Handbook
for
Setting up National Power Exchanges in SAARC

SAARC Energy Centre
Islamabad, Pakistan

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Foreword

Over the years, the SAARC region countries are witnessing steady development. Electricity plays a major role in development. The power markets of each country are in the developing stage and there is a need for further development of power markets. With changing dynamics of the energy sector across the world and geopolitics around it, there is a need for every country to be self-reliant.

As the region enjoys abundant sunshine and thus solar power potential, regional energy cooperation can be a game-changer for the region. This can also help the governments to become resilient to climate change. Regional cooperation for energy is always an aspiration of the region to adopt measures for enhancing power trade between the SAARC Member Countries. A national power exchange in each country and an interconnection between them can play an instrