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INTERCONNECTION DESIGN EQUIPMENT REQUIREMENT FOR IPPS IN PAKISTAN

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Abstract: In Pakistan, electrical energy is produced from a variety of sources, and the government is currently planning to combine renewable energy sources to provide end users with cheaper electricity. This would support Pakistan's manufacturing sector and may also result in more exports, which will reduce Pakistan's import-export imbalance and boost total reserves, which are now being depleted from the country's overall economy. These renewable energy projects have created new business opportunities in Pakistan, where investors are urged to become independent power producers (IPPs) and generate electricity using standardized technologies for both producing and selling electricity. Understanding the processes that IPPs must take in order to install a Power Plant is the goal of this publication. This paper will assist IPP investors in making better plans and managing projects within the allotted time frames and budgets. Additionally, it will provide an overall standard checklist for IEC or NTDC to choose better equipment and designs to run their plant more effectively.
Keywords: NTDC (National Transmission and Dispatch company); IEC (International Electro technical Commission); IPP (Independent Power Producers); PSP (Planning section of power system); MW (Mega Watt); MOU (Memorandum of understanding); EOI (Expression of Interest); NEPRA (National Electric Power Regulatory Authority)

1 INTRODUCTION

The power system in Pakistan is a combination of several sources that provide power to the end consumer through various interconnected systems. It is a positive development that the government, particularly the NTDC, has created a thorough plan to incorporate new energy sources, particularly renewable ones, in order to reduce the impact of existing energy costs on consumers and to boost Pakistan's economy especially in the field of manufacturing and exports to increase overall country revenue. According to statistics provided by the NTDC PSP department.

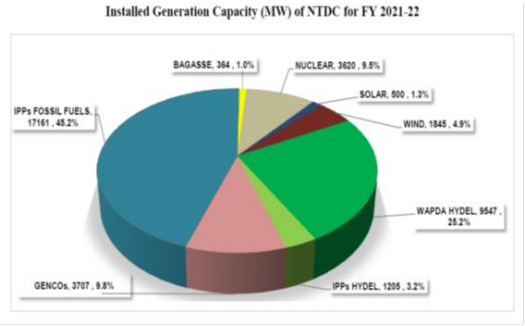


Figure 1 Showing Power Generation capacity of Pakistan [2]

Pakistan is capable of producing a total of 37,809 MW of electricity utilizing a variety of sources, the majority of which come from the combustion of fuel [1]. Pakistan, through NTDC PSP, wants to use renewable energy sources in the same way that the rest of the world is doing. This is definitely will boost overall economy of Pakistan and at the same time is a great chance for IPP's to come forward in the trade of renewable energy and earn fortune.
The government is undoubtedly advancing the renewable sector as it solicits EOIs, launches them, and signs MOUs to demonstrate its commitment to this industry.
The government intends to start 14,000 megawatts worth of solar power projects [4].The Pakistani PM declares that all government buildings would be solar-powered by April. [5]
The news like above is definitely and eye opener for potential upcoming IPP's, especially in solar and wind sector. The purpose of this document is to provide information about the approval process and the requirements for the approval of equipment.

2 RESEARCH METHODOLOGY

This paper's research methodology used a systematic approach to understand the needs and practices of IPPs in Pakistan. Here a detailed review of regulations, standards, and guidelines set by Pakistani organization like IEC and NTDC will be the part of this study. The study collected data from multiple sources, including Government reports, industry standards, and case studies of existing power plants.

3 LITERATURE REVIEW

A recent study has emphasized the importance of integrating different renewable energy resources into Pakistan's national grid, highlighting the need for standardized guidelines for independent power plants (IPPs). Reza et al. (2022) discussed the difficulties, challenges, and prospects of modern smart grid implementation in Pakistan, emphasizing the importance of new and well-designed interconnection framework [7]. Apart from this, some other research focuses on the technical aspects, advocating highly advanced technologies and reliable equipment to reduce the energy losses to some extent and ensure more stability of the system [8].
Another paper that examines the role of corporate social responsibility (CSR) in enhancing the overall performance of independent power pants (IPPs) in Pakistan [9], CSR practices, innovations, and environmental impacts in context of the entire thermal power generation sector in the country.

4 INRODUCTION TO PAKISTAN POWER STRUCTURE: GENERATION & DISTRIBUTION

Pakistan's power structure is a convoluted merger of departments, each of which is responsible for carrying out a certain duty, including the following.

4.1 NEPRA

It is also responsible for issuing licenses for generation, transmission and distribution of electricity, establishing and enforcing standards to ensure quality and safety of operation and supply of electric power to consumers; approving investment and power acquisition programs of utility companies; and determining tariffs for the generation, transmission, and distribution of electric power.

4.2 CPPA-G

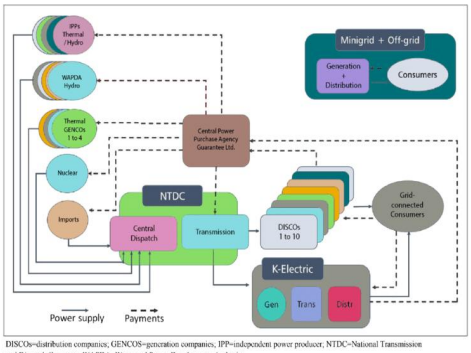
CPPA-G is Pakistan's market operator and is enabling the change from a single buyer to a competitive market for electricity.

4.3 NTDC

NTDC operates & maintains eighteen 500kV grid stations & Forty-Nine 220kV grid stations; it is also responsible for the approval of Projects in terms of Design, protection and communication.

4.4 NPCC

NPCC is the nerve center of Power Sector. Entire power generation and its transmission to the load centers is controlled and coordinated from its National and Regional Control Centers. NPCC is a contracting outfit and its charter includes management of Power Projects on turnkey basis i.e. Extra High Voltage Transmission Lines, Distribution Networks, Substations, Power Generation Plants, Industrial Electrification, External Lighting of Housing Complexes etc.
Figure 2 depicts the division of work among these departments and their standing in relation to job descriptions established by the Ministry of Energy and Power. The CPPA-G is in charge of calculating load demand and allocating the required values to various power production sectors, while NTDC assists in power transmission to various Power distributors sectors that distribute power to end customers, as can be seen in the figure. IPPs, WAPDA, and other generation stations receive payment from CPPA-G for the amount of power they have produced.



DISCOs=distribution companies; GENCOS=generation companies; IPP=independent power producer; NTDC=National Transmission and Dispatch Company; WAPDA=Water and Power Development Authority.

Figure 2 Showing Power Structure of Pakistan[6]

5 INTERCONNECTION DESIGN EQUIPMENT

The architecture of the plant, the choice of the equipment, and the equipment's type, all fall under the category of interconnection design equipment for power plants. Furthermore, the type of interconnection equipment that is chosen depends greatly on the generation source.
Interconnection equipment, also known as BOP, must be approved by regulatory agencies in accordance with certain IEC and NTDC standards.
These interconnection equipment are "Air Circuit Breaker, Batteries, Bus Support Insulators, Capacitor Bank, Circuit Switchers, Concrete Foundation, Conduits, Control House, Control Panels, Control Wires Current Transformers, Disconnect Switches, Distribution Bus, Duct Runs, Frequency Changers, Grounding Resistors, Grounding Transformers, High-Voltage Underground Cables, Lightning Arresters, Manholes, Metal-clad Switchgear, Meters, Microwave, Oil Circuit Breakers, Potential Transformers, Potheads, Power-line Carrier, Power Transformers,Rectifiers,Relays,SF6 Circuit Breakers, Shunt Reactors, Steel Superstructures ,Supervisory Control, Transmission Bus, Vacuum Circuit Breakers" .The equipment mentioned falls under a peculiar category in terms of design perspective and have been segregated by the regulatory agencies for approval which is covered in the lateral section of this document.

6 INTERCONNECTION DESIGN EQUIPMENT REQUIRMENT

Interconnection equipment has been segregated in three major categories:
1. Primary Design Equipment
2. Secondary Design Equipment
3. Communication Devices – Telecom Equipment

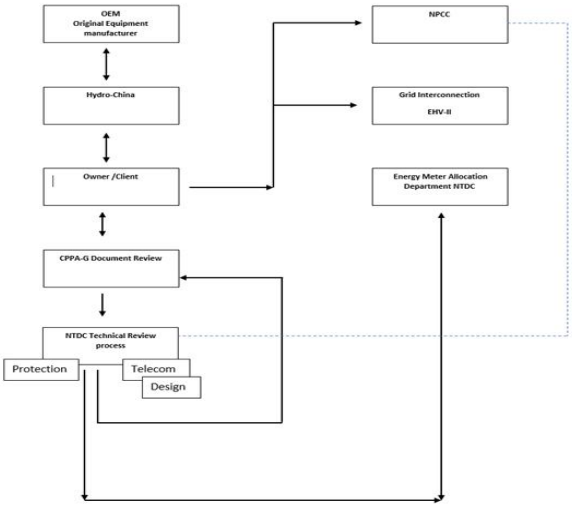


Figure 3 Revealing Flow Chart for the Approval Process at NTDC

In order to install a power plant for generation and specially to sell Electricity to CPPA-G, it is mandatory that the interconnection equipment should be approved by the regulatory authority and in case of selling to public sector, NTDC plays a vital role in approval.

