optic fiber network and the Hydel, coal mining and power projects

(iii)**Medium projects up to 2025**: Hydel Power Plants, Railways and Industrial zones

(iv)**Long term projects up to 2030:** Completion of Industrial zones, Agriculture, Tourism, Science & Information Technology etc.

6.3.1 Institutional Framework of CPEC

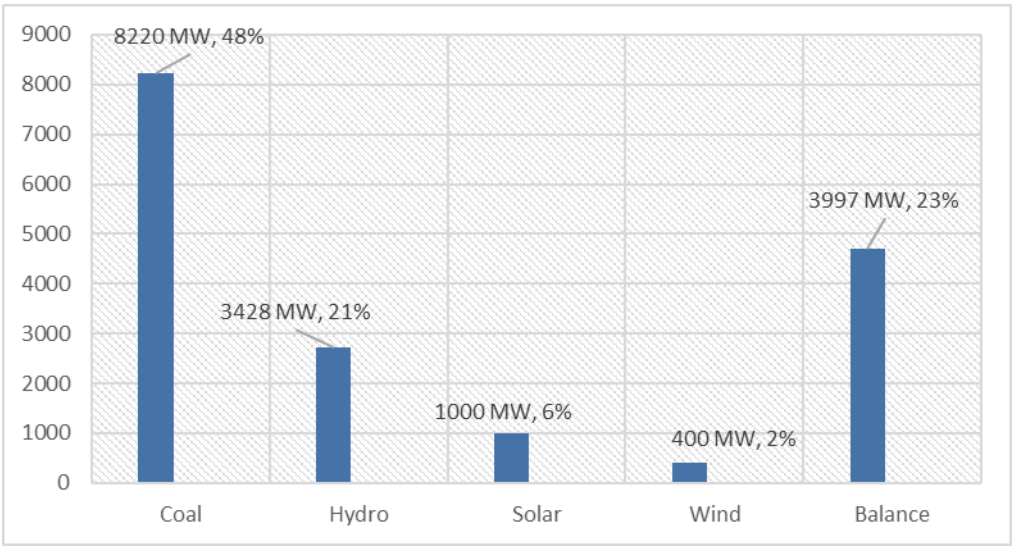
To implement and monitor the CPEC Projects, the following institutional arrangement is in place:



Institutional Framework of CPEC

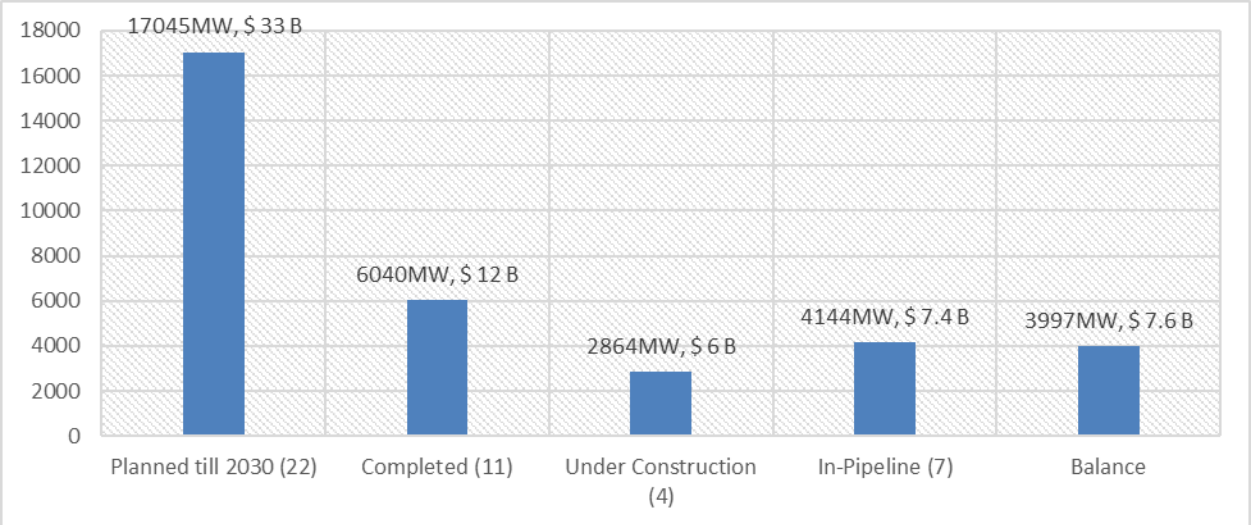
6.3.2 Energy Cooperation (22 Projects, 33 Billion USD)

In 2014, both countries decided to install a 17,045 MW new generation capacity mix of hydro, wind, solar, and coal clubbed with two High Voltage Direct Current (HVDC) transmission lines from South to North and North to South. The energy mix of CPEC power projects (17,045MW) has been shown below, in which coal is leading with 8,220 MW (48%), followed by the balance part of 3,997 MW (23%), Hydel 3,428 MW (21%), Solar 1,000 MW (6%) and Wind 400 MW (2%).



Energy mix of CPEC power projects (17,045 MW)

However, 13,048 MW and one HVDC transmission line (dual pole 660 KV Lahore-Matiari) have been specified, while 3,997 MW and one HVDC transmission line are yet to be specified with subject to the supply and demand analysis of power (electricity) in Pakistan. The CPEC Portfolio of Projects, consisting of 22 projects of 17,045 MW and having an investment of 33 Billion USD, are shown below:



CPEC Portfolio of Projects (22 projects of 17,045 MW and investment of 33 Billion USD)

This commissioned 6,040 MW (11 projects) are 15 percent of overall rated power generation capacity of Pakistan (41,557 MW)[1] and one dual pole 660KV HVDC Transmission Line (886Km, Matiari-Lahore) followed by 2,864 MW (4 projects) are under different construction stages, those will be commissioned by 2025. Moreover, commissioned and under construction projects will add a total of 8,904 MW (15 projects) to the national grid by 2025 which will be

[1] Pakistan Economic Survey 2022

20 percent of the overall rated power generation capacity of Pakistan in 2025. 4,144 MW (7 projects) are in pipeline stage, including two big run of the river hydro power projects i.e., 1124 MW Kohala (AJK) and 700 MW Azad Pattan (AJK, Punjab) on river Jhelum. However, 3,997 MW is the balance part which will be specified in the future by 2030.

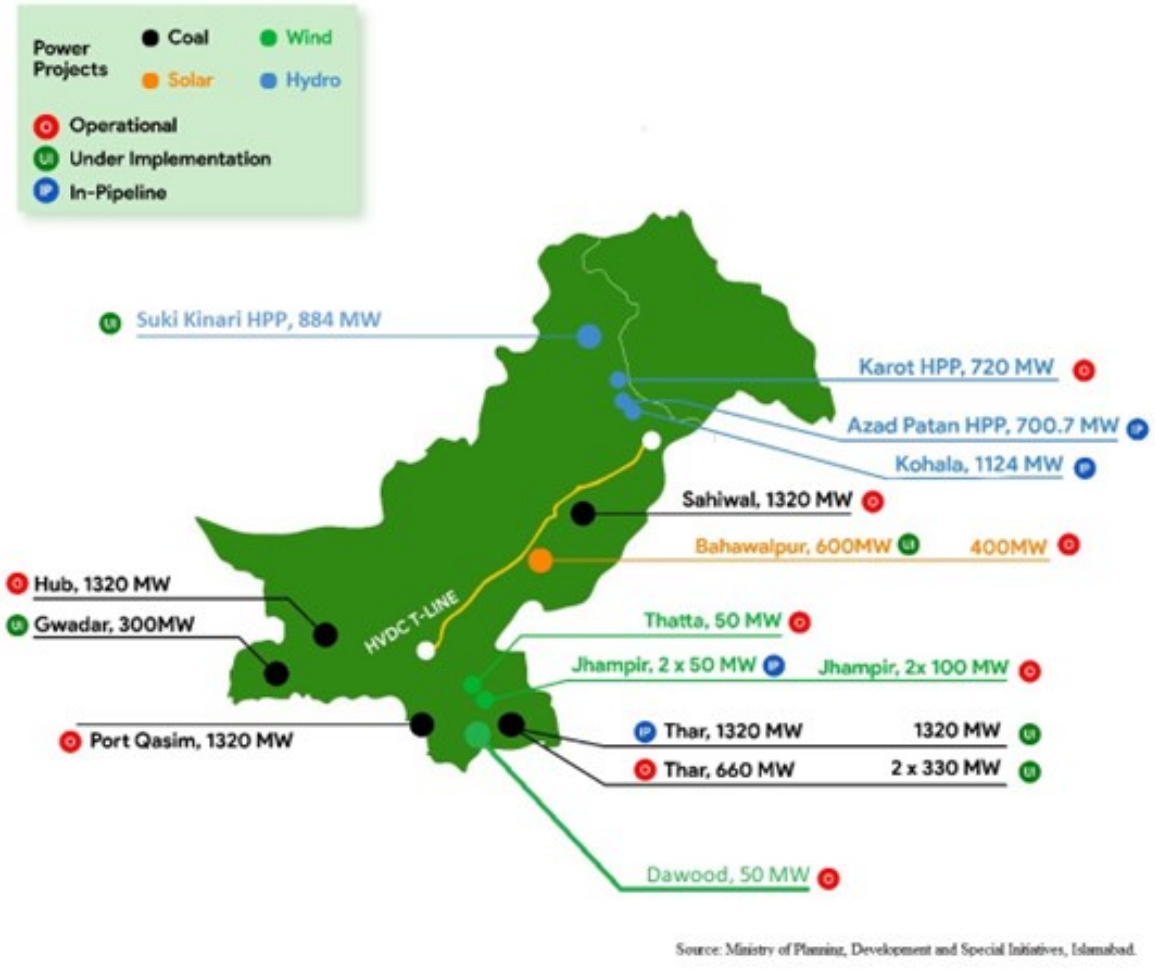
The details of power projects under CPEC are as follows:

Sr. No.	Name of Project	Capacity (MW)	Actual / Expected COD
Projects already commissioned			
1	Sahiwal Coal Power	1,320	Oct-17
2	Port Qasim Coal Power	1,320	Apr-18
3	China-HUB Coal Power	1,320	Aug-19
4	Engro Thar Power & Mine	660	Jun-19
5	Quaid-e-Azam Solar Park	400	Aug-16
6	Hydro China Dawood Wind	50	Apr-17
7	UEP Wind Farm	100	Jun-17
8	Sachal Wind Farm	50	Apr-17
9	Three Gorges Wind Power Projects	99	Jun-18
10	±660KV Dual Pole HVDC Lahore-Matiari Transmission Line	-	Sep-21
11	Karot HPP	720	Jun-22
	Total (MW)	6,039	
Projects under construction / under development			
1	Shanghai Electric (TCB-1) & Mine	1,320	2023
2	HUBCO Thar Power	330	2022
3	ThalNova Thar Power	330	2022
4	Suki Kinari HPP	884	2022
5	Azad Pattan HPP	700.7	2026
6	Kohala HPP	1,124	2029
7	Gwadar Coal / Solar Power Plant	300	2023
8	Thar (Oracle) Coal Plant	1,320	2026
9	Quaid-e-Azam Solar Park	600	2024
10	Cacho Wind Power Project	50	2026

11	Western Energy (Pvt.) Ltd.	50	2026
	Total (MW)	7,009	
Potential Projects (expected be included in CPEC in Future)			
1	Mahl HPP	640	-
2	Taunsa HPP	135	-
3	Toren More HPP	350	-
4	Jameshill More HPP	260	-
5	Phander HPP	80	-
6	Port Qasim-Faisalabad HVDC Transmission Line	-	-
	Total (MW)	1,465	

Details of power projects under CPEC

A map highlighting location of CPEC power projects in Pakistan is as follows:



Map highlighting location of CPEC power projects in Pakistan

6.4 Big Achievements of CPEC Projects:

6.4.1 Improving macroeconomic conditions in Pakistan

CPEC Projects have been the catalyst for driving the development in Pakistan in recent years. CPEC has solved the problem of limited investment capacity caused by insufficient savings and shortage of foreign exchange and Foreign Direct Investment (FDI) in Pakistan and provided a high-quality source of impetus for Pakistan's economic development. As of June 2022, twenty-seven (27) projects with an investment of around $19 billion have been completed under CPEC and twenty-seven (27) projects under CPEC with investment of around $7.7 billion are at construction stage. It drove Pakistan's economic growth by one to two percentage points every year and created 46,500 job opportunities in Pakistan. As a result of CPEC Projects, Pakistan's macroeconomic conditions have started improving and its economy is maintaining a momentum of rapid growth.

6.4.2 Alleviating Pakistan's energy shortage through the addition of more than 6,000 MW of Generation Capacity

Before CPEC, Pakistan's energy shortages were restricting the country's economic development. The electricity gap cost Pakistan an annual average loss of $13.5 billion in GDP, according to a study by PwC in 2012. Power shortage left Pakistan in the dark for a long time, with rolling blackouts across the country lasting about 10 hours a day in major cities and up to 22 hours in rural areas. The power projects under CPEC helped in eliminating power shortages in a short time by developing and commissioning power projects of more than 6,000 MW based on imported and local coal, hydropower, wind and solar resources on a Fast-track basis within the last 5 years.

6.4.3 Addition of Pakistan's first ever HVDC Transmission Line in the National Grid

Another major achievement of CPEC is adding 886 km long dual pole first ever High Voltage Direct Current Matiari–Lahore ±660kV Transmission Line Project in Pakistan from Lahore to Matiari with an evacuation capacity of 4,000 MW at very low transmission losses (less than 4%). This project is helping in transporting a large quantity of reliable power from south to north.

6.4.4 Addition of Clean and Green Energy in the National Grid

The CPEC Framework has added 1,440 MW of clean and green energy based on hydro, wind, and solar resources (720 MW Hydel, 400 MW Solar, 300 MW Wind). This includes the 1st ever biggest run of the river hydro power project (720 MW Karot HPP), which was commissioned on 29th June 2022 and supplied economic, cheap, and clean energy to national grid of Pakistan.

6.4.5 CPEC Projects provided immense Employment Opportunities in Pakistan

Considering the various economic fissures prevailing in Pakistan (i.e, inequitable underdevelopment, low energy access, low human capital, and accompanying low productivity) - the CPEC power plants have performed commendably in raising overall direct local

employment (46,500) throughout Pakistan. In doing so, the overall socioeconomic demographic of around 46 thousand families have been raised, while thus skilled work force enjoys on-site training by both local and international professionals that professional work environment far surpasses the sort they would receive while employed with other local projects.

6.4.6 Foreign Direct Investment in Pakistan

All CPEC power plants have been installed under GOP Policy 2002, 2015, and AEDB Policy 2006 and 2019 as Independent Power Producers (IPPs) and are puerly Foreign Direct Investment (FDI). All equity and private debt have been arrranged by respective project companies. These plants' total investment (Equity plus private debt) have been arranged in US dollars and directly transfered by Chinese banks (China EXIM Bank, China Development Bank, etc.) to Pakistan.

6.4.7 Technology and Skill Transfer to Pakistan

The Coal based CPEC Projects are based on super-critical coal technology. The prevailing engineering graduate skill-set was insufficient to meet the requirements for technical personnel. As a result, Chinese management began focusing on the employment of graduates from specific universities in Pakistan. The first batches were completely hired from the NED University of Engineering and Technology, Karachi, and the National University of Sciences and Technology (NUST) Islamabad. Six hundred young and dynamic engineers were selected and sent to China for a 6-month technical and management training. They returned to the Project site after finishing training sessions to take charge of important operation work. The engineering employees, soon after recruitment, were sent to China for 6 months for technical training to complete a module program specifically designed for the operational phase of these power plants. Currently, foreign workers are mostly employed in the maintenance department and have an exit window from the Pakistani work force market of three years.

Per the vision and direction of the company's leadership, the share of Pakistani work force will be 80 percent from the current 68 percent within the next five years. Moreover, plants will be completely (100 percent) operated by the Pakistani workforce in next decade. It is evident from the survey that the foreign workers employed in this phase will return-back to their country within 5-10 years due to the length of their contracts as well as continuous human resource development as practice on the site itself. Keeping this in mind, an advantageous approach adopted for hiring the workforce in this phase consisted of a policy requiring that all domestic workers are freshly-qualified engineers from numerous engineering universities within Pakistan. In addition, new advanced technical training institutes are planned to open within the premises to provide technical training free of cost for the domestic workers e.g. collaboration of CSAIL with local government for the establishment of Technical Training School for locals.

To cater to the technical manpower requirements of the Karot HPP, the company selected students from the local area and awarded them for undertaking electrical engineering degrees under a well thought international scholarship program. The students, who have completed their degrees, have been provided jobs at Karot HPP.

6.4.8 Fast track development of Power Projects in Pakistan

Considering the energy shortfall of Pakistan in 2013, the speedy solution was in dire need at that time, and coal power plants were developed on a fast track at that time e.g. 1320 MW Sahiwal Power Plant was commissioned in 22 months (worldwide record in 2017).

6.4.9 CPEC Projects providing electricity in Pakistan at Competitive Rates

All CPEC coal power plants produce electricity at lower costs across the country. However, recently due to the increase in the international fuel prices caused by Ukrain War, some increase in their cost of generation has been experienced. However, 660 MW Engro Power Thar Limited is completely running on local coal and is providing electricity at competitive rates.

720 MW Karot Hydropower Project also provides power to the National Grid at a very competitive price. Besides, CPEC Wind and Solar Power Projects also provide power to the National Grid at competitive rates.

6.4.10 CPEC Projects bringing prosperity to the local community

CPEC Projects have helped in the improvement of livelihood, health, education, recreation, and infrastructure facilities in the local community as many projects under CPEC have completed many socioeconomic development projects in the local areas under their Corporate Social Responsibility (CSR) and Community Investment Plan (CIP) bringing a prosperity of the local population. Besides, in the future, many more of these projects will be completed.

6.4.11 Improving infrastructure connectivity in Pakistan

The China-Pakistan cross-border economic belt, linked by the China-Pakistan Karakoram Highway, has taken shape under CPEC. Through international logistics nodes such as Gwadar Port, Karachi and Peshawar, Pakistan serves to transport products from western China to countries in the Middle East and the Indian Ocean via transit transport. Therefore, infrastructure connectivity is also one of the important areas in the early harvest projects of CPEC.

6.4.12 Cross-border fiber optic project completed and opened

The 820-km China-Pakistan Cross-Border Fibre Optic Project, which is laid between the city of Rawalpindi, Pakistan, in the south and the Khunjerab Pass, China, in the north, was completed and opened on July 13, 2018.

6.5 Conclusion

Over ten years ago, Pakistan experienced a severe electricity crisis, with an average shortfall of 8,000-9,000 MW during peak hours due to inefficient generation capacity and transmission constraints. Hence, the growth of the economy was severely hampered by these bottlenecks. This hurdle had to be addressed immediately, necessitating a billion-dollar investment in the sector with long-term planning. Therefore, the government planned significant investments in the power sector, most of which were through CPEC.

The CPEC Energy Projects of 6,039 MW not only focused on the provision of electricity generation but also highlighted how the projects encourage sustainability, long-term employment evolution in their respective areas and technology transfer.

CPEC Energy portfolio is giving a big relief in the short term and long term to Pakistan because the approved tariff will be reduced to around half after 10-12 years of operations of these projects, and hydropower projects under CPEC will be transferred to provincial governments free of cost after 30 years of operation after COD. So, these energy projects brought up efficient, uninterrupted electricity in a short time, along with the foreign direct investment resulting in the revival of local industry. These projects utilize world-class state-of-the-art energy generation technologies and have provided abundant local direct and indirect employment opportunities in the construction and operational phases of these projects.

CHAPTER 7:

IGCEP 2021-30 AND POWER DEMAND / SUPPLY ANALYSIS

7.1 Background:

Electricity is a critical input for economic development, and correspondingly power sector comprises an indispensable infrastructure in any economy. Providing adequate, reliable, affordable electric power is essential for economic development, human welfare, and better living standards. The growth of economy along with its global competitiveness hinges on the availability of reliable and affordable power to all consumers throughout the country. Electricity is central to achieving sustainable human development's economic, social and environmental objectives. Development of different sectors of the economy is impossible without matching the development of the power sector.

Future opportunities in the sector depend on the growth of the power sector in terms of demand requirements, objectives of the federal government, and corresponding investment needs. Expansion plans are therefore regularly developed, which act as a tool for the policy makers and investors to take necessary steps and align their priorities. For meeting energy demand over the future, preparation of a realistic and accurate demand forecast is the key, which forms the basis for reliable development of generation, transmission and distribution expansion plans given technical, economic and financial parameters. The demand forecasts directly influence future investment decision. The following sections provide a detailed account of important steps involved in the planning process to develop such plans. In this respect, preparation of load demand forecast and development of Indicative Generation Capacity Expansion Plan (IGCEP) have been thoroughly analyzed to provide a fair idea about investment avenues in the future, especially for the private sector.

As per the Planning Code (PC4) of the NEPRA Grid Code, NTDC is required to prepare and submit the following plans to NEPRA for approval:

- Load Forecast
    - For at least next 20 years
- Generation Expansion Plan
    - Ten year Indicative Generation Capacity Expansion Plan (IGCEP)
- Transmission Expansion Plan
    - Comprehensive Transmission Line plan

NTDC prepared the first IGCEP (for the period 2021-30) on April 20, 2020, which NEPRA approved, on Sep 24, 2021 after various meetings and public hearings. NTDC is required to

prepare such plan every year which would be used for capacity planning given the system demand forecast and technical, economic, and financial parameters. It is to be noted that IGCEP has been prepared to meet the electricity demand of the whole country except the areas served by K-Electric (KE).

Earlier, NTDC / WAPDA prepared the following five (05) major generation expansion plans:

a) National Power Plan (NPP 1994-2018) developed by Canadian Consultant, M/s ACRES International Limited;
b) National Power System Expansion Plan (NPSEP 2011-2030) developed by Canadian Consultant, M/s SNC Lavalin;
c) Least Cost Plan (LCP 2016-2035) developed by Japanese Consultant, M/s International Institute of Electric Power, Ltd., and
d) Indicative Generation Capacity Expansion Plan (IGCEP) 2040
e) Indicative Generation Capacity Expansion Plan (IGCEP) 2047

IGCEP provides a comprehensive view of the future electricity demand forecast, existing generating system and future power generation options. IGCEP also provides basis for the expansion of the transmission network. It identifies the types of generation to be added to the system and also the location in case of hydropower plants. The IGCEP is being used as one of the main inputs to the Transmission System Expansion Plan (TSEP) along with spatial demand growth to work out the power evacuation requirements and reliably serving the load.

7.2 Salient Features of IGCEP:

Following are the salient features of the IGCEP:

a) Significant Induction of Renewable Energies (clean and indigenous)
b) Tapping of indigenous coal-based power
c) Balancing the overall basket price with increased share of hydro power
d) Optimal indigenization: less reliance on imported fuel i.e. coal, RFO, RLNG etc.
e) Substantial reduction in carbon emission owing to induction of REs and hydro's

7.3 Planning Horizon

The IGCEP covers the whole country except the K-Electric system. However, the IGCEP includes an export of 1,100 MW from NTDC system to K-Electric in summer months up-to 2023, which is further increased to 2,050 MW after the commissioning of 500 kV KANUPP Karachi Interconnection grid station by K-Electric, as detailed in proposed tri-partite agreement among K-Electric, NTDC & CPPA-G, till the end of study horizon. The planning horizon of the IGCEP is from the year 2021 to 2030.

7.4 Approach and Methodology:

The development of the least cost generation capacity expansion plan is the process of optimizing i) existing and committed generation facilities and ii) the addition of generation from available supply technologies/options, which would balance the projected demand while

satisfying the specified reliability criteria. For the IGCEP, the following methodology has been adopted, as illustrated hereunder:

1) **First Step:** Review the existing generation facilities, and committed power projects and explore the range of generation addition options available to meet the future demand.
2) **Second Step:** Determine the economically attractive/viable generation option (s).
3) **Third Step:** Define the Base Case after identification of the economically attractive options.
4) **Fourth Step:** Develop the least cost planwhile considering the reliability criteria and reserve requirements under the already defined Base Case.

7.5 Power Demand and Supply Analysis

Power demand and supply analysis provide the basis for all planning activities in the power sector. Planning Code (PC4) of the Grid Code states:

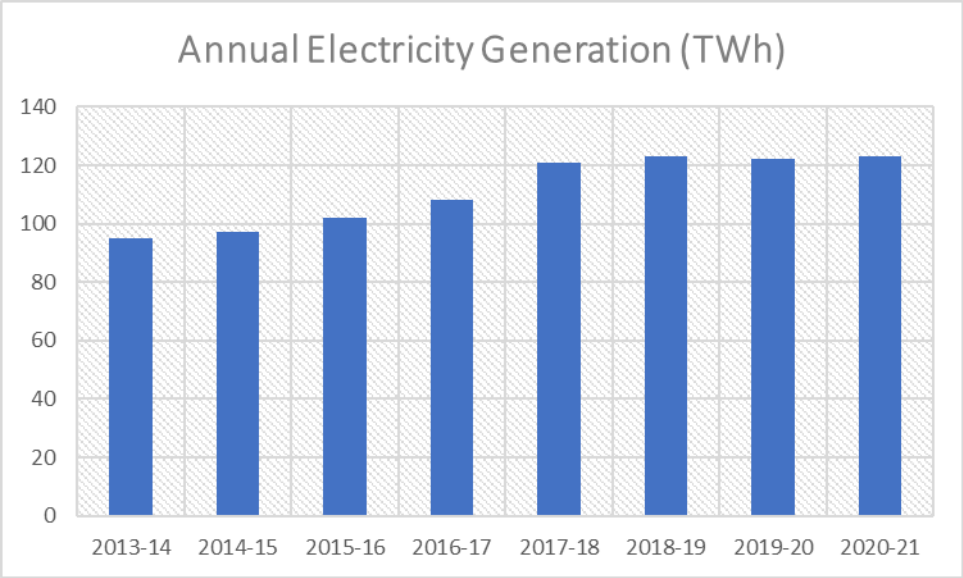
Factors to be considered while preparing the load forecasts include economic activity, population trends, industrialization, weather, distribution companies' forecasts, demand side management and load shedding, etc.

A reliable and precise demand forecast is highly critical for preparing generation, transmission and distribution expansion plans. Future investment decisions in the power sector depend heavily on the demand forecast results. Even slight underestimations may result in load management in the country, and any overestimations may result in a monetary loss in the form of 'capacity payments' due to the non-utilization of power generation.

7.6 Latest Power Demand and Supply utilized in IGCEP 2021-30

7.6.1 Historical Trends of Energy Generation (2014-2021)

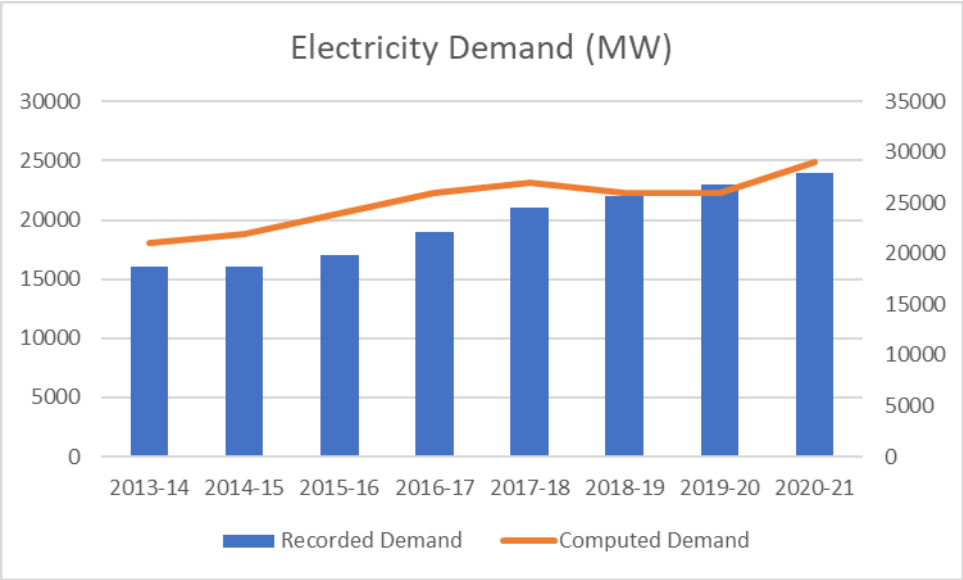
An increasing trend in electricity generation from 2013-14 to 2019-20 may be noted from the information as provided below. In 2020, however, a slight decrease is observed due to lesser demand owing to struggling economy coupled with the impacts of COVID-19 pandemic. In 2021, slight increase in energy generation over that of 2019-20 had been recorded, as shown below:



Trend of Annual Energy Generation from year 2013 till 2021

7.6.2 Historical Trends of Peak Demand (2014-2021)

The power demand (MW) has been growing steadily with improved development of electricity supply in the country, as is evident from the electricity peak demand trend, which is shown below:



Trend of Peak Demand from year 2013 till 2021

The Peak demand increased from 2014 to 2017, while due to COVID-19 the demand remained steady for around two years, while showing an increasing trend in the year 2021.

7.7 Preparation of Demand Forecast:

The electricity consumption of Pakistan is segregated into the following four major sectors:

i. Domestic;
ii. Commercial;
iii. Industrial; and
iv. Agriculture

These sectors typically show different consumption patterns throughout the year. Hence, they are forecasted separately. The load demand forecast of these sectors is then combined to obtain the total electrical energy demand forecast. In order to forecast the annual consumption of electricity up to the year 2030, a multiple regression model has been used by NTDC. NTDC also considers the following factors for the forecast:

a) Annual total GDP and its components i.e. agriculture sector, industrial sector and services sector
b) Tariff-wise electricity prices i.e. domestic, commercial, agriculture and industrial;
c) Number of consumers;
d) Lag of dependent and independent variables; and
e) Consumer Price Index.

The demand forecast results of the four categories are combined to calculate the sale forecast at the country level. Required generation (GWh) is calculated after adding projected distribution losses at 11 kV and Transmission Losses at 132 kV and 500/220 kV according to the loss reduction plan of respective DISCOs and NTDC.

In order to convert the energy into forecasted peak demand, load factors for the base and future years are used.

Accordingly, as shown below, NTDC worked out demand forecast for the next ten years. By 2025, the demand is expected to be 29,389 MW, which would increase to 37,129 MW by year 2030.

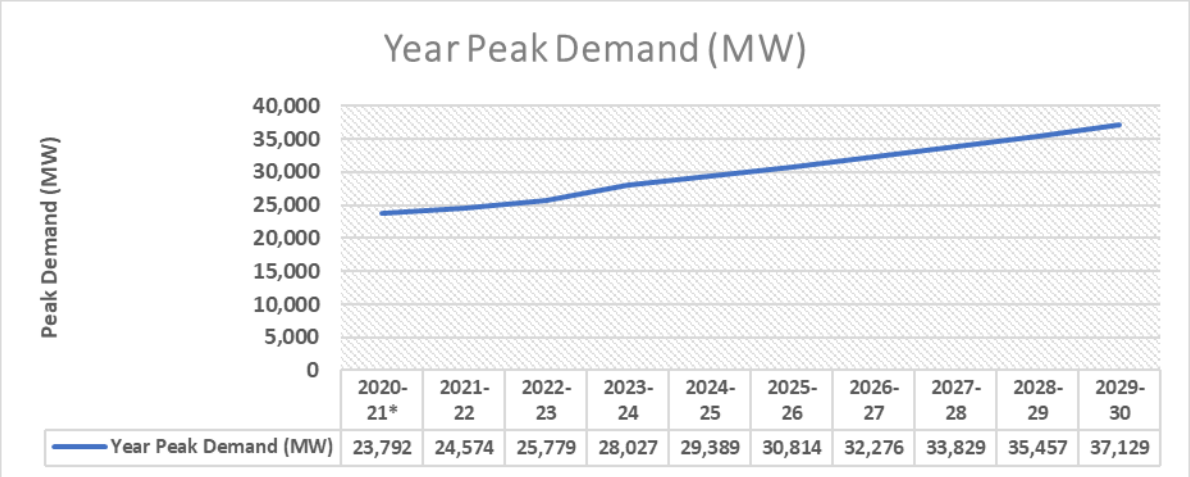
Year	Power Demand	
	Generation (GWh)	Peak Demand (MW)
2020-21*	130,652	23,792
2021-22	136,151	24,574
2022-23	142,563	25,779
2023-24	159,319	28,027
2024-25	166,550	29,389
ACGR 2021-25	6.26%	5.42%
2025-26	174,102	30,814
2026-27	181,834	32,276
2027-28	190,037	33,829

2028-29	198,622	35,457
2029-30	207,418	37,129
ACGR 2025-30	4.47%	4.77%
ACGR 2021-30	5.27%	5.07%

Yearly demand forecast from 2020-21 to 2029-30

*Actual Demand (MW) and Energy Generation (GWh) used by NTDC for preparation of IGCEP

The following graph shows increasing trend of peak demand as forecasted by NTDC:



Trend of yearly demand forecast from 2020-21 to 2029-30

7.8 Forecasted Generation:

In order to meet the demand of 37,129 MW in the year 2030, a capacity generation of 61,112 will be made available. The share of each source of energy generation available in year 2030 is mentioned in the below table along with available capacity. The data shows that the share from Variable Renewable Energy (VRE) resources stands out to be 7,932 MW, 5,005 MW and 749 MW of Solar, Wind, and Bagasse, respectively by 2030. Moreover, including renewable energy projects, hydro and Thar coal will also help lower the basket price of the overall system, which would help relieve the end consumers. The share of gas fired power plants would also be decrease significantly from 15% to just 6% in the next five years, this would further aide in reducing the cost of energy generation.

Moreover, the addition of generation through local coal based projects will be increased to 15%. Due to this fact, the share of RLNG based plants will decrease from 18% to 2% in 2025, eventually falling nearly to 0% in 2030. The same is the case for imported coal-based plants, whose contribution in the overall generation mix falls from 21 % in 2021 to only 9% by 2030. Moreover, the share of solar and wind in the overall energy mix increases from 3% to 16% by 2030. The summary of the total expected Installed Capacity (MW) & Energy Generation (GWh), respectively by the year 2030, is as follows:

Technology	Installed Capacity (MW)	Energy Generation (GWh)
Solar	7,932	15,916
Wind	5,005	17,225
Bagasse	748.6	3,380
Hydro	23,653	94,649
Imported Coal	4,920	18,448
Local Coal	3,630	23,145
RLNG	6,786	686
Gas	2,582	5,623
Nuclear	3,635	24,910
Cross Border	1,000	3,436
RFO	1,220	-
Total	61,112 MW	207,418

Summary of Installed Capacity and Energy Generation by 2030

CHAPTER 8:

COMPETITIVE MARKET FRAMEWORK AND PARTICIPATION BY PRIVATE SECTOR

8.1 Background:

The development of the wholesale competitive electricity market in Pakistan was envisioned at the outset of power market reforms of the 1990s. Generation companies were allowed to sell directly to Bulk Power Consumers (BPC- consumers with a load of 1 MW or above) under the Regulation of Generation, Transmission, and Distribution of Electric Power Act, 1997. Later on Transmission License granted by Nepra to NTDC contained an elaborate blueprint for a competitive market by identifying several entities to be created for moving to competitive market. The concept of 'single-buyer-plus' model was also introduced which was planned to lead to multiple seller and buyer market. Nepra Amendment Act (Amendment Act) introduced material changes in the Nepra Act 1997 by identifying new players in the sector like market operator, system operator, trader, and supplier. Amendment Act also stipulated salient features of National Electricity Policy (NEP) in respect of future competitive market model development.

Further, the ECC in its decision dated April 2015 mandated CPPA-G to prepare and submit the model of the Competitive Trading Bilateral Contract Market (CTBCM) to NEPRA in consultation with the stakeholders.

In November 2020, NEPRA approved CTBCM model that provided a roadmap for opening the Wholesale Electricity Market of Pakistan. , aiming to provide choice to the bulk power consumers

CPPA-G has been assigned the Central Facilitator role to assist all entities in implementing their respective action plans under CTBCM.

CTBCM is not a standalone mechanism, rather it complements the framework as provided under Amendment Act, 2018.

8.2 Chronology of CTBCM Development in Pakistan

8.2.1 Transmission License Granted by Nepra to NTDC

In 2002, NTDC was granted Transmission License by NEPRA to reorganize itself to perform the following four (04) functions:

1) Central Power Purchasing Agency (CPPA)
2) Transmission Network Operator (TNO)
3) System Operator (SO)
4) Contract Registrar and Power Exchange Administrator (CRPEA)

NTDC was mandated to develop CTBCM by year 2008.

CPPA-G

CPPA-G was legally formed in 2009. It functioned as Department of NTDC from year 2009 to 2015.