7 OVER VIEW OF NTDC

National Transmission & Despatch Company (NTDC) was incorporated on 6th November, 1998 and commenced commercial operation on 24th December, 1998. [3] It was organized to take over all the properties, rights and assets obligations and liabilities of 220 KV and 500KV Grid Stations and Transmission Lines/Network owned by Pakistan Water and Power Development Authority (WAPDA).
National Transmission and Despatch Company (NTDC) links Power Generation Units with Load Centers spread all over the country (including Karachi) and thus establishes and governs one of the largest interconnected Networks.
The Company is responsible for evacuation of Power from the Hydroelectric Power Plants (mainly in the North), the Thermal Units of Public (GENCOs) and Private Sectors (IPPs) (mainly in the South) to the Power Distribution Companies through primary (EHV) Network.

8 TRANSMISSION NETWORK OPERATOR (TNO)

Operation and Maintenance of the 500/220kV Network: Planning, Design, and Construction of the New 500/220kV Systems, and Strengthening/Up gradation of Existing One [3].

8.1 System Operator (SO)

Arranging non-discriminatory and non-preferential economic dispatch to ensure a safe, secure, and reliable supply [3].

8.2 Wire Business

- Transmission Planning
- Design and Engineering
- Project Development and Execution
- Operation and Maintenance of Transmission Assets

8.3 System Operation & Despatch

- Generation Despatch
- Power System Operation and Control

9 NTDC ORGANOGRAM W.R.T TO DIFFERENT DEPARTMENTS

9.1 Design Department

- Reviewer Office
- Manager office
- Manager Dispatch office
- Chief office
- Chief Dispatch office
- GM office
- GM Dispatch office
- MD Office
- MD Dispatch office

9.2 Protection Department

- Reviewer Office
- Manager office
- Manager Dispatch office
- Chief office
- Chief Dispatch office
- GM office
- GM Dispatch office

9.3 Telecom Department

- Reviewer Office
- Manager office
- Manager Dispatch office
- Chief office
- Chief Dispatch office
- GM office
- GM Dispatch office

9.4 Transmission Design Office

9.5 TSG – Technical Service Group

9.6 Reports Review office

9.7 HR office

10 DEPARTMENTS & EQUIPMENTS

With respect to approval process as mentioned in figure 2 three departments of NTDC plays a vital role namely

1. Project design office
2. Protection and control Office

3. Telecom department

It should be taken in consideration that these standards are revised by NTDC from time to time in order to better surveille the equipment.

10.1 Design Department

List of equipment for designing department:

Table 1 List of Equipment for Designing Department

Sr#	Submission Item	IEC Standards	NTDC Specifications
1	SLD	N/A	N/A
2	Substation Layout	N/A	N/A
3	AIS Equipment Circuit Breaker	IEC 62271-100 IEC 62271-1 IEC 60273	P-193:2010
4	Type Test, FAT and Routine Tests of Circuit Breaker	IEC 62271-100	P-193:2010
5	AIS Equipment Line Disconnectors ,AC Bus Disconnectors & Earthing Switch	IEC 62271-102 IEC 60417 IEC 60273	P-128:2011
6	Type Test & Routine Tests of Line Disconnectors ,AC Bus Disconnectors & Earthing Switch	IEC 62271-102	P-128:2011
7	Instrument Transformer Protection Current Transformer	IEC 60044-11 IEC 60273 IEC 60044-1	P-90:2012
8	Routine Test ,Factory Acceptance Test &Type Test Protection Current Transformer	IEC 60044-1 IEC 60296 IEC 60273	P-90:2012
9	Instrument Transformer Metering Current Transformer	IEC 61869-1 IEC 61869-2 IEC 62155 IEC 60273	P-205:2020
10	Routine Test , Factory Acceptance Test &Type Test Metering Current Transformer	IEC 61869-1 IEC 61869-2 IEC 62155 IEC 60273	P-205:2020
11	Instrument Transformer Metering Voltage Transformer	IEC 60044-2 IEC 60385 IEC 296	P-206:2005
12	Routine Test , Factory Acceptance Test &Type Test Metering Voltage Transformer	IEC 358 IEC600044-22 ANSI C93.2	P-206:2005
13	Surge Arrestor	IEC 60099-4	P-181:2012
14	Type Test, FAT, Routine Test	IEC 60068 IEC 60099-4	P-181:2012