8.2.2 Economic Coordination Committee's Decision in April 2015

Economic Coordination Committee (ECC) of the Cabinet made following decision regarding CTBCM during the meeting held in April 2015:

- CPPA-G, through consultation, to prepare CTBCM Model and Plan by June 2017
- The CTBCM is for wholesale market
- The CTBCM will be approved by NEPRA
- Commercial Operations date: June 2020
- CPPA-G Operationalized
- CPPA-G formed Market Development Department

8.2.3 CTBCM Approval by NEPRA

- CPPA-G submitted the model and plan of CTBCM to NEPRA in 2018 for review and requested for ECC in amending timelines
- CPPA-G received the approval of NEPRA on the High Level Design of CTBCM Model via determination dated December 5, 2019.
- Road Map subject to certain enabling conditions approved by Nepra in November 2020.

8.3 Main Features of CTBCM

As observed earlier CTBCM complements the framework of a regime as foreseen under the Amendment Act. Accordingly, the roles of new license holders identified under the Act have been dovetailed in CTBCM framework and certain new entities have been proposed to deal with the ground realities. For instance the concept of Special Purpose Trader (SPT) has been included for the continuity of existing contractual arrangements for power procurement. Similarly, the Independent Auction Administrator will facilitate centralized power procurement. The main features of CTBCM are listed as follows:

- Establishment of an independent and impartial Market Operator & System Operator
- Improved dispatch operations through strengthening of System Operator
- Tool based Security Constrained Economic Dispatch
- Generation adequacy ensured through Capacity Obligations

- New Capacity for Distribution Companies (DISCOs) procured through centralized auction by Independent Auction Administrator (IAA)
- Introduction of Credit Covers to cover non-payment risks in the market
- Government Support for low-performing DISCOs
- Balancing Mechanisms introduced to trade imbalances on market prices
- Rules and Regulations established for Market Participants and Service Providers
- Legacy PPAs/EPAs will be commercially allocated to the DISCOs and will be legally administered by the CPPA-G
- Introduction of flexibilities in new contracts
- Contract Registrar to check the validity of contracts and verify capacity obligations of the market participants
- New Commercial Code to govern the operations of the Market

8.4 Roles of Institutions in implementing CTBCM

8.4.1 System Operator (SO)

SO, a separate licensed entity will be entrusted with the following roles:

- Real-time operations and system balancing within security and reliability constraints
- Medium and short-term planning, forecasting, Day ahead Security Constrained Economic Dispatch (SCED)
- Long term planning and forecasting
- Administration of Open Access to the Grid and Ancillary Services

8.4.2 Transmission Line Companies

- Provide reliable and stable transmission infrastructure to enable the trade
- NTDC as the National Grid Company (NGC) to coordinate with other transmission licensees for adequate design and construction of network
- Execute the construction of projects, as proposed by the planner in a timely manner
- Allow open access to the participants, sign connection agreements

8.4.3 Independent Auction Administrator (IAA)

PPIB/AEDB will be merged to assume the Independent Auction Administrator (IAA) role, which will perform the auctioneer function for procuring generation capacity against the incremental demand, primarily for DISCOs. In order to undertake this function, PPIB/AEDB would need to get themselves registered with NEPRA as IAA. The functions of IAA will be as follows:

- To Prepare the Capacity Procurement Plan based on IGCEP prepared by NTDC, Energy Gap by DISCOs and energy policies of the government.
- To conduct the competitive auctions for the new power procurement.
- To prepare the standard bidding documents and submit to NEPRA for review.
- To prepare and obtain the regulatory approval of PPAs / EPAs templates for the centralized auctions.
- To assist the DISCOs in finalizing the bilateral PPAs/ EPAs with each generator that has been awarded in the auction.

- To arrange Guarantees for low performing DISCOs through GoP.

8.4.4 Special Purpose Trader (SPT)

- SPT will Perform the same functions as CPPA-G does in its agency role today.
- SPT, without any implication, will honor existing PPAs, however, no new procurement will be allowed to be signed by SPT.

8.4.5 Regulator (NEPRA)

In addition to its role as an exclusive regulator, Nepra is foreseen to perform the following functions as specifically relevant to CTBCM.

- **Issue** licenses to the Market Participants and Service Providers
- **Monitor and supervise** the functioning of the market (particularly the risk of market power abuse)

8.4.6 Market Operator (MO)

- **Contract Registrar** (Admission, suspension and cancellation of Participants)
- Registration of Common Delivery Points (CDPs)
- Sign a **Market Participation Agreement** (MPA) with Participants establishing rights, responsibilities and obligations, including the obligation of the Participant to provide credit cover
- Calculate **energy and capacity imbalance quantities** for each Participant;
- Calculate **hourly imbalance prices** for energy
- Calculate monthly **transmission use of system charges and market fee**
- **Balancing Mechanism for Energy (BME) Settlement** on a weekly (provisional) and monthly (final) basis
- **Balancing Mechanism for Capacity (BMC) settlement** on annual basis

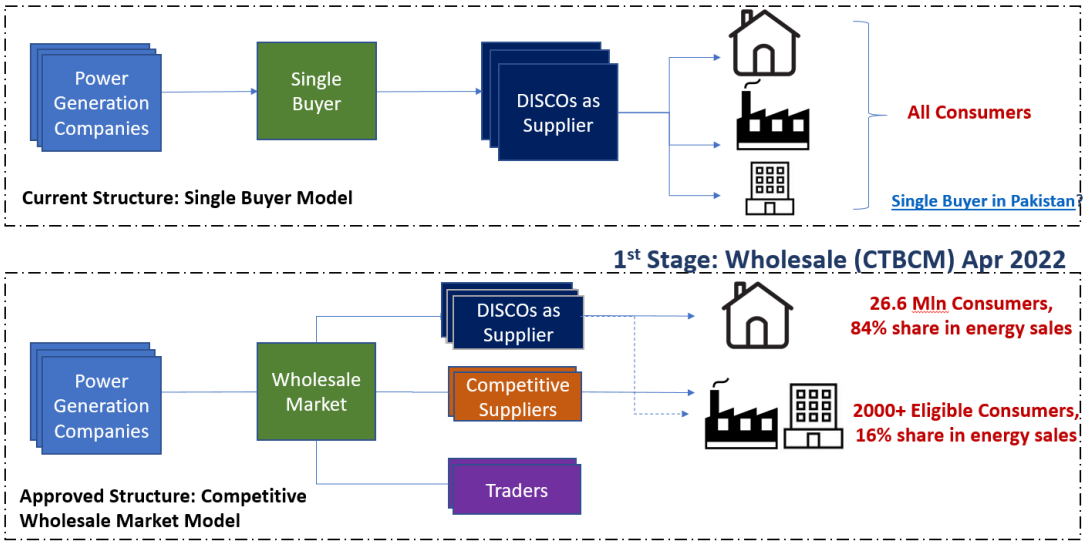
8.4.7 DISCOs as Distribution Network Operators

- **Develop adequate and reliable distribution networks** in the specified service territory

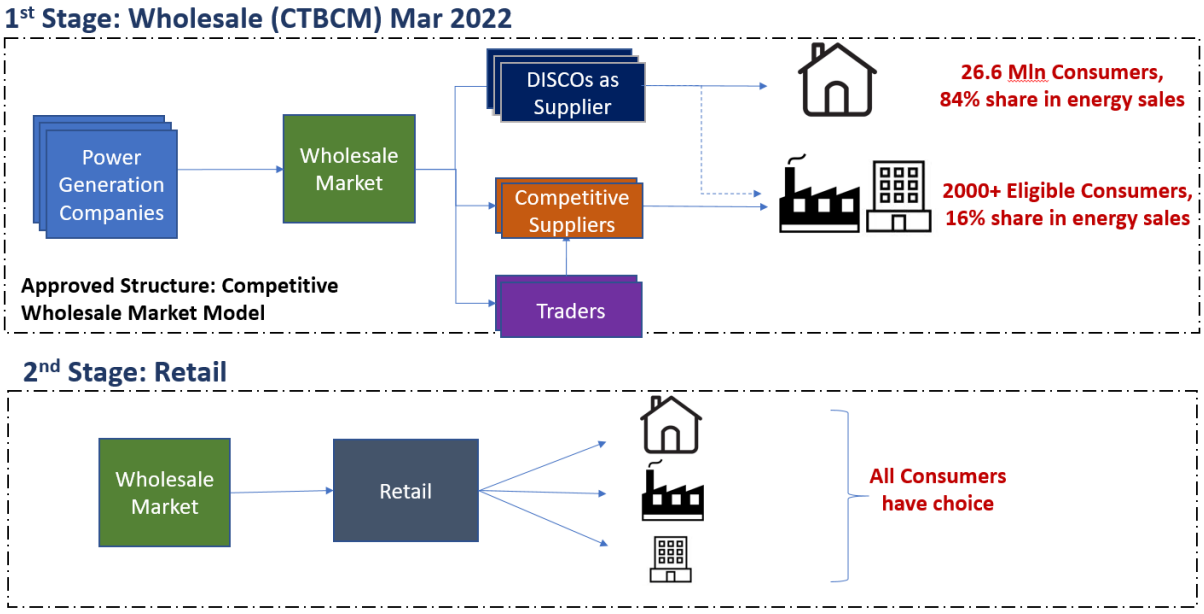
8.4.8 DISCOs as Suppliers

- Obtain **Electric Power Supply license** with the defined service territory from NEPRA
- **Supply power** to all non-eligible consumers and eligible consumers (not opted for competitive supplier) on **regulated rates**
- Contribute to the reliability and security of the power system by fulfilling **capacity obligations**
- **Procure power** as per the approved **IGCEP** and **Procurement Plan** (to be prepared by IAA)
- **Sign** market based **Bilateral Contract** with generators as a result of **centralized auctions run by IAA**
- Procure power from CPPA-G (agent) as per **commercial allocation of existing PPAs**

A schematic diagram of CTBCM Model under implementation in different stages is as follows:



CTBCM: Single-Buyer Model and Wholesale Competitive Market



CTBCM: Competitive Wholesale and Retail Markets

8.5 Aim & Objective of CTBCM:

The basic aim of the CTBCM is to introduce competition in the Electricity Market and provide an enabling environment where multiple sellers and buyers can trade electricity. Under CTBCM, there will be multiple buyers and sellers, and the hourly electricity price will be determined by the economic forces of supply and demand.

The main objective of CTBCM is to develop an efficient and transparent wholesale electricity market. For such reason, significant emphasis has been put on transparency and publication of information. The System Operator (SO), Market Operator (MO), DISCOs, NTDC as Planner, Transmission Network Operator (TNO), Metering Services Provider (MSP), Independent Auction Administrator (IAA) and the Special Purpose Trader (SPT) shall have IT based systems

and information publishing mechanisms as given in CTBCM Plan to ensure all market participants are aware of the market decisions and market results.

8.6 Regulatory Framework:

In order to provide an enabling regulatory framework for successful commercial operations of CTBCM, the Authority has also formulated following regulations:

1) NEPRA Licensing (Market Operator) Regulations, 2022;
2) NEPRA (Electric Power Trader) Regulations, 2022;
3) NEPRA Licensing (Electric Power Supplier) Regulations, 2022;
4) NEPRA Electric Power (Performance Standards) Regulations, 2022;
5) NEPRA Licensing (Distribution) Regulations, 2022;
6) NEPRA Consumer Eligibility Criteria (Electric Power Suppliers) Regulations, 2022;
7) NEPRA Consumer Eligibility Criteria (Distribution Licensees) Regulations, 2022;
8) NEPRA (Registration) Regulations, 2022;
9) Amendments in NEPRA (AMEC) Procedure Regulations, 2022;
10) Amendments in Fee Regulations.

8.7 Contractual Framework in CTBCM:

- The legacy Power Purchase Agreements (PPAs) will be allocated to all the DISCOs based on the allocation factors approved by NEPRA. The allocation will be among the DISCOs, K-Electric and all other existing distribution licensees (in the role of suppliers), including these small DISCOs based on the criterion defined in the detailed design and subsequent methodologies to be developed. Through this allocation, each distribution licensee will be assigned a fixed share (subject to revisions in the future) from the existing contracted capacity so that the individual future needs can be calculated based on their respective demand forecasts. A diagram showing the treatment of Legacy PPAs is as follows:

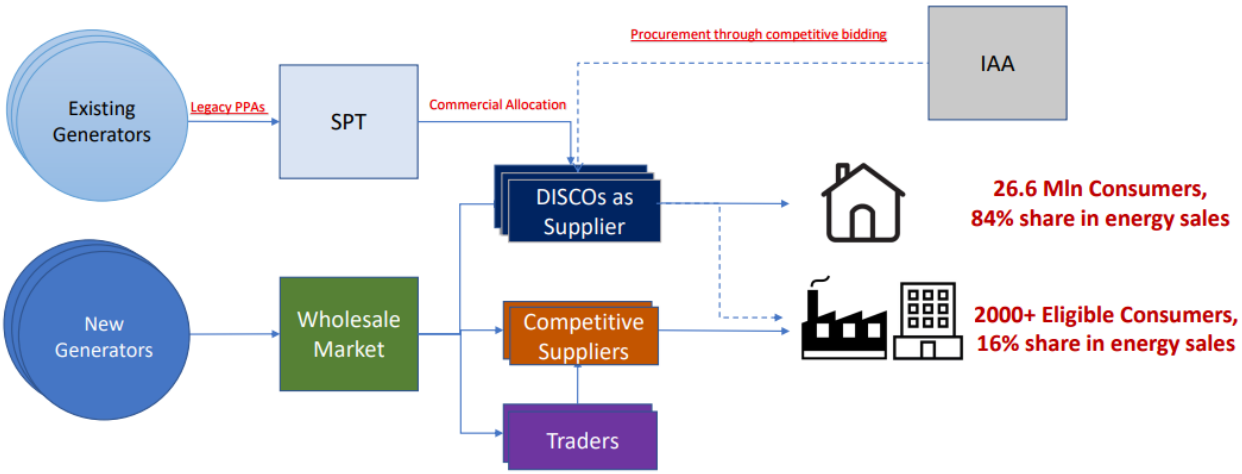


Diagram - Legacy PPAs

- There will be no impact of allocation on Rights and obligations established under the existing PPAs/EPAs. CPPA (to be SPT) will be dealing with legacy contracts in the

same manner as today. These contracts will be protected and there will be no alteration of these agreements under CTBCM.

- Future procurement for regulated consumers will be done through competitive auctions conducted by IAA, against the forecasted incremental demand of DISCOs. Power procurement of new contracts for DISCOs will be through competitive processes, initially administered centrally by the Independent Auction Administrator (IAA) and/or, at a later stage, through direct competitive contracting by each DISCO, when NEPRA authorize this possibility following applicable regulations and guidelines.
- Electricity imports from AJK or any other area will be considered as a Generator "connected" in the international interconnection and represented in the market by the Participant that is the purchasing/import party in the contract.
- End-consumer tariffs for regulated consumers will be determined by NEPRA in a similar way as done today. The procurement process will also be regulated; the generation tariff will be determined through the competitive auction process instead of cost-plus and upfront tariff regimes.

8.8 Wholesale and Retail Market:

Initially, CTBCM will introduce completion in the wholesale market only allowing large consumers, suppliers, traders, and generators to negotiate a bilateral contract of sale and purchase of electricity in bulk (> 1MW). As the market maturity and liquidity increases the regulator shall gradually decrease this threshold to introduce competition at retail level where the end-consumers will have choice to select their own supplier.

Future procurement for regulated consumers in CTBCM: In the initial stage of the market opening, the contracts will still be backed by government guarantees but their volume will be reduced significantly in CTBCM and would be limited only to DISCOs having low creditworthiness.

Captive generators and Wheeling under the CTBCM: Captive generators can obtain a supplier license and enter into a bilateral contract with any BPCs for electric power supply. Alternatively, captive generators can sell their energy and capacity in the market without bilateral contracts.

The framework for wheeling i.e., wheeling regulations, has been repealed with the commencement of the CTBCM. In order to sell electric power to a BPC under the CTBCM, a generation company will have to obtain a license as an electric power supplier under NEPRA (Electric Power Supplier) License 2022.

Financing under CTBCM: At the start of the market, sovereign guarantees will continue from the federal government for future DISCOs procurement. However, in CTBCM, contracts will be signed bilaterally between DISCOs and generators. Gradually, sovereign guarantees will be withdrawn as DISCOs become credit worthy. Power plants selling power to under B2B arrangements through competitive suppliers will secure their investments and risks at their own.

Transmission and Distribution Use of System Charges (UoSC) under CTBCM: The UoSC have been already determined in various tariff determinations of the DISCOs, NTDC, MO fee etc.

Captive Power Generation in CTBCM: Captive power generation based on fossil fuels will only be dispatched when it qualify for merit order despatch. Such situations can occur as some of them are also based on coal and bagasse. Fossil based generation can also be dispatched to alleviate congestion in some regions in which it might become feasible to run small captive generators for alleviation rather than large IPPs. Captives connected on 11kV will be on self-dispatch and will not be able to trade capacity. They can sell their energy in BME at a marginal price or through bilateral contracts. The opportunity for Captive Power Plants in CTBCM is Sale of power as a merchant plant and the Sale of power under B2B.

Bulk Power Consumers under CTBCM: Bulk Power Consumers (BPCs) who opt to buy power from market competitive supplier will not be allowed to buy excess energy from Supplier of Last Resort (SOLR) on regulated tariff. They can only buy electricity through bilateral contracts and any imbalances arising out of it will be settled at marginal price through market operator. As per the Market Commercial Code approved by the Authority, the minimum contract duration that a BPC will enter is two (2) years.

Under the approved CTBCM Design, the hybrid BPC arrangement is not allowed. A BPC can purchase electric power from the SOLR (XWDISCO) or a competitive supplier.

Participation of Private Sector in Competitive market

The CTBCM provides for several major changes in the institutional set up as new organizations have been identified to play their role in the market operation. At the same time however, CTBCM is foreseen to open doors for the private sector participation as well.

Privatization of DISCOs as Network Operators

The Amendment Act 2018 has separated distribution into wire and supply functions. Henceforth, DISCOs will only perform the duties of network operators according to the NEPRA Act. The new role, which excludes the sale function, will certainly be more conducive for placing DISCOs for privatization. It is expected that a simplified model with minimum involvement of end consumers will draw less resistance from lower-level employees relative to earlier such initiatives.

Competitive Suppliers

The Amendment Act allows the DISCOs to continue for five year (2018-23) to act as Supplier of the Last Resort (SOLR). However, in addition to that, any person can be engaged in the supply of electricity subject to a license granted by NEPRA under Section 23E of the Act. Therefore, generation companies and others as a 'suppliers' will be able to supply to BPC in the territory specified in their license. Accordingly, large-scale induction of RE-based power generation plants under GOP Policy, also established through IGCEP, may also participate in

the competitive market as 'competitive suppliers'. Similarly, 'Captive Power Generation' will have opportunities to participate in the Competitive Market

IPPs after Expiry of Legacy Agreements

A number of IPPs established under earlier policies are expected to complete their contracts with NTDC/CPPA-G in the near future. Depending on the useful life of such power generation plants, they may participate in the market as a merchant plant, which will create additional opportunities for the private sector as SPT (CPPA-G) will not procure power from those IPP under the competitive market framework.

Traders

Trading under the Amendment Act means facilitating bilateral trading of electricity by entering mutual contracts between parties. Any person can engage in electricity trading, subject to NEPRA License under Section 23C of the Act.

8.9 Present Status of CTBCM:

In May 2022, NEPRA granted a market operator license to CPPA-G and approved **Market Commercial Code (MCC)**. As per the approved MCC:

d) The single buyer regime will end, and DISCOs will be procuring power through centrally organized auctions run by the Independent Auction Administrator (IAA),
e) bulk power consumers (more than 1 MW load) will be given a choice to procure power either from distribution company (DISCO) or its competitive supplier and
f) market sales on a merchant basis will also be allowed to interested generation plants including those retiring from legacy generation fleets or connected with the national grid as captive generating plants.

8.10 Benefits of CTBCM in Power Sector of Pakistan:

- Transparency and efficiency in wholesale market operation will improve operational efficiencies, such as respective variable costs (up to 10%) through optimized dispatch.
- Institutional strengthening.
- Reduction in market, regulatory and other associated risks resulting in lower returns (prices) by investors.
- Generation costs are likely to go down (up to 15%) through auctions.
- Removing sovereign guarantees over time thus reducing burden on government for future procurements.
- Avoiding over and under supply of power through clear, transparent and accountable market mechanisms.

CHAPTER 9:

ELECTRIC VEHICLES

9.1 Background

Energy is at the heart of development. Energy poverty can directly be linked to economic and social development and vice versa. Despite a decent-enough power generation capacity, Pakistan remains an energy deficient andenergy-insecure country. While the thrust of all major energy policies in the country up till 2019 has been in the industrial and consumer sectors, the fact remains that transport is a large, untargeted sector, consuming almost one-third of all energy. The paucity of a unified approach towards the transport sector leads not only to poor availability of low-carbon, efficient public transport in all major cities of the countries but also to heavy reliance on expensive imported fuel, and constantly deteriorating air quality in urban centers. While numerous initiatives have been taken by automakers and governments globally to reduce sectoral and country-specific carbon footprints, reducing unsustainable reliance on fossil fuels, Pakistan has only recently joined the conversation through its first-ever national Electric Vehicles (EV) policy in 2019. The policy targets 30% of its road vehicles to be EVs by 2030. This means that a window of opportunity has opened to allow global car manufacturers investing in EVs, such as Tesla, Volkswagen, Ford, BMW, Mercedes, Toyota, and Nissan, among other large Chinese manufacturers, to see Pakistan as a viable market.

9.2 Electric Vehicle and its Types:

EVs are of several types, broadly categorized as Hybrid Vehicles (HVs), Plug-in Hybrid Electric Vehicles (PHEVs), and Battery Electric Vehicles (BEVs) or also called EVs.

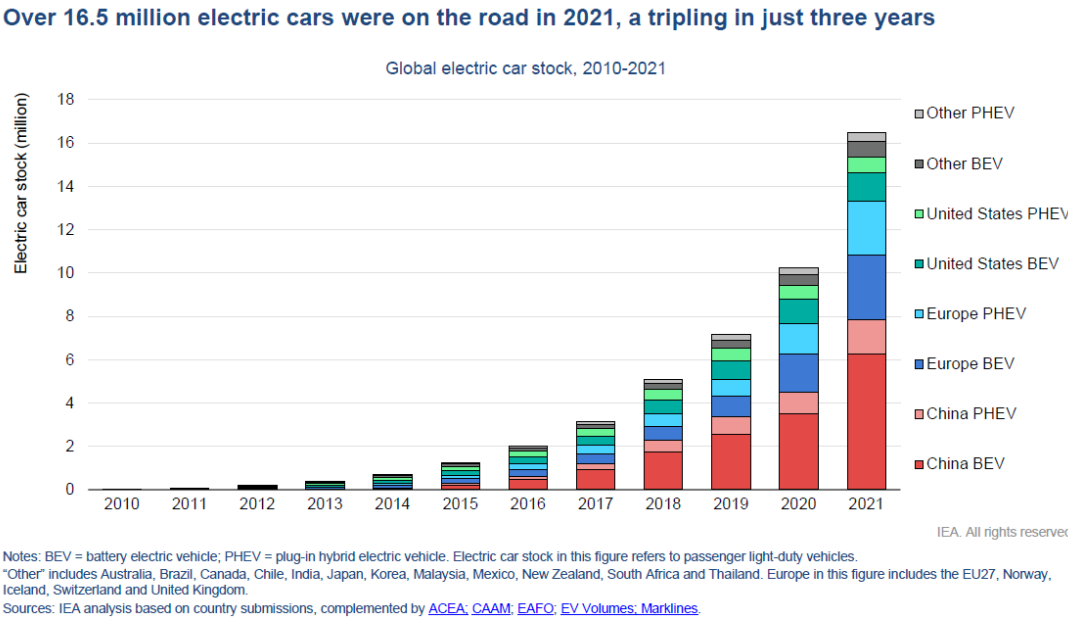
- HVs are self-contained vehicles that have a small battery, typically in the range of 1-3 kWh. The engine and the braking charge the battery, and the car's computer system switches between the engine and battery power or between a combination based on speed and driving patterns.
- PHEVs, in addition to an engine and a large battery, which typically has a capacity of 10-30 kWh, have an option to charge the battery from an electric outlet. The typical range of PHEVs, with fully charged batteries, is 30-50 km. Once the battery depletes, the engine kicks in, and the PHEVs then work as HVs.
- Battery Electric Vehicles (BEVs) must be charged from electric outlets and the typical driving range with one full charge is between 150-300 km.

9.3 EV Plans and Targets of various countries

Despite the COVID-19 pandemic and supply chain challenges, EV sales have reached a record high in 2021. In 2012, about 120k electric cars were sold worldwide. In 2021, that many were

sold in a week. After increasing in 2020 despite a depressed car market, sales of electric cars – Battery Electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs) – nearly doubled year on year to 6.6 million in 2021, bringing the total number of electric cars on roads to over 16.5 million.

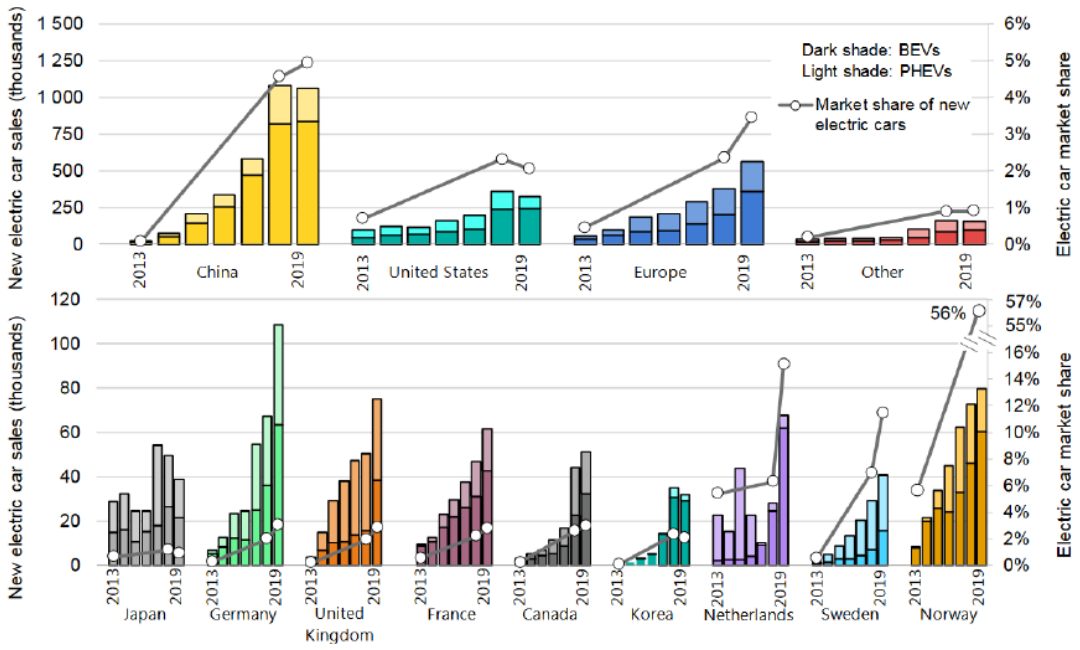
As in previous years, BEVs accounted for most of the increase (about 70%). EV markets are expanding quickly. Electric car sales accounted for 9% of the global car market in 2021 – four times their market share in 2019. All the net growth in global car sales in 2021 came from electric cars. Sales were highest in the People's Republic of China, where they tripled relative to 2020 to 3.3 million after several years of relative stagnation, and in Europe, where they increased by two-thirds year-on-year to 2.3 million. Together, China and Europe accounted for more than 85% of global electric car sales in 2021, followed by the United States (10%), where they more than doubled from 2020 to reach 630 000 (Global EV Outlook 2021).



Global EV Outlook 2021

Still, the goal of all EVs is not ordinary. Thus, it may not be achieved until a couple of decades for even the most advanced countries in the world. Therefore, countries have set deadlines to go all-electric in their new car sales. Norway is planning to sell all EVs by 2025. The Netherlands is planning for 2030, while UK and France are targeting a deadline of 2040 for all EV sales. India has a target to sell 30 percent of new vehicles as all-electric cars by 2030.

Due to these targets, several automakers are also set to remove Fossil Fuel-based Vehicles (FFV) from their vehicles lineup. Volvo is set to remove complete FFVs from its lineup and plans to increase BEV share to 50 percent by 2025. Similarly, all major automakers have targets to increase their share of PHEVs and BEVs through new models and targets in the next several years.



Global Car Sales Source: IEA 2020

Advantages for Pakistan for replacing EVs with gasoline Vehicles

The transportation sector has been growing with double-digit growth in Pakistan. Almost all of the transportation sector is dependent on oil-based products, and the country spends almost USD 13 billion on the import of oil every year. If Pakistan's transport sector continues to grow at the same double-digit rate, the bill for oil imports is expected to reach USD 30 billion by 2025.

- Pakistan, at the moment, is hit by the worst ever smog. The country is the fifth most vulnerable to climate change in the world. According to Sectoral Emission Inventory for Punjab, the transport sector is responsible for 43% of air pollution emissions. Industry and agriculture remain second and third, respectively. Smog in Pakistan is being termed as the fifth season. Adopting EVs may address smog issues in Pakistan, especially in densely populated cities.
- By replacing conventional vehicles with EVs, Pakistan's fuel import bill will be reduced as most of the finished petroleum products used in transport are imported. Electric vehicles are estimated to bring down the country's annual oil import bill by US$ 2 Billion. According to an estimate, Pakistan's 30% of vehicles will go electric by 2030.
- More investment will be required for the upgradation of the grid infrastructure, where it is very poor. However, the grids in most developed nations will be just fine, so long as the demand is appropriately managed. Developing nations may need to invest to upgrade the grid infrastructure but it will be good rather than always depending on the imported fuel
- The power sector of Pakistan has also faced challenges especially due to the heavy reliance on imported fuel. Pakistan is blessed with excellent sunshine, which is considered ideal for power generation. Apart from this, Pakistan has an excellent wind

corridor to generate wind energy. The extensive hydro potential is also available to be tapped to generate clean energy that can be used when the electricity demand will increase due to the adoption of EVs.

- Homes equipped with solar rooftops can charge their EVs with clean energy virtually for free as long as the sun is shining and cheap electricity would be available in the near future due to a sharp drop in the price of solar and wind turbines.
- Due to the efficiency of battery-based energy storage, EVs can give the same mileage with one-third of the cost compared to their oil-based vehicles, and if charged by using clean energy, this will have a dual impact on climate and a reduction in import bills of the oil.
- Pakistan can initiate the indigenous manufacturing base of small EVs and their related industries, namely batteries and charging stations. Due to a larger market of such vehicles, it would be financially viable to develop an indigenous production capability that can be later on geared towards export sales. Such initiative will generate business and of course a lot of job opportunities.

Pakistan took its first step toward EVs in 2017, with a first charging station established in Lahore by BMW motors. Recently in July 2020, Pakistan State Oil Company installed its first EV charging station in Islamabad. GOP also intends to launch 24 charging stations across all motorways in Pakistan, as directed by the Ministry of Water and Power. Efforts for EV awareness are underway via both the government and private sectors.

9.4 Indigenization and Development of Infrastructure for EVs

This automotive transition to EVs will not only help the country combat climate change in large urban centers but also provide a useful avenue for improved utilization of excess electricity, whenever available, especially in Pakistan. This benefit can be further enhanced by indigenously developing manufacturing, R&D, and testing facilities for EV components. As EVs take off in Pakistan, indigenization of key components will reduce reliance on imported technology and make the transition economically viable. Local component supply chains could be developed, leading to local capacity development and sectoral growth. With enough support, Pakistan could become the regional hub of selected low-cost EV components (along with testing facilities).

9.5 Pakistan's National Electric Vehicle Policy an Overview

Pakistan's National Electric Vehicle Policy 2019 (EV Policy) sets EV adoption targets and includes incentives for buyers and manufacturers. It also focuses on developing a nationwide charging infrastructure to ease the adoption of electric vehicles. The salient points of the EV Policy are as follows:

9.5.1 Goals

- Passenger Vehicles: EV sales to constitute 30% of new sales by 2030 and 90% of new sales by 2040.
- 2 & 3 wheelers: EV sales will constitute 50% of new sales by 2030 and 90% by 2040.
- Buses: EV sales to constitute 50% of new sales by 2030 and 90% of new sales by 2040.

- Trucks: EV sales to constitute 30% of new sales by 2030 and 90% of new sales by 2040.

9.5.2 Tax Incentives

- 1% GST for EVs (down from 17%)
- 1% Import Duty on charging equipment
- Lower electricity tariffs for EV charging stations
- All greenfield investments apply to EV manufacturers and those converting their existing facilities to manufacture EVs.

9.5.3 Other Incentives

- State Bank to offer lower rate financing to EV manufacturers

9.6 A brief outline of a plan for Pakistan to convert gasoline vehicles to EV

Currently, Pakistan is going through a rapid expansion in the network of highways (motorways and expressways). The commencement of the China Pakistan Economic Corridor (CPEC) has revitalized the construction and rehabilitation of the network of highways under the Belt and Road Initiative (BRI). The contemporary web of highways spans 12,131 km and is responsible for almost 80 percent of the total commercial traffic in the country. By 2025, there will be an additional 3,070 km of highway network to the existing network. Hence, in the next seven years, the network of highways in Pakistan is anticipated to proliferate by 25 percent while the total length of motorways is expected to increase by three times. Cumulatively, the aforementioned factors will burden the existing road network tremendously. The density of cars per 1,000 people in Pakistan is 16. This number is estimated to reach almost double by the year 2025. Additionally, various international automakers have also recognized such a projected increase in vehicles.

A consequence of urbanization is an increase in the number of vehicles. Large cities often require commuters to travel relatively larger lengths. Hence, it requires them to utilize transportation for their daily commute, increasing the number of vehicles.

9.7 Concluding Remarks

The future of the transportation world lies in EVs, and the question is how Pakistan can best prepare for that future. The transition of the transport sector towards electrification is the need of the hour.

- More investment will be required for the upgradation of the grid infrastructure, which it is very poor. However, the grids in most developed nations will be just fine, so long as the demand is appropriately managed. Developing nations may need to invest in upgrading the grid infrastructure, but it will be good rather than always depending on imported fuel.
- With time, energy storage technologies will further evolve and become more efficient, and EVs will be more efficient. As the world may see further turmoil in oil-rich countries, the price of oil may see further uncertainty and it will directly affect the oil importing countries.

- As the technology will take many years to fully mature, Pakistan should make a gradual, phase-wise entry into the EV space.
- Pakistan also needs an indigenous Research & Development hub to utilize the potential of electric vehicle technology fully. The R&D hub should have programs to promote the development and supply of EV technology within the country and the nation's capacity building. This hub can be used as support for new business ventures or to increase exports.
- The major challenge in making a move a success is the public mindset. Awareness needs to be created among the masses about the advantages of electric vehicles over combustion engine vehicles.

CHAPTER 10:

CASE STUDIES FOR POWER PROJECTS

10.1 Case Study 1: Karot HPP

10.1.1 Introduction

- **CTG is the Owner, developer and operator of world largest Three Gorges Dam (22,500 MW installed capacity).**
- **CTG has the world's largest hydropower developer with installed and under construction capacity of over 139,000 MW, Annual Energy Generation of over 290 TWh**
- **CTG is a wholly state-owned enterprise with operation in over 40 countries.**
- **Total Assets of CTG are over US$ 100 Billion and Annual Profit of around US $ 5 Bln and having more than 37,000 employees around the world.**

The China Three Gorges Corporation (CTG) is world leader in Hydro Power Projects, they are the owner, developer and operator of World's largest Three Gorges Hydro Power Project having an installed Capacity of 22,500 MW and CTG a total installed capacity of over 140,000 MW in China and around the world. The CTG having total assets of over US$ 100 Billion is operating in more than 40 different countries and regions worldwide.

CTG is investing in Pakistan through a special purpose Company, CSAIL (China Three Gorges South Asia Investment Ltd), which has 70% shareholding of CTG, 15% shareholding from IFC and 15% from Silk Road Fund. In Pakistan, CSAIL operates three (03) wind power projects with an installed Capacity of about 150 MW at Jhimpir, Sindh and three (03) Hydro Power Projects on Jhelum river having Installed Capacity of around 2,500 MW. The installed capacity of CSAIL Projects in Pakistan is around 2,600 MW having an investment of around 6.3 Billion US Dollars. All the three (03) wind power projects are providing reliable Power to the National Grid. The 720 Karot HPP is the first CPEC Hydro Power Project, which has been commissioned in June 2022. The 1124 MW Kohala HPP and 640 MW Mahal HPP are at various stages of development.

10.1.2 Unique and Distinctive Features of Karot HPP

The 720 MW Karot HPP is located on the dual boundary of the Province of Punjab and AJK and is under CPEC Framework. It is located very close to the Load Center, around 76 km from Islamabad and about 65 km from Gujar Khan. The location of the Project is shown in a map at **Annex-IX**.