	Report of Surge Arrestor		
15	Grid Hardware	---------	P-176:2011 P-187:2010 P-142:1996 P-143:1996 P-188:1996
16	Metering Panel	---------	P-199:08 P-202:12
17	Energy Meter	--------	P-202:12

10.2 Protection Department

Table 2 List of Equipment for Protection Department

Sr#	Submission Item	IEC Standards
1	SLD	For Protection following specification are incorporated for the approval of submission items • NTDC specs for 132kV Relay and Control Panels-> P-151:2008 • NTDC specs for Auxiliary AC/DC panels: P48:81 • NTDC Specs for Metering system: P199:08 & P202:12 • P-204-08 is for the relays and protection system usually conforms with the IEC standard relays
2	PMSLD	
3	Relay Ordering Codes	
4	Trip Logic and Interlocking Logic	
5	AC DC SLD	
6	Signal List	
7	Relay and Control Panel Schematic	
8	Relay Settings	
9	FAT of Protection Panels	

10.3 Telecom Department

Table 3 List of Equipment for Telecom Department

Sr#	Submission Item	IEC Standards
1	OPGW	IEEE Standard 1138
2	Optical Fibre	IEC 60794 Optical
3	Protection Class of Cabinets/Cubicles	Fiber Cables EN 60529
4	line traps	IEC 60353
5	coupling devices for power line carrier systems	IEC 60481
6	Coupling Capacitors	IEC 60044
7	Recommended values for characteristic input and output quantities of single sideband power line carrier terminals	IEC 60495 IEC 60663
8	Planning of (single side band) power line carrier systems	IEC 60834-1
9	Tele-protection equipment of power systems – performance and testing	

11 CONCLUSION

In this paper, we have identified a way for IPPs investors to better plan and manage projects within the allotted time frame and budget. Furthermore, this study can help IEC or NTDC operate their plant more efficiently. However, this study also provides an overall standard checklist for choosing the best equipment and design to run. It is obvious from the previous description that the road map for constructing a power plant is laborious for IPPs. But the aforementioned steps are designed to improve the electricity system. However, the Government may make it easier for IPP investors by creating an online system. Since typical operating procedures call for the printing of millions of pages, many of which are ultimately thrown away, creating an online system could prevent this waste and make job easier.

COMPETING INTERESTS

The authors have no relevant financial or non-financial interests to disclose.

REFERENCES

[1] National Transmission & Despatch Company Limited (NTDC). "Power System Statistics 47th Edition December 2022." Report, 2022. Available at: https://es.scribd.com/document/709410151/47th-Edition-Final-Version.
[2] National Electric Power Regulatory Authority (NEPRA). "State of Industry Report 2022." NEPRA Report, 2022. Available at: https://nepra.org.pk/publications/State%20of%20Industry%20Reports.php.
[3] National Transmission & Despatch Company (NTDC). "Official Website." NTDC, 2024. Available at: https://ntdc.gov.pk/.
[4] Tribune Express. "Official Website." Tribune Express, 2024. Available at: https://www.tribuneexpress.com/.
[5] Saur Energy. "Official Website." Saur Energy, 2024. Available at: https://www.saurenergy.com/.
[6] Central Power Purchasing Agency (CPPA-G). "Official Website." CPPA-G, 2024. Available at: https://www.cppa.gov.pk/.
[7] Muhammad Amir Raza, Muhammad Mohsin Aman, Abdul Ghani Abro, et al. Challenges and potentials of implementing a smart grid for Pakistan's electric network, Energy Strategy Reviews, 2022, 43, 100941. DOI: https://doi.org/10.1016/j.esr.2022.100941. https://www.sciencedirect.com/science/article/pii/S2211467X22001353
[8] PITCO Pakistan. "Projects." PITCO Pakistan. Accessed August 9, 2024. https://www.pitcopk.com/projects.
[9] Dunnan, Liu, Gul, Rana, Jaffri, Nasif, et al. Independent Power Producer (IPPs) of Pakistan and CSR to Enhance Performance. 2020. 1-5. DOI: 10.1109/iCoMET48670.2020.9073918.