The Project is very close National Grid, Neelum Jhelum 500 kV Transmission Line is just 3 km away from the Project. The Project is unique, as it does not have any significant adverse environmental impact and a proper and detailed Environmental Impact Assessment study was

conducted to mitigate the project's environmental impacts. The Project has been developed by CTG, which is highly experienced (being the largest hydropower enterprise in the world) and has all the necessary technical, technological and financial strengths to undertake such large-scale hydropower projects. The fool proof security for the Project is being provided by Pakistan Army. Under its Corporate Social Responsibility (CSR), the Project Company has constructed hospitals, schools, bridges, roads, and international scholarships (for Electrical Engineering study) are being provided to the deserving students belonging the Project affected areas.

10.1.3 Key Strengths of the Project

The main strength of the Project is that it is being developed by CTG, which has a proven track record of developing Mega Hydro Power Projects not only in China but in various parts of the world. The Project has been constructed by TGDC (a subsidiary of CTG), which is well experienced EPC contractor and has a number of success stories to its credit and it is being operated by a well reputed and experienced O&M Contractor i.e. CTGO (another subsidiary of CTG). Another strength of the Project is that it is under CPEC, hence, it is being fully supported by both Governments of Pakistan and China, since its inception. As it is a CPEC Project, hence with the support of Sinosure (China Export & Credit Insurance Corporation), the Project secured financing from China Development Bank and China Exim Bank. It is the first CPEC Project with equity and debt from International Finance Corporation (IFC) and Silk Road Fund.

Furthermore, 24/7 foolproof Security for the project is being provided by the Pakistan Army. The Project provided tremendous benefits to the Governments of Punjab and AJK during its construction and operation. Besides, the company has paid around 10.5 Billion Taxes and duties and provided employment opportunities to about 3000 local people during its construction phase. In the operation phase, the Company will be paying Rs 1.2 Billon as Water Use Charges (WUC) annually to GOAJK and Punjab, duties and taxes to GOAJK/GOPb. Furthermore, after 30 years of the operation, the 1.7 Billion Dollars Project will be transferred to the Government of Punjab free of cost. The project is presently providing 3,206 GWh of cheap, clean and green energy to the National Grid of Pakistan. The project is expected to cut annual carbon dioxide emissions of around 3.5 million tons, uplifting clean energy output mix and optimizing the energy consumption structure.

10.1.4 Project Key Features

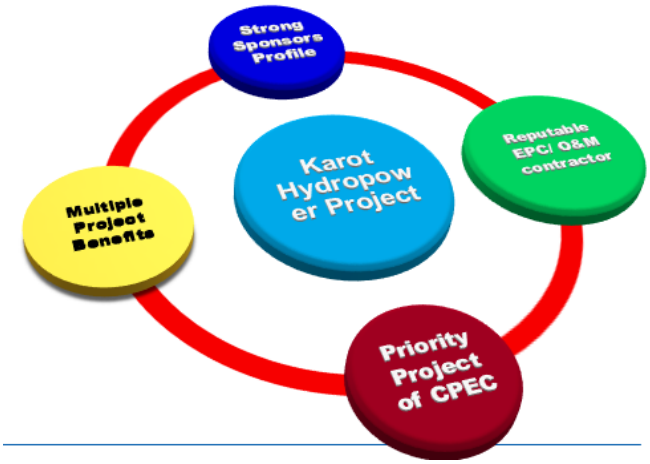
Following are the Key Features of the 720 MW Karot HPP:

- Location : Distt. Rawalpindi, Punjab & AJK
- River : Jhelum River
- Capacity : 720 MW
- Average Annual Energy : 3,206 GWh
- Design Discharge : 1,200 m^3/s
- Gross Head : 79 m
- No. and Type of Units : 4 Francis Turbine Units
- Project Cost : US$ 1,740 million (estimated)
- Feasibility Stage Tariff : US cents 6.5005 kWh
- EPC Stage Tariff : US cents 7.6152 kWh

- Term

  30 Years

:



10.1.5 Key Milestones

Following are the Key Milestones of the 720 MW Karot HPP:

- Issuance of LOI : 2007.05.19
- Approval of Feasibility Study : 2009.10.07
- Approval of Feasibility stage Tariff : 2012.12.12
- Issuance of Letter of Support (LOS) : 2013.08.29
- Construction Start Date : 2016.04.02
- Financial Close : 2017.02.22
- COD achieved on : Jun 29, 2022

10.1.6 Key Events

Following are the Key Events of the Project:

- PPA signed : 2016.08.30
- GOP IA and SA signed : 2016.09.08
- AJK IA and AJK WUA signed : 2016.09.28
- GOPb WUA signed : 2016.10.25
- CTA signed : 2016.11.25
- Notice to Proceed : 2016.12.01
- PPA DA and RAA signed : 2016.12.14
- GOPIA DA, AJKIA DA, AJKWUA DA,

  GOPBWUA DA signed :2016.12.15

- Financial Closing : 2017.02.22

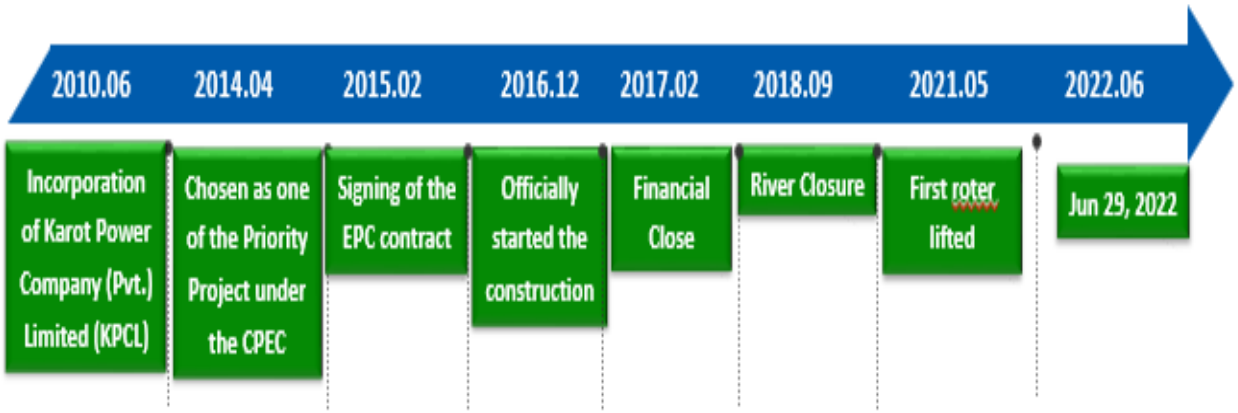
10.1.7 Project Updates

PPIB visualized the Project in year 2006. It was selected for advertisement by a team of PPIB professionals, as it is located close to load center, geographically connected with roads, and very close to the NTDC's Transmission Network. After necessary bidding, the PPIB issued LOI

to successful bidder i.e. Associated Technologies Limited and they carried out the Feasibility study of the Project, which was monitored and approved by the Panel of Experts (POE) appointed by PPIB.

In 2009, CTG took over the project and updated the Feasibility Study. The Project's Letter of Support (LOS) was issued to the company on Aug 29, 2013. The Karot Power Company (Private) Limited (KPCL) was incorporated on Jun 2010. The project was included in CPEC in April 2014. The EPC Contract with TGDC was signed in February 2015 and the project started construction in December 2016 well before achieving financial close, which was achieved in February 2017. The River Closure Ceremony of the Project was held in Sept 2018 and the Project's Commercial Operation Date (COD) was achieved on Jun 29, 2022.

The schematic diagram of the Project's key milestones is as below:



10.1.8 Institutional Support

The 720 MW Karot HPP has more than 100 years of useful life. The Project has been through different development stages; at each stage, it was fully supported by various government and private Institutions. It took nearly 10 years for its development, and 5.5 years for its construction and it will be operated for 30 years by the Company, since the achievement of its COD, after which it will be handed over to the Government of Punjab.

The project, during its life cycle, is being fully supported by the following Institutions of the Government of Pakistan and other local governments:

- Ministry of Energy, Power Division
- Ministry of Planning, Development and Special Initiative
- Ministry of Finance
- NEPRA
- PPIB
- CPPA-G
- NTDC
- GoAJK

- GoPunjab
- CPEC Authority
- EPA AJK
- EPA Punjab
- PPC AJK
- PPDB
- FBR
- PRA
- CBR AJK
- SBP

10.1.9 Pictures of the projects

The Karot HPP is located at a very beautiful valley near village Karot near Kahuta in Punjab. The pictures related to the construction of the Project are at **Annex-X**.

10.1.10 Community Investment Plan

KPCL has developed a Community Investment Plan (CIP) at a cost of Rs 655 Million to ensure that the project benefits are shared with local communities around the project. The CIP has been implemented during the project construction.

10.1.11 Distribution of Budget for Community Investment Plan (CIP):

Budget allocation for Punjab Side Rs. 171 Millions

Budget allocation for AJ&K Side Rs. 480 Millions

10.1.12 Completed CIP Projects in Punjab

1. Construction of Government Girls Primary School Channi Awan Kahuta
2. Construction of Government Boys Primary School Kannad Karot
3. Construction of Rest House at Beor
4. Construction of Government Dispensary at Brohi Azad Pattan (Punjab)
5. Rehabilitation and Argumentation of Rural Water Supply Scheme at Brohi Area (Kahuta)
6. Construction of New Emergency Block (Trauma Center) at THQ Hospital Kahuta
7. Construction of Access Roads in Tehsil Kahuta Area in Punjab
8. Rehabilitation of Kahuta Club

10.1.13 Completed CIP Projects in AJ&K

1. Rehabilitation and Improvement of Basic Health Unit (BHU) Hollar (AJ&K)
2. Construction of Government Boys Middle School Hollar (AJ&K)
3. Construction of Government Girls Middle School Hollar (AJ&K)
4. Rehabilitation and Construction of Access Roads (1st phase) Hollar AJ&K
5. Establishment of Public Park at Hollar AJ&K

The pictures of the various works / projects undertaken under CIP in Punjab and AJK are at **Annex-XI**.

10.1.14 CSR Activities in the Field of Education

The Company under its Corporate Social Responsibility (CSR) launched Fully Funded International Scholarship Program of Engineering (Four year Bachelors' Degree in Electrical Engineering with first two years of study in Punjab University in Pakistan and the remaining two years of Study in Jiangxi University of Science & Technology in China) for students belonging to Project Affected Areas & AJK.

Under the scholarship program, so far 33 Students have been selected from project affected areas, after proper tests and interviews taken by Professors of University of the Punjab and the Company. Below number of students were selected in years 2017 & 18:

Year 2017	18 students
Year 2018	15 students

In Year 2021, 18 students completed their studies at Jiangxi University of Science & Technology China.

In Year 2021, 15 students have completed their courses from University of Punjab and have started their education at China, Jiangxi University of Science and Technology.

CSAIL/KHCL has already incurred around Rs. 50 million on this Scholarship Program.

The KPCL has hired ten graduated students for the Operation and Maintenance of the Project, who have completed their studies under the CTG Scholarship program.

The pictures related to the fully funded scholarship for students of the local area of the Project are at **Annex-XII**.

10.1.15 Biodiversity Management Plan (BMP)

The Karot Hydropower Project company has established eight (8) Valley Conservation Committees in the project area. The precious plants have been passed to the greatest extent

possible during the project's design. The precious plants or trees, which are over 100 years old, were well protected in situ in the plant area to ensure that the precious Pakistan vegetation is not damaged. In addition, eight (8) nature conservation clubs have been established in the schools around the project through community and school outreach strategies.

The communities and school children have been mobilized to participate in the conservation of biodiversity, thus enhancing the public awareness of environmental protection and promoting public participation in protecting and conserving the ecological environment.

The Company has prepared Biodiversity Management Plan (BMP) to provide a clear and concise outline of the actions and methods required to mitigate likely impacts on biodiversity (Flora and Fauna). The main objective is to demonstrate 'No Net Loss' of biodiversity in natural habitats, where feasible, as required by IFC Performance Standards.

The BMP is focused on the following areas:

1- Controlling illegal fishing, hunting and logging

2- Controlling illegal mining in the project areas

3- Development of Sediment Mining Plan

4- Community and School Outreach Strategy

5- Development of Murree-Kahuta-Kotli Sattian National Park Management Plan

6- Development of Azad Pattan National Park Management Plan

The BMP is being implemented and monitored through consultants and with the support and full participation of the relevant departments of the GOAJK and GOPb.

Karot is the only Project in Pakistan that implements a very comprehensive and detailed BMP.

10.1.16 Donations to the GoP related to COVID-19

In April 2020, CTG/CSAIL, the sponsors of the Karot HPP, donated medical supplies / medical equipment to GoP through National Disaster Management Authority (NDMA) to fight against Corona Virus (COVID-19) pandemic.

Following items/equipment were provided through three (03) Chartered Flights from China to Pakistan:

- Disposable Surgical Masks
- Protective Clothing
- Medical Face Shields
- Disposable Medical Caps
- Disposable Medical Shoe
- Infrared Thermometers
- KN-95 Masks

- Non- Portable Ventilators
- S9 VPAP ST
- Portable Ventilators
- CM 10 Monitors

A Donation Ceremony was held in Beijing, China on April 21, 2020, which was participated by high-ranking officials of China and Pakistan and also a graceful Ceremony was held on April 26, 2020 at Islamabad Airport in which the donated Equipment/items were handed over to NDMA / Government of Pakistan.

The Medical Supplies were also provided to the Government Offices of Project Affected Area & Community to support them in their fight against COVID-19.

Some pictures related to COVID donations are at **Annex-XIII**.

10.1.17 Corporate Awards

The Karot HPP has been constructed as per International best practices and following the performance standards, environmental rules & regulations of the IFC, Silk Road Fund, CTG, CSAIL and Environmental Departments of GOP, GOAJK and GOPb. As per Integrated Generation Capacity Expansion Plan (IGCEP) approved by NEPRA on Sept 24, 2021, the Project was expected to be commissioned by Jun 2023. However, despite the delays caused by COVID-19, the Project was successfully commissioned on Jun 29, 2022.

Due to its excellent performance, the company has been awarded by various reputable institutions of the world, some of which are:

- The Asia Pacific Hydro Deal of the Year (2017), awarded by IJ Global, the global energy infrastructure authority
- Karot project camp won the 2018 China overseas project excellent camp award
- 2019 China International Sustainable Infrastructure Project Award", awarded by China International Contractors Association in December 2019 in Changsha, China
- CSR Awards Achievement during 2019 for Education and Health
- NEPRA CSR STALWART Award Year 2022
- NFEH CSR Award Year 2022

10.1.18 Karot HPP Successes:

The 720 MW Karot HPP has achieved a lot of successes, some of which are as follows:

- Acquired a total of 24,261 Kanals of land in Punjab and AJK.
- Sought timely approvals from GOP / GOAJK for IA, PPA and WUA, ESIA Study NOC.
- Mechanism for tax sharing between Federal, Punjab and AJK Governments developed with consensus of all.
- Resolved the issue of 16% sales tax on Construction Contractor levied by Government of Punjab and GOAJK amicably.
- Successfully obtained extension of Environmental NOC from GOAJK and GOPb.

- Resolved the issue of seeking consent for the design of seven bridges constructed by KPCL on Jehlum River (under its CSR and CIP Programs) from the Governments of Punjab and AJK
- Successfully carried out Impoundment of Water after completion of construction of main dam.
- Successfully completed activities related to River Closure
- Successfully completed Dry and wet testing of the Karot HPP
- Resolved all the technical issues related to testing and commissioning of the Project in coordination with NTDC / CPPA-G
- Resolved the issue of Type tests for GIS and AIS equipment installed at Karot Grid Station
- Successfully completed the 168 hours Reliability Run Test in one go without any interruption in Jun 2022.

10.1.19 Karot HPP Challenges

- Getting COD tariff adjustment from NEPRA in a timely manner.
- Make timely payment to lenders of Karot HPP. First payment is due in Nov 2022.
- Regular dispatch of the energy generated by Karot Project by NTDC / NPCC
- Getting timely payments from CPPA-G

10.1.20 Conclusion

720 MW Karot HPP is a flagship Hydro Power Project of the CPEC. The project is providing cheap, clean and green energy to the National Grid of Pakistan and is also playing an important role in improving the living conditions of the local community and providing multiple and multi-pronged socio-economic benefits.

10.2 Case Study 2: Matiari-Lahore HVDC Transmission Line

10.2.1 Introduction

Under CPEC more than 6,000 MW of projects have been commissioned, most of which are located in the South of Pakistan. In additional around 1,200 MW of Nuclear Power Projects have also been commissioned in Karachi, which is also in the South of Pakistan.

In order to transport large quantities of power from South to the load centers in the North and mid-country, a high capacity transmission line was required to transport the large quantum of power efficiently and reliably. Hence, a 600 kV HVDC transmission line was envisaged from Matiari to Lahore by NTDC. As the estimated project cost was US$ 1.6 Billion, it was difficult for NTDC to arrange the timely financing of the project and to construct the line in a given timeframe. Hence, it was decided that the project be implemented by the private sector under GoP's Transmission Line Policy 2015.

The Matiari-Lahore transmission project is an 878km-long, 660kV high voltage direct current (HVDC) transmission line constructed under the framework of CPEC as part of China's Belt and Road Initiative (BRI). This line was commissioned on 1st September 2021.

10.2.2 Unique and Distinctive Features of Matiari-Lahore HVDC Transmission Line

The Matiari-Lahore HVDC Transmission Line is the first HVDC line and the first private sector transmission project developed in Pakistan. It shall be transferred to NTDC free of cost after twenty five (25) years of operation. It is located between the two provinces (Punjab and Sindh) of Pakistan. It crosses the mighty Indus River. The land for the project has been acquired successfully in a shortest possible time. It does not have any adverse environmental projects on the route it passes.

The $1.65bn (£1.2bn) transmission project has been developed on a build, own, operate and transfer (BOOT) basis by the State Grid Corporation of China (SGCC) through the special purpose company Pak Matiari-Lahore Transmission. It was constructed by China Electric Power Equipment and Technology Co. Ltd., which is a reputable international company.

10.2.3 Project Key Features

Following are the Key Features of the Matiari-Lahore HVDC Transmission Line Project:

- Location: from Matiari, Sindh to Lahore, Punjab
- Capacity: 4,000 MW Power Transfer Capability
- Project Cost: US$ 1,658.34 Million
- Debt: Equity 80:20
- Approved Tariff: 0.7121 US ¢/kW/h
- EPC Cost US$ 1,374.36 Million

10.2.4 Key Milestones

Following are the Key Milestones of the Matiari-Lahore HVDC Transmission Line Project:

- Issuance of LOI: 27th March 2017
- Approval of Technical Studies: 30th December 2020
- Issuance of LOS: 4th August 2017
- Financial Close Date: 27th February 2019
- Term of the project: 25 Years
- Signing of Transmission Services Agreement (TSA): 14th May 2018
- Signing of Implementation Agreement (IA): 14th May 2018
- Achievement of Financial Close: 27th February 2019
- Construction Start Date 1st December 2018
- COD achieved on 1st September 2021

10.2.5 Institutional Support

The Matiari-Lahore HVDC Transmission Line Project has a useful life of more than 50 years.

The project, during its development and construction, has been fully supported by the following Institutions of the Government of Pakistan and other local governments:

- Ministry of Energy, Power Division

- Ministry of Planning, Development and Special Initiative
- Ministry of Finance
- NEPRA
- PPIB
- CPPA-G
- NTDC
- GoPunjab
- GoSindh
- CPEC Authority
- EPA Sindh
- EPA Punjab
- FBR
- PRA
- SBP

10.2.6 Pictures of the projects

The pictures related to the construction of the Matiari-Lahore HVDC Transmission Line Project are at **Annex-XIV**.

10.2.7 Project Challenges

- Land Acquisition.
- Higher security requirements due to longer distance involved.
- Testing and Commissioning Issues: Due to spread of COVID-19 certain project activities including testing / commissioning were affected however through mutual consultation between PMLTC and NTDC and continuous support of other GOP entities, the project was completed and the COD was declared w.e.f. 1st September 2021.

10.2.8 Project benefits

In addition to creation of a number of job opportunities, the project is expected to bring stability, reliability and sustainability in the national transmission system. It has primarily been established to transmit power generated from indigenous Thar coal-based power generation projects in south to load centers in north, thus enhancing the share of indigenous fuel-based generation and saving significant foreign exchange.

10.2.9 Success of the Project:

The Project is another true manifestation of socio-economic development being achieved through CPEC. It is not only the first private sector transmission project in the country but also happens to be the first transmission project employing HVDC technology. It is anticipated that the Project would further pave the way for implementation of more transmission line projects in Pakistan through private sector.

10.2.10 Project Pictures


工程名称:巴基斯坦默蒂亚里-拉合尔±660kV直流输电项目默蒂亚里换流站工程
施工部位:直流场电容器塔值阻测试试验
当前日期:2020年03月08日
2020/03/08 16:29

10.3 Case Study 3: CTG Second and Third Wind Power Projects

10.3.1 Introduction

The China Three Gorges Second (TGS) and China Three Gorges Third (TGT) each have a capacity of about 49.5 MW and are operating and providing reliable power to the National Grid. These projects are under CPEC. China Three Gorges Corporation (CTG) has provided investments for these Projects through a Special Purpose Company, CSAIL (China Three Gorges South Asia Investment Ltd), which has a 70% shareholding of CTG, 15% shareholding from IFC and 15% from Silk Road Fund. The names of Project Companies are Three Gorges Second Wind Farm Pakistan Limited and Three Gorges Third Wind Farm Pakistan (Private) Limited for TGS and TGT, which are implementing these projects.

The China Development Bank is the lender for these Projects. The EC Contractor is Shanghai Investigation Design & Research Institute Co., Ltd and equipment has been procured from Sumec Group Corporation Company Limited. The Employer Engineer is Lahmeyer International Gmbh.

10.3.2 Project Key Features

Following are the Key Features of the TGS and TGT Wind Power Projects:

- Location : located at Jhimpir, Thatta District, Sindh Province
- Capacity : 2x49.5 MW
- Average Annual Energy : 3,206 GWh
- No. and Type of Units : 66 Wind Turbines
- Project Cost : US$ 224 million
- EPC Stage Tariff : US cents 10.4481 kWh (Levelized)
- Term : 20 Years

10.3.3 Key Milestones

Following are the Key Milestones of the TGS and TGT Wind Power Projects:

- Approval of Feasibility Study : TGS Jun 23, 2015
  : TGT Jun 23, 2015
- Issuance of LOI (Extension) : March 16, 2016
- Issuance of Letter of Support (LOS) : Aug 01, 2016
- Construction Start Date : March 2017
- COD achieved on : Jun 2018

10.3.4 Key Events

Following are the Key Events of the Project:

- PPA signed : Dec 2016
- GOP IA signed : Dec 2016
- Financial Closing : Dec 17, 2017

10.3.5 Project Challenges

- Land Acquisition

  TGS and TGT are located at barren, rocky and scrubland area and rarely populated. The land is sub-leased by AEDB from its Master lease. The area of TGS is 680 acres, whereas area of TGT land is 702 acres. These land are located in Jhimpir Village District Thatta, Sindh. The sublease was signed on 24 Jan 2017.

- Conditions Precedent completion for Financial Close

  The time is the biggest challenge for TGS&TGT, PPA signed in Dec, 2016, GOP IA was signed on December 2016, the company had only 3 month to completed a number of contracts with lenders, which were executed in a timely manner.

- Transmission line completion and issues

  NTDC completed transmission line in a timely manner. However, some issues related to the Optical fiber communication in commissioning were resolved with the cooperation of NTDC.

- Grid Availability

  NTDC built one new 220 kV substation nearby the wind farm in Jhimpir, Sindh to service all wind farm power projects.

- Equipment Shipment Clearance

  Exemption was given under the SRO from Government of Pakistan, which exempted the import duties and taxes. Whereas, P Contract was registered with State Bank of Pakistan, because of which the payment remittance was made under P Contract.

- IEE/EIA(s) Approvals from Provincial Environmental Departments

  TGS & TGT conducted initial environmental examination from Sindh Environmental Protection Agency (SEPA) approved vendor and submitted the report, which was later approved and NOC was granted. However, by the time the project was under construction phase, the NOC was expired, which was renewed after conducting new survey and submission of report to SEPA and conduct of the public hearing by SEPA.

  TGS & TGT conducted monthly environmental monitoring of the project activities and submitted regular Quarterly Environment Monitoring Reports through Independent

Monitoring Consultant to SEPA.

COVID-19 and its Impact on the Project

The COVID-19 had the following implications on the project:

a) Restriction on free movement of officials and outside visitors
b) Continued confinement due to continuous Isolation in confined space was a great challenge for the employees and workers

CSR/CIP Activities of the Project

2017	**Provisioning of School Furniture**
	Water Tanks to villagers
	Medical Camps
2018	Installation of Hand pumps
	Scholarships to students and School Accessories
	Donation of School Furniture
	Construction of Ablution Area
2019	Electrification of 100 houses through Solar
	Scholarship to Students
2020-21	Provisioning of following items to District Hospital Portable Ventilators Protective Cloths Face Shields Masks etc.
2022	Construction of Primary School

10.3.6 Project benefits to NTDC/ GOP / Province

Following are the major project benefits:

- Provision of uninterrupted Power Supply to the National Grid to eradicate Power crises.

10.3.7 Project Issues

- Since 2020, the COVID-19 has affected the economy for a long time, resulting in the delays in the payment by CPPA-G to the company.
- The billing periods of TGS and TGT bill were delayed from 7 months by the end of 2021 to 10 months by the end of July 2022.

10.3.8 Lessons Learnt

a) Pakistani standards needs to be integrated with Chinese Standards;
b) Delays in the execution of various agreements has an adverse impact on the progress of the project. Hence, these agreements be executed as early as possible.
c) The owner's engineers and local consultants are very important to the project construction.
d) Local construction personnel need to strengthen technical training and guidance to ensure construction quality
e) Strengthen health and environmental monitoring and protection, and actively fulfill social responsibilities.
f) Community Development must be done along-with Project Construction.

Corporate Awards to the Company/ Project

a) Safety Award: 1,000,000 Safe Men Hours HSE Award without lost time incident
b) Youth team excellence award of CTG in 2017

10.3.9 Project Pictures


CTG

CHAPTER 11:

KEY POWER SECTOR CHALLENGES AND WAY FORWARD

A. Key Power Sector Challenges

Some of these key challenges in Pakistan Power Sector are highlighted as follows:

11.1 Circular Debt

Definition of Circular Debt

Circular Debt is a shortfall of payments from the Power Purchaser i.e. Central Power Purchasing Agency Guarantee Limited (CPPA-G) in the power sector of Pakistan. Generally, CPPA-G does not fully receive the outstanding payments from DISCOs in a timely manner and as a result make payments to GENCOs, IPPs and NTDC. GENCOs/IPPs fail to clear their dues to fuel suppliers. The fuel suppliers, in turn, default on their payment towards refineries and international fuel suppliers. This leads to the accumulation of Circular Debt.

Major Causes of Circular Debt:

The major causes of Circular Debt are as follows:

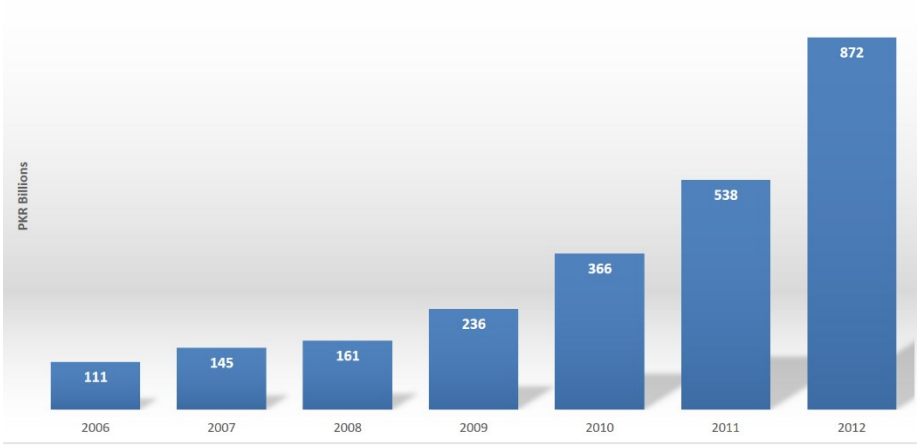
- the difference between the actual cost and the tariff determined by NEPRA, on account of low recoveries and higher than allowed losses,
- Impact of delayed or non-payment of subsidies by government, and
- delayed determination and notification of tariffs by NEPRA.

History of Circular Debt

The Circular Debt started emerging in Pakistan in 2006 due to a **shift from low-cost hydel to high cost thermal generation** from 1985 – 2007 since GOP did not substantially increased the Electricity prices. A **sharp devaluation** of Pakistani Rupee occurred from PKR 60/US$ to PKR 75/US$ during this period. Besides, in this period there was a **steep rise in international oil prices**. Fuel cost in electricity generation rose but **notified tariffs were insufficient** to cover the increased cost. High operational (technical and non-technical) losses of distribution companies (DISCOs) further added to the service cost. Besides, **delays in payments by consumers** contributed to low revenue collection from electricity sale. Notified electricity tariffs **remained below the cost-recovery level**. As a result, the Circular Debt **(of about Rs 111 billion)** emerged in **2006** for the first time.

Increase in Circular Debt over the years

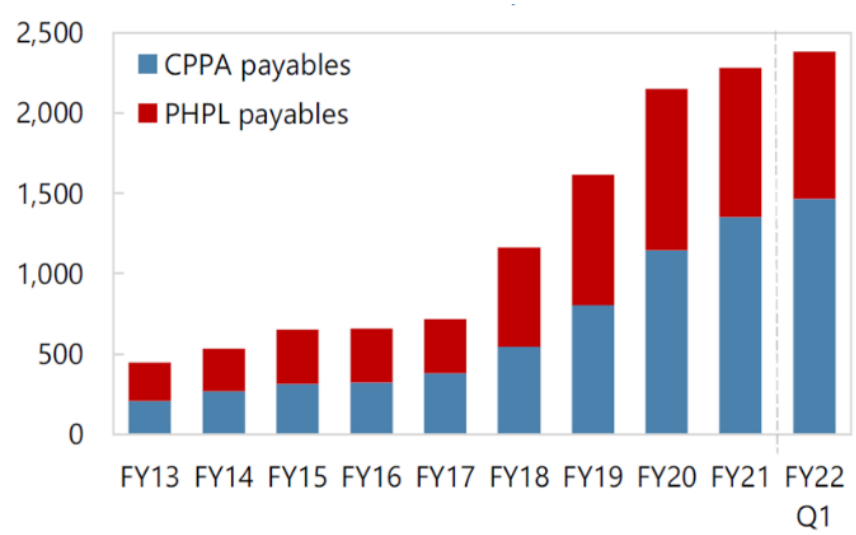
A graph depicting the increase in Circular Debt in Pakistan from 2006 to 2012 is as follows:



Source: Planning Commission 2013

Circular Debt in Pakistan from 2006 to 2012

A graph depicting the increase in Circular Debt in Pakistan from FY 2013 to FY 2022 is as follows:



Sources: Pakistani authorities; IMF staff calculations.

Circular Debt in Pakistan from FY 2013 to FY 2022

Composition of the Circular Debt

Presently, the composition of the Circular Debt in Pakistan Power Sector is as follows:

- Delayed tariff adjustments – around 35%
- DISCO's inefficiencies - around 31%
- Unbudgeted subsidies by the GOP – around 18%
- Financial costs – around 16%

Cash Flow Problem causing increase in Circular Debt

The cash flow needed to run power generation units (including IPPs) is collected by DISCOs from consumers at a tariff determined by NEPRA and notified by GOP. NEPRA determines tariff for all 11 DISCOs, the GOP asks the DISCOs to charge the lowest of all these eleven tariffs as uniform National tariff. The GOP pays the difference as subsidy.

The GOP and Provincial governments further reduce the uniform tariff for certain categories of consumers such as agricultural, tube well, FATA, Balochistan, etc., and pay the difference as a subsidy to CPPA-G. The tariff fixing by NEPRA, subsidy by GOP, performance of DISCOs and revenue collection by DISCOs / CPPA-G, and line losses all contribute to a reduction in cash flows.

NEPRA determines tariff for DISCOs based on 100% recoveries and average line losses of 15.3%. However, in reality, the recoveries are 88-89%, and line losses are around 19% causing an increase in Circular Debt.

Key Reasons of Circular Debt

The key reasons of Circular Debt are:

1. Time delays:
    - Delay in Tariff Determination by NEPRA
    - Delay in Tariff Notification by GOP
2. Collections & Recovery:
    - Poor Collection by DISCOs
    - Delay in payment by Ministry of Finance (Tariff Differential Subsidy (TDS))
    - Fuel Price Methodology
3. Legal Issues:
    - Stays on fuel price adjustments by the court of law
4. Operations & Management:
    - Issues in Governance
    - T&D Losses
    - Theft of Electricity

Impact of Circular Debt

The major impacts caused by Circular Debt are as follows:

- Discourages Potential Investors
    - Investors are uncertain about the timely payments from CPPA-G, which discourages them from further investment in Pakistan's Power Sector.
    - Investors are uncertain for their Return on Investment
- Cost Escalation for End User

    - 54 Paisa / kWh built in Tariff for interest payment on loans procured by DISCOs to settle losses & low bill recovery to make payments to CPPA & IPPs (Power Division)
    - Interest on payables keeps on piling which is then added to Tariff that is passed on to consumer
- Increased Load Shedding
    - No payment means no fuel…. so no electricity generation, hence load shedding.

GOP Efforts to Reduce Circular Debt

In Pakistan, the Circular Debt (CD) in the Power Sector has largely remained uncontrolled. Successive governments have made some efforts to reduce the circular debt; however, the issue still remains. From 2008, the Government started procuring commercial loans at high interest rate to retire circular debt. These loans were parked in Power Holding Private Limited (PHPL) and were procured against assets of DISCOs. These STFF loans/bonds have reached over Rs. 1 Trillian.

From year 2006 to year 2012, the CD kept on increasing from 236 Rs Billion to 852 Rs Billion. The government intervened on an ad hoc basis by pumping in money many times (more than Rs 1 trillion) between FY2008 to FY2012 to rescue the system from total collapse and keep circular debt to a manageable limit.

In Year 2013, the government cleared the circular debt (Rs 480 billion) using budgetary support as well as direct liquidity injection of Rs 342 billion. However, no serious efforts were made to reform the expensive generation mix and remove inefficiencies in the system.

Circular Debt Management Plan (CDMP)

In September 2015, the government introduced a comprehensive Circular Debt Management Plan (CDMP) to reduce CD gradually. The plan focused on privatizing DISCOs to increase their efficiency and resolve subsidy and tariff issues and discrepancies. However, the DISCOs receivables kept on increasing and later, the government shelved the decision to privatize DISCOs.

In Year 2018, the CD was 1.18 Trillion Rs. The government's main focus was on increasing the electricity tariff and it continued with the policy of uniform tariffs and directing subsidies for tariff differential, FATA, AJK, agriculture tube-wells and industry and some efforts were made but CD kept on rising.

From PRs 450 billion in fiscal year (FY) 2013, the circular debt was reported at Rs 2.3 trillion as of 31 December 2020. The net annual circular debt flow for the year 2019–2020 remained at PRs 538 billion. The circular debt as of June 30, 2022 is Rs 2.253 trillion. The current CD is equivalent to 5.6% of the country's Gross Domestic Product (GDP) and represents 6.8% of Pakistan's general government debt.

The GOP prepared CDMP in year 2020 after holding a number of meetings with stakeholders and in consultation with the World Bank, Asian Development Bank (ADB), and IMF based on prevailing market conditions. The CDMP was thoroughly discussed in the Cabinet Committee of Energy and approved by the Cabinet on March 15, 2021. It is for years 21, 22 and 23. The CDMP describes mechanism and initiatives to address the issue and suggests an action plan to control Circular Debt with a monitoring matrix. Cabinet Committee on energy is monitoring the implementation of the CDMP on monthly basis.

CDMP Objectives

The objectives and targets of CDMP are as follows:

- Reduce CD
  - CDMP intends to reduce the quantum of CD to its minimum possible level. The Plan covers FY 21, FY22 and FY23.
  - CDMP provides a mechanism to address the CD issue in Pakistan Power Sector and how to control CD flow.
- Enabling Monitoring of CD
  - To review the progress and impact of CDMP, complete monitoring and reporting framework has been worked out.

Monitoring of CDMP

As per CDMP, the Ministry of Energy (Power Division) will ensure for achieving the objectives of CDMP. The **Power Planning and Monitoring Company (PPMC)** has been established and is responsible for:

- **Coordination will all concerned stakeholders implementation agencies**
- **Submission of Reports to ECC and CCOE**
- **Determine the level of monitoring and for enabling activities at the implementing sites**

Monitoring Framework

The Monitoring Framework for implementation of CDMP is as follows:

- Monthly meetings to be convened on 18th of each month to review the progress and outcome to be reported to Cabinet Committee on Energy regularly every month by the Ministry of Energy (Power Division).
- Quarterly meetings to be convened on 15th of each month after end of each quarter starting from April to review the progress and outcome to be shared with International Financial Institutions and other stakeholders at the end of every quarter by the Ministry of Energy (Power Division).

It is expected that the CDMP, if properly implemented as per targets enshrined in the plan, may resolve the CD Problem of Pakistan Power Sector.

11.2 Inconsistent Power Policies

Clear policies by the Federal Government and support by coherently implementing agencies are key to the success of any sector. This is true particularly for power sector, which is one of the most critical sectors driving the country's economic health. In the past GOP has announced and successfully implemented, a number of power sector policies by taking unambiguous steps and other measures for incentivizing foreign investment in the country. The government and its various departments and entities remained totally committed to implementing those.

The government has announced various power policies from time to time to encourage investors for the development of power projects and renewable energy based projects. During the implementation of these policies, the investors have observed a number of inconsistencies resulting in a financial loss to them. It is to be realized that once the investors' confidence is shaken, it also dilutes any such future effort, as the skeptical investors tend to stay away from any future initiatives.

In addition to the induction of renewable energy, re-opening of the closed contractual arrangements under the previous policies, different interpretation than earlier provided by the Regulator about the application of Up-front tariffs on different projects, have also affected the confidence of investors. Similarly, DISCOs' stance on the NEPRA notified regulations on Wheeling of Power and treatment of 'take-or pay' and 'take-and pay' principles under NEPRA determinations have not gone well with the private sector investors.

11.3 High Transmission and Distribution Losses

The Transmission & Distribution (T&D) losses of DISCOs are among the most discussed and debated issues in the context of power sector. The federal government and the Regulator (NEPRA) have also been advising and directing the DISCOs to take operational and managerial steps to control their losses and bring them closer to prudent levels. High T&D losses have remained a major challenge for the viability of the sector, as higher actual losses posted by distribution companies relative to the target losses assigned by NEPRA directly add to the circular debt.

The following table shows a five-year data of DISCOs' actual T&D losses. In the FY 2016-17, Discos reported actual losses of 17.93%, which increased to 18.86% in 2019-20 and with a slight reduction, discos reported overall losses of 17.95% in 2020-21. The disco losses not only far exceed the levels normally maintained by prudently operated discos, but also not acceptable when compared with the target losses allowed by Nepra. In the years 2014 to 2018 Nepra set target losses close to 14 percent, however, in view of the financial health of the sector and discos' inability to show improvement in this area, Nepra set higher target levels which currently are close to 16.5%.

Table: DISCOs Actual Losses %

DISCOS	2016-17	2017-18	2018-19	2019-20	2020-21
Overall Average	17.93	18.32	17.61	18.86	17.95

During FY 2020-21, HESCO, PESCO, SEPCO and QESCO reported highest losses with 38.55%, 38.18%, 35.27% and 27.9% losses, respectively. While the losses of TESCO, GEPCO, FESCO, MEPCO, LESCO and IESCO remained 9.58%, 9.23%, 9.28%, 14.93%, 11.96% and 8.54% respectively. The actual losses of most of the DISCOs for FY 2020-21 remained higher than the given targets of even FY 2019-20. KE also could not meet the target losses allowed to it under its multiyear tariff regime.

In view of their impact on the overall financial health of the sector, DISCOs need to improve their operational performance. Since all DISCOs are owned and controlled by the Federal Government, therefore these DISCOs be privatized as soon as possible.

11.4 Privatization of DISCOs

The majority of the challenges faced by the power sector are linked to the below par performance of state-owned entities. Power generation plants of GENCOs have significantly lower operating efficiencies relative to their design efficiencies, whereas power plants in the private sector (IPPs) have maintained same efficiency levels as originally approved. As a result of induction of IPPs, over time the ratio of installed capacity of thermal IPPs to GENCOs' capacity is currently almost 3 to 1. Therefore, generally speaking, participation of private sector has benefitted the generation sector as a whole. On the other hand, private sector participation in the distribution functions is limited to KEL experience, which serves only 3.2 million consumers of Karachi compared to around 31 million consumers served by public sector discos.

KEL, a vertically integrated utility was privatized in 2005. It is noted that KEL has significantly reduced its Transmission & Distribution (T&D) Losses as compared to DISCOs. Prior to 2009, KE's T&D Losses of 35.9% (2009) were at par with HESCO's and SEPCO's T&D Losses. KE reduced its T&D losses by close to 16 % since 2009, whereas DISCOs showed deterioration or barely maintained their performance levels over the same period.

In terms of Aggregate Technical and Commercial Losses, KE's Losses have reduced from 43.2% in 2009 to around 22%, showing a decrease of about 21 percentage points.

KEL has been able achieve considerable growth in its consumer base, whereas the Discos could not achieve a comparable rate of addition, although there are pending applications for new connections. It also reflects that Discos cannot increase their number of consumers; therefore, their energy base is not adequate to absorb incremental capacity costs due to the addition of generation power plants in PEPCO system.

Subsequent to privatization, KEL has shown improved operational performance in its transmission and distribution sectors. Therefore, it is pertinent that the government explores the option of privatization of these XW-DISCOs – encouraging private investment, making them financially self-sufficient and thereby, reducing the burden on national exchequer.

11.5 Low Efficiency of Public Sector plants

In the generation sector, most of the power generation plants in public sector GENCOs are being operated at substantially lower performance levels than their designed values and as per prudent practices.

For instance, Jamshoro power plant (Genco 1) has been operating at net efficiencies in the range of 26 to 27% relative to its efficiency at the time of commissioning of 38 %.

Guddu Power Plant (Units1-4) of Genco II operated over 2017-2019 period at 24 % efficiency against 37% (the initial level). TPS Guddu (units 11-13) reported a net efficiency of 22 % in the year 2020-21 which is way inferior to its design efficiency levels. Guddu (units 14-16) called as Guddu 747 is a relatively efficient and newest unit of Genco II. From 2017-19 it reported efficiencies in the range of 48 to 49% against its desired levels of 57 %. During 2020-21 it showed a slightly improved performance; efficiency of 55%, however reportedly due to a recent major fire eruption, it is expected to remain out of service for a considerable time.

Thermal Power Station Muzaffargarh (Genco III) the largest complex in Gencos with an installed capacity of 1350 MW has de-rated to 1183 MW by 2020-21. It has operated at efficiencies range of 30-32 % against desired levels close to 38%. Similarly Gas Turbine Power Station (GTPS) Faisalabad Genco III has been operating at efficiencies in the range of 20 to 21% against design levels of 34%.

Plants like Nandi Pur (Genco III) had shown relatively acceptable levels of efficiency however the fuel issues have also forced sub-optimal performance.

Further, due to low efficiency, the GENCOs are not called by the system operator, resulting in quite low plant utilization factors. During FY 2020-21, the total generation of GENCOs has been recorded as 6,802.93 GWh, which is lower than the previous year's generation of 7,907.85 GWh. All of the power plants produced lower electricity than they did last year. The low efficiencies of GENCOs old plants cause inefficient burning of fuel and increases the cost of generation.

Due to low efficiency of public sector power plants and lower utilization factors, operation of these power plants on part load also qualifies them for Partial Load Adjustment Charges (PLAC), which also adversely affects the cost of electricity. The CPPA-G has verified an amount of Rs. 177.74 million and Rs. 192 million on account of PLAC to GENCO-I and GENCO-III respectively for the FY 2019-20 while the PLAC for the said GENCOs during FY 2018-19 was Rs. 894.87 million and Rs. 431.23 million respectively. The operation of inefficient GENCO power plants is a continuous burden on the country.

Retaining the old inefficient steam thermal power plants, while having sufficient capacity of efficient power plants, is not desirable. Nepra has repeatedly emphasized the need to retire the older power plants of GENCOs to reduce financial burden on the sector and diversion of precious fuel to the most efficient power plants. Therefore, urgent steps are needed to be taken to retire these plants and if essential to have generation facilities in the area, these may be replaced with new power plants that are more efficient.

11.6 Delay in timely completion of Transmission line projects

In most of the power projects, NTDC delays the construction of transmission line interconnection due to its financial constraints and management related issues. The inability of NTDC to complete transmission line projects, as scheduled, have been hampering the overall performance of the sector. NTDC 's delayed completion of transmission lines has resulted in power evacuation constraints like for the corridor of Lucky Electric and Port Qasim Coal projects affecting reliability of power supply to the system. Such delays have resulted in cost escalation of projects and led to contractual disputes between parties.

One of the major causes has been the right-of way issues. Resolution of these issues requires total commitment by the provincial administration. Therefore, provincial bodies must be fully involved in the project construction activities at all stages.

11.7 Security Issues

The law and order situation in the country is not very good, particularly in Balochistan and KPK. The hydel projects, which are being developed in the remote northern part of the country are encountering security problems. There have been a number of terrorist attacks reported on the security forces and civilians in the last few years including on some of the staff and officials of the power companies. The progress of some of the projects during their construction have suffered a lot due to precarious security situation in their areas and the security issues need to be resolved on the highest priority basis.

11.8 Difficulties in Land Acquisition

Nearly all project companies are facing problems while acquiring the land for their projects. A lot of time is consumed in acquiring the land as the locals of the project areas demand very high cost of land and sometimes, the desired support from the provincial / local government is not provided. A proper framework for acquiring the land for the projects must be developed and implemented transparently.

11.9 Rapid Changes in Tax regime

The government announces the private power policies from time to time, with clearcut Tax regime. However, during the implementation of the projects, the tax regime changes, and new taxes are imposed on the project companies, which have serious financial implications and discourage investors.

11.10 Lack of Coordination between Federal Government Institutions and Provinces / AJK

The GOP policies related to private power generation are being implemented by Federal Government and Provincial / AJK governments. As hydro, coal, wind and solar are provincial resources, the provinces / AJK play a major role in developing these projects by the private sector. Besides, sometimes, the stance of federal and provincial governments have also been seen to differ on different policy level issues, specifically on induction of renewable energy, including hydel power. Similarly, provincial government insistence on certain responsibilities upon investors, which are not covered under their contractual obligations or the policy under which the project is implemented, not only delays project completion, but also gives a negative signal to the investors. Moreover, there is a lack of coordination between the institutions at the Federal government level and provinces / AJK, resulting in the unnecessary delays and discouragement for the companies.

B. Way Forward

Background

Provision of a reliable and affordable electricity supply to end consumers has remained one of the major objectives of the federal governments. Currently, however, numerous issues in supply, transmission and distribution of electricity sectors, have negatively affected the earlier efforts to overcome power shortages in the country. Among such issues, high cost of electricity certainly poses the biggest challenge for the policy makers

On the supply side, rising cost of imported fuels in the international markets and sharp depreciation of Pakistani rupee against international curries have made inputs very expensive. At the same time, fuel availability and transmission system constraints have forced uneconomic dispatch and underutilization of efficient power plants. In addition, continued operation of inefficient public sector generation plants at their partial loading levels not only deprived the sector of resources which more efficient power plants could have used, have added to already expensive generation mix. On the distribution end, high T&D losses, small energy sales base coupled with low recovery ratios added to the woes of the sector.

Similarly contractual commitments about 'Take or Pay' mechanism contributed to higher capacity payments leading to increased circular debt

During the FY 2020-21, most of the RLNG and Coal based power projects were underutilized, which directly resulted in increase in Energy Purchase Price of these plants due to operation on lower part of efficiency curves. In addition, capacity payments were payable for these plants' full capacity, irrespective of the fact that their full capacity was not used in the system. Discos and KE also followed a policy to carry out revenue based load shedding further reducing demand of the system, although discos reported unattended/ pending application of new consumers of electricity.

Growing circular debt in the power sector is worrying for the power sector and the whole economy. The circular debt as on 30-06-2021 stood at Rs. 2,280 Billion. This increase in the

circular debt is detrimental to the power sector's financial viability. To arrest the pace of accumulation of circular debt, necessary measures, including but not limited to, increase in electricity sales, ensuring optimum utilization of efficient electric power generation plants, retiring the old GENCOs plants with very low efficiency and utilization, retiring the IPPs having completed term of their licenses, fast track development on indigenous fuels, etc. need to be undertaken immediately. The competitive electricity price is not only necessary to boost the industrial activity in the country but also to up-lift the living standard of the common man.

Despite all these challenges discussed earlier, Pakistan Power sector has a silver lining. Due to the huge potential of indigenous RE resources, producing cheap and environment-friendly renewable energy (RE) power plants (wind and solar) to displace the costlier electricity is the need of the hour. According to Nepra State of Industry Report the RE sources are most suitable for providing environment friendly cheap electricity. Being indigenous, RE are assumed to contribute to achieve the goal of energy security for the country and sustainable supply of electricity. Presently, the share of RE power plants (wind and solar) in the country's generation mix is around 5%. Given the abundant potential for solar power generation across the country and considerable potential for wind power generation in specific corridor along with the coastal line, the solar and wind energy can play a significant role in providing sustainable supply of electricity in the country's power system. Accordingly, the RE Policy 2019 (RE Policy) envisages increase of share of RE in the generation mix of the country to 30% by 2030.

Like wind and solar, hydropower is also based on indigenously available cleaner resource and helpful in reducing reliance on imported fuel. The share of installed capacity of hydropower projects in the generation mix of the country as on 30-06-2021 is 24.96% with the total installed capacity of 9,915 MW comprising 9,443 MW of WAPDA Hydro and 472 MW of IPPs. Hydropower is an indigenous resource of power generation. Therefore, developing hydropower is critical for sustainable energy and diversity in the supply of electricity in the long run.

To reduce air pollution and curb climate change, the Government of Pakistan has already announced Electric Vehicle Policy 2019 (EV Policy). However, the EV Policy has not received an encouraging response. The EV Policy be reviewed, updated and strengthened, for large scale induction of EVs in the Transport Sector, providing incentives to the masses by providing financing and ensuring minimum quality and safety standards for the use of EV vehicles or converting the existing vehicle to EVs. This will save on the import of the fuel and will positively impact Environment and Economy by reducing the country's dependency on fossil fuels. The government to develop a robust institutional framework for the implementation of the revised EV Policy, so that EVs are inducted in the country in large scale, as soon as possible.

Under a requirement of the EV Policy, NEPRA is in the process of finalizing tariff structure and regulatory regime for Electric Vehicle Charging Stations. Uninterrupted power supply is necessary for the EV charging stations to carry out its business, which could be provided through cost effective power projects based on indigenous energy resources.

Pakistan has abundant indigenous energy resources such as Hydro, Solar, Wind and Thar Coal therefore, the Government needs to focus on the development of these in the country to reduce

reliance on imported fuels. The Government has already announced various power policies, which contain some very lucrative incentives, furthermore, purpose built Institutions are already in place to facilitate investors to develop power projects based on Indigenous resources. As a result of the efforts of the Government of Pakistan, around 55% of power generation in the country is already from the private power projects. Hence, focus for future power generation be through induction of private power projects based on indigenous resources.

The lead time for solar and wind Power Projects is 1-2 years, and due to rapid technological advances, the cost of electricity is also very low. Furthermore, solar and wind power projects can be located very close to the load centers, hence, may not need investment on very long EHV Transmission Lines; hence, in the short term, the Government may focus on the development of Solar and Wind Power Projects. IGCEP results show that to meet a demand of 37,129 MW by the year 2030, a generation capacity of 61,112 MW is proposed, which include the utilization of existing generation facilities, consideration of committed power plants and optimization of candidate power plants. It is to highlight that to meet the demand by the year 2030, the share from variable renewable energy (VRE) resources stands out to be 7,932 MW, 5,005 MW and 749 MW of Solar, Wind and Bagasse based Power Projects, respectively and over 60% of energy generation will be through Renewable Energy Sources by 2030.

In the national grid, about 6,447 MW of Power Projects operating on RFO, RLNG and Gas in public and private sector are very old, inefficient and having very low availability. These Power Projects need to be retired as soon as possible or per their EPA / PPA term or government decision. This will result in reducing the overall tariff.

In the long run, i.e. 6-10 years, the government should develop Power Projects based on Hydro resources and thermal Power Projects. The Power Generation through Hydro and Thar Coal Based Power Projects is much lower than imported fuel project, hence, this will help in reducing the basket price of electricity. These projects could be operated as base load plants.

In Pakistan, there are no pumped storage projects, therefore, there is a need that a proper Feasibility Study be undertaken to determine the capacity, location and merits of pumped storage projects.

Some of the major issues Discos are facing are as follows:

- Load-Shedding Despite Available Generation Capacity
- High Transmission & Distribution Losses
- Less Recoveries
- Pending Applications for New Electricity Connections
- Inability of Sustainable Sales Growth
- Over-Loading of Power Transformers, 11 kV Feeders and Distribution Transformers

In order to address the above problems, the reforms as earlier approved by the government of Pakistan be implemented without any further delay. Furthermore, due to the inefficiencies in the DISCOs, all the DISCOs are immediately privatized so that the private sector with the proper financial, technical and management skills can operate the DISCOs efficiently.

In view of the above, the following way forward is suggested:

1. New Power Policy

GOP prepares a new Power Policy in consultation will all stakeholders to encourage investors for the development of Power Projects based on indigenous resources (Wind, Solar, Coal and Hydro). Furthermore, the policy addresses the existing investors' problems and issues. The policy may focus on the development of power projects in the order of the following priority:

- Solar and Wind Power Project - Short to Medium Term (2-3 years)
- Hydro and Local Coal based Power Projects - Medium to Long term (3-7 years)

2. Utilization of existing and upcoming power projects

The existing and upcoming coal, hydro and nuclear power projects be operated as base load plants. The Solar and Wind Power Projects be operated during the day time (Solar) or whenever the resource is available (Wind) displacing expensive imported fuel based power projects.

3. Retirement of inefficient and old projects in public and private sector

The 6,447 MW of inefficient and old projects in public and private sector operating on RFO, RLNG and Gas be retired as soon as possible or as per the their EPA / PPA term or government decision. This will result in reducing the overall tariff.

Keeping in view the above way forward, the IGCEP be updated.

4. Pumped storage power projects

Proper Feasibility be undertaken for Pumped Storage Hydro Power Plants at various viable locations and Pumped Power project be developed accordingly.

5. Large scale induction of Electric Vehicles (EVs)

Due to the multiple advances of EVs, the future of the transportation world lies in EVs and the question is how Pakistan can best prepare for that future. The transition of the transport sector towards electrification is the need of the hour.

Following is the proposed way forward for large-scale induction of EVs in Pakistan:

- The existing GOP EV Policy be reviewed, updated and strengthened, for large scale induction of EVs in the Transport Sector, providing incentives to the masses by providing financing and ensuring minimum quality and safety standards for the use of EV vehicles or converting the existing vehicle to EVs.
- Pakistan has abundant indigenous resources so more investment be made for the upgradation of the grid infrastructure and in new power projects based on economic and indigenous renewable energy resources, so that power for charging of EVs could be provided economically and reliably.
- As the technology will take many years to fully mature, Pakistan should make a gradual, phase-wise entry into the EV space.

- Pakistan needs to learn from the success stories of China, UK, Norway, etc. for fast track induction of EVs in their respective countries.
- An indigenous Research & Development hub be made to utilize the potential of EV technology fully. The R&D hub should have programs to promote the development and supply of EV technology within the country and the nation's capacity building. This hub can be used as a support for new business ventures or to increase exports.

6. Reform the Power Sector and Privatize DISCOs

In order to address the problems being faced by DISCOs, the reforms, as earlier approved by the government of Pakistan, be implemented in the DISCOs without any further delay. Furthermore, due to the inefficiencies in the DISCOs, all the DISCOs are immediately privatized so that the private sector with the proper financial, technical and management skills can operate the DISCOs efficiently.

ANNEXURES

Annex-I

List of commissioned Hydro Power Projects by WAPDA

Power Station	Plant Location	Type of Power Station	Installed Capacity (MW)
Major Hydropower Units			
Tarbela	Tarbela, KPK	Reservoir	3,478
Tarbela 4th Ext.	Tarbela, KPK	Reservoir	1,410
Ghazi Barotha	Ghazi Barotha, Punjab	Run of River	1,450
Mangla	Mangla, AJ&K	Reservoir	1,000
Warsak	Warsak, KPK	Run of River	243
Chashma	Chashma, Punjab	Run of River	184
Khan Khwar	Shangla, KPK	Reservoir	72
Allai Khwar	Battagram, KPK	Reservoir	121
Jinnah Hydel	Mianwali, Punjab	Run of River	96
Duber Khwar	Kohistan, KPK	Reservoir	130
Neelum Jhelum	Muzaffarabad, AJ&K	Run of River	969
Golen Gol	Chitral, KPK	Run of River	108
Sub Total (MWs)			9,261

Small Hydropower Units			
Dargai	Dargai, KPK	Run of Canal	20
Rasul	Rasul, Punjab	Run of Canal	22
Shadiwal	Shadiwal, Punjab	Run of Canal	14
Chichoki Mallian	Chichoki M., Punjab	Run of Canal	13
Nandipur	Nandipur, Punjab	Run of Canal	14
Kurram Garhi	Kurram Garhi, KPK	Run of Canal	4
Renala	Renala, Punjab	Run of Canal	1
Chitral	Chitral, KPK	Run of Canal	1
Gomal Zam	South Waziristan, KPK	Reservoir	17
Malakand/Jabban	Malakand, KPK	Run of River	22
Daral Khwar	Swat, KPK	Run of River	37
Ranolia	Kohistan, KPK	High Head	17
Sub Total (MWs)			182
Total Hydel (WAPDA)			**9,443**

Annex-II

List of IPPs commissioned under 1994 Power Policy

S. No.	Project Name	Gross Capacity (MW)
1.	AES Lalpir Limited	362
2.	AES Pak Gen. (Pvt) Limited	365
3.	Altern Energy Limited	29
4.	Fauji Kabirwala Power Company	157
5.	Gul Ahmed Energy Ltd. (GAEL)	136
6.	Habibullah Coastal Power (Pvt) Co.	140
7.	Japan Power Generation (Pvt) Limited	135
8.	Kohinoor Energy Limited	131
9.	Liberty Power Project	235
10.	Rousch (Pakistan) Power Limited	450
11.	Saba Power Company Limited	125
12.	Southern Electric Power Company Limited	136
13.	Tapal Energy Limited	126
14.	Uch Power Limited	586
Total (MWs)		3,113

Annex-III

List of IPPs commissioned under 2002 Power Policy

S. No.	Project Name	Gross Capacity (MW)
1.	Attock Gen Power Project, Rawalpindi	165
2.	Atlas Power Project, Sheikhupura	225
3.	Engro Power Project, Qadirpur, Sindh	227
4.	Sahiwal (Saif) Power Project, Sahiwal	229
5.	Orient Power Project, Balloki, Punjab	229
6.	Nishat Power Project, Near Lahore	200
7.	Nishat Chunian Power Project, Near Lahore	200
8.	Sapphire Power Project, Muridke, Punjab	225
9.	Liberty Power Tech Project, near Faisalbad	200
10.	HUBCO-Narowal Project, Narowal, Punjab	220
11.	Fauji Daharki Power Project, Daharki, Sindh	185
12.	Bhikki (Halmore) Power Project, Bhikki, Punjab	225
13.	Uch-II Power Project, Dera Murad Jamali, Balochistan	404
14.	Patrind Hydropower Project, Muzaffarabad AJK	147
15.	Gulpur Hydropower Project, Poonch River, Gulpur, AJ&K	102
16.	Karot Hydropower Project, Jehlum River, Rawalpindi	720
Total (MWs)		3,903

Annex-IV

List of IPPs commissioned under 2015 Power Policy

S. No.	Project Name	Gross Capacity (MW)
1.	Sahiwal Coal Power Project, Qadarabad, Sahiwal	1320
2.	Port Qasim Coal Power Project, Port Qasim,Karachi	1320
3.	RLNG based Haveli Bahadur Shah Project, Haveli Bahadur Shah, Jhang	1230
4.	RLNG based Bhikki Power Project, Bhikki, Sheikhupura	1180
5.	RLNG based Balloki Power Project, Balloki, Kasur	1223
6.	Engro Thar Coal Power & Mine Project, Thar, Sindh	660
7.	China Power Hub Generation Company (Private) Limited, Hub, Baluchistan	1320
8.	Lucky Electric Power Project, Port Qasim, Karachi	660
Total (MWs)		8,913

Annex-V

List of Wind Power IPPs commissioned under ARE Policy

S/N	Name of Project	Capacity	Location	COD
1	FFC Energy Limited	49.5	Jhampir, Dist. Thatta	16 May, 2013
2	Zorlu Enerji Pakistan (Pvt.) Ltd	56.4	Jhampir, Dist. Thatta	26 Jul, 2013
3	Three Gorges First Wind Farm Pakistan (Pvt.) Limited	49.5	Jhampir, Dist. Thatta	25 Nov, 2014
4	Foundation Wind Energy – II Ltd.	50	Gharo, Dist. Thatta	10 Dec, 2014
5	Foundation Wind Energy – I Ltd.	50	Gharo, Dist. Thatta	11 Apr, 2015
6	Sapphire Wind Power Company Ltd	52.8	Jhampir, Dist. Thatta	22 Nov, 2015
7	Yunus Energy Ltd.	50	Jhampir, Dist. Thatta	16 Sep, 2016
8	Metro Power Company Ltd.	50	Jhampir, Dist. Thatta	16 Sep, 2016
9	Tapal Wind Energy Pvt. Ltd.	30	Jhampir, Dist. Thatta	7 Oct, 2016
10	Tenaga Generasi Ltd.	49.5	Gharo, Dist. Thatta	11Oct, 2016
11	Master Wind Energy Pvt. Ltd.	52.8	Jhampir, Dist. Thatta	14 Oct, 2016
12	Gul Wind Energy Ltd	50	Jhampir, Dist. Thatta	18 Oct, 2016
13	Hydro China Dawood Power Pvt. Ltd.	49.5	Gharo, Dist. Thatta	5 Apr, 2017
14	Sachal Energy Development Pvt. Ltd.	49.5	Jhampir, Dist. Thatta	18 Apr, 2017
15	United Energy Pakistan Pvt. Ltd	99	Jhampir, Dist. Thatta	16 Jun, 2017
16	Hawa Energy Pvt. Limited	49.6	Jhampir, Dist. Thatta	15 Mar, 2018
17	Jhampir Wind Power Limited	49.735	Jhampir, Dist. Thatta	16 Mar, 2018
18	Artistic Energy Pvt. Ltd. (formerly Hartford Energy	49.3	Jhampir, Dist. Thatta	16 Mar, 2018

	Pvt. Limited)			
19	Three Gorges Second Wind Farm Pvt. Ltd.	49.5	Jhampir, Dist. Thatta	30th Jun, 2018
20	Three Gorges Third Wind Farm Pvt. Ltd.	49.5	Jhampir, Dist. Thatta	9th Jul, 2018
21	Tricon Boston Consulting Corporation Pvt. Limited (A)	49.6	Jhampir, Dist. Thatta	16 Aug, 2018
22	Tricon Boston Consulting Corporation Pvt. Limited (B)	49.6	Jhampir, Dist. Thatta	14 Sep, 2018
23	Tricon Boston Consulting Corporation Pvt. Limited (C)	49.6	Jhampir, Dist. Thatta	11 Sep, 2018
24	Zephyr Power (Pvt.) Ltd	50	Gharo, Dist. Thatta	27 Mar, 2019
25	Master Green Energy Ltd.	50	Jhampir, Dist. Thatta	20 Aug, 2021
26	Tricom Wind Power (Pvt.) Ltd.	50	Jhampir, Dist. Thatta	31 Aug, 2021
Total (MWs)		**1,335**		

Annex-VI

List of Solar PV IPPs commissioned under ARE Policy

Sr. No.	Name of Projects	Capacity (MW)	Location	Date of Completion
1.	Quaid-e-Azam Solar Power (Private) Limited	100	Quaid-e-Azam Solar Park, Bahawalpur	15 July 2015
2.	Appolo Solar Development Pakistan Limited	100	Quaid-e-Azam Solar Park, Bahawalpur	31 May 2016
3.	Best Green Energy Pakistan Limited	100	Quaid-e-Azam Solar Park, Bahawalpur	31 July 2016
4.	Crest Energy Pakistan Limited	100	Quaid-e-Azam Solar Park, Bahawalpur	31 July 2016
5.	Harappa Solar (Private) Limited	18	Harappa, Sahiwal	14 October 2017
6.	AJ Power (Private) Limited	12	Addi Kot, Khushab	13 December 2017
Total (MWs)		**430**		

Annex-VII

List of Bagasse / Biomass based Co-generation IPPs commissioned

Sr. No.	Name of Project	Location	Fuel	Capacity
1	Jamal Din Wali-II	Rahim Yar Khan,	Bagasse+Biomas	**26**
2	Jamal Din Wali-III	Rahim Yar Khan,	Bagasse+Biomas	**27**
3	RYK Mills	Rahim Yar Khan,	Bagasse	**40**
4	Chiniot Power	Chiniot, Punjab	Bagasse	**63**
5	Fatima Energy	Muzaffargarh, Punjab	Biomass/Coal	**120**
6	Hamza Sugar Mills	Rahim Yar Khan,	Bagasse+Biomas	**15**
7	The Thal Industries	Layyah, Punjab	Bagasse	**20**
8	Almoiz Industries	Mianwali, Punjab	Bagasse	**36**
9	Chanar Energy	Faisalabad, Punjab	Bagasse+Biomas	**22**
Total Bagasse/Biomass Power Projects				**369**

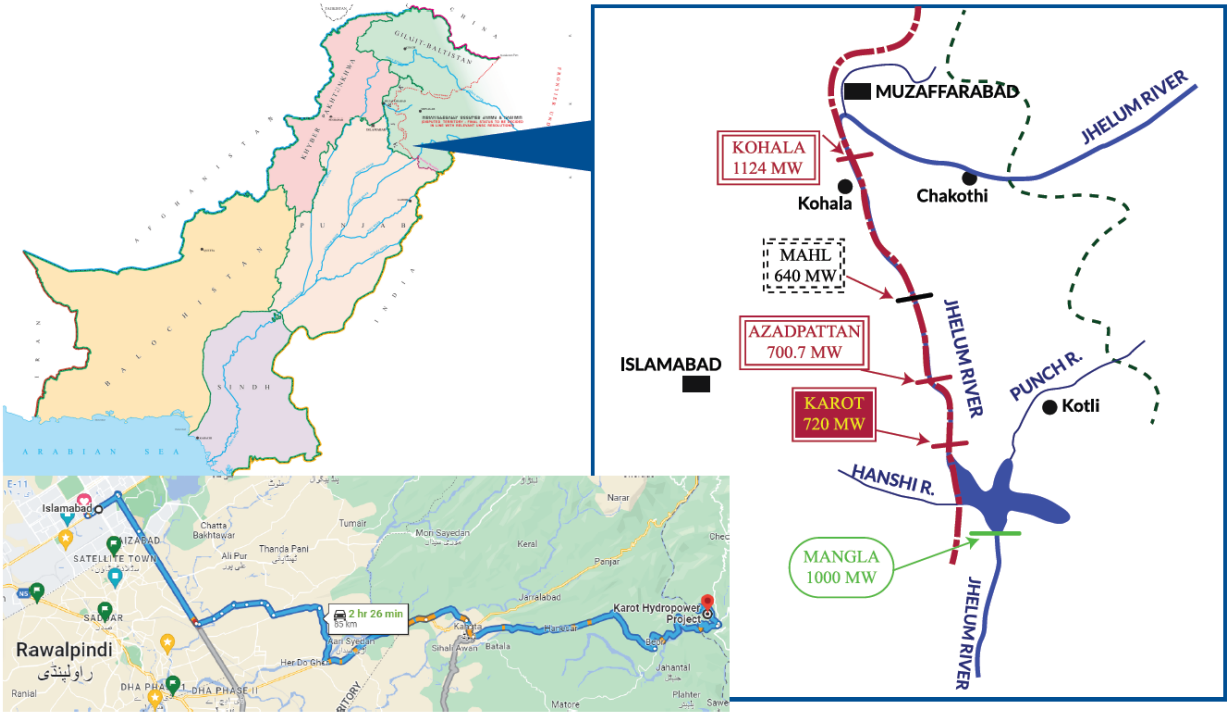
Annex-VIII

List of Commissioned Power Projects by AJK PDO

Sr. #	Power Stations	Cap. (MW)
1	Kundal Shahi	2.00
2	Kathai	3.20
3	Leepa	1.60
4	Jagran-1	30.40
5	Changan	0.05
6	Sharian	3.20
7	Halmat	0.32
8	Ranger-I	0.60
9	Qadirabad	3.00
10	Rehra	3.20
11	Sharda	3.00
12	Kel	0.75
13	Pattika	0.50
14	Battar	4.80
15	Dhannan	1.7
16	Galater	1.0
17	Kel	0.500
18	Kappa Banamula	2.00
19	Hajira	1.60
20	Hillan	0.600
21	Rangar-II	0.45
22	Guin Nullah	0.25
23	Jhing	14.4
	Total	79.12

Annex-IX

Location Map of Karot HPP



Annex-X

Pictures related to the construction of Karot HPP

Annex-XI

Pictures related to various works / projects undertaken under CIP in Punjab and AJK by Karot HPP

View of BHU Hollar

KPCL Provided Ambulance at BHU

Public Park Hollar

New Constructed Access Road in Hollar

New classroom at Girls school Hollar

View of New Boys School Building Hollar

Newly constructed rest house in Beor

New Trauma Center at THQ Hospital

new school building in Punjab

Inner view of beautiful classroom

A view of new dispensary building at Brohi

Construction of Access Road Kahutta

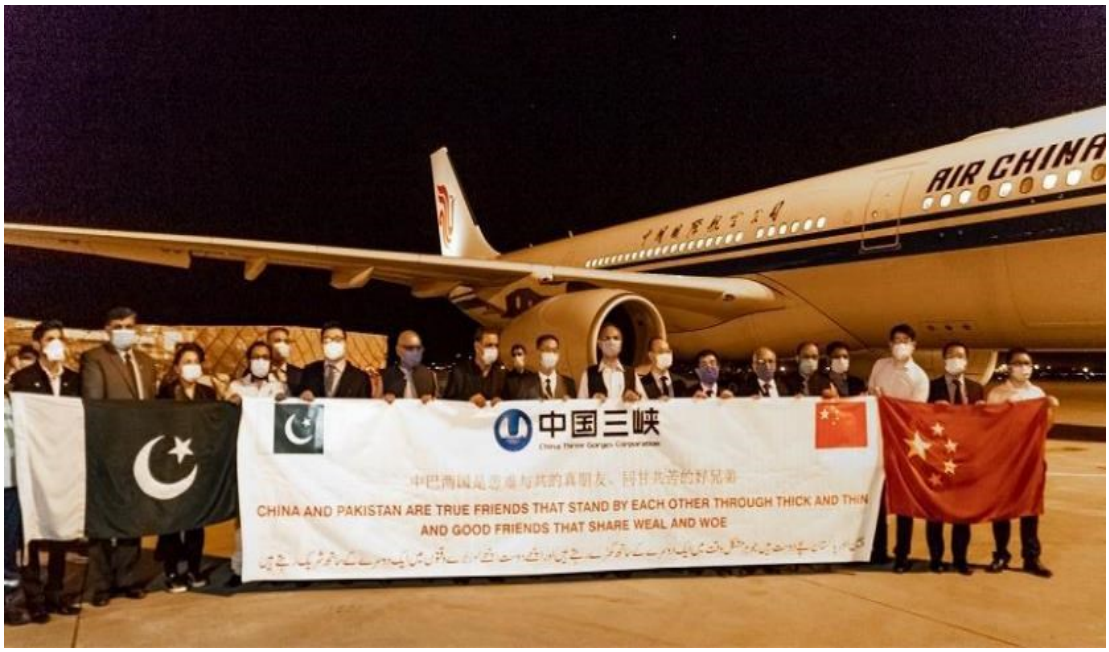
Annex-XII

Pictures related to the fully funded scholarship for students of the local area of Karot HPP


CTG-Scholarship Program for Pakistani

Annex-XIII

Pictures related to the COVID donations by CTG Group




中国三峡
China Three Gorges Corporation
热烈欢迎宜昌市第一人民医院医疗队一行抵达巴基斯坦

Annex-XIV

Pictures related to the construction of the Matiari-Lahore HVDC Transmission Line Project


工程名称:巴基斯坦默蒂亚里-拉合尔±660kV直流输电项目默蒂亚里换流站工程
施工部位:直流场电容器塔值阻测试试验
当前日期:2020年03月08日
2020/03/08 16:29


工程名称:巴基斯坦默蒂亚里-拉合尔±660kV直流输电项目默蒂亚里换流站工程
施工部位:交流场碎石铺铺
当前日期:2020年04月09日
2020/04/09 08:17

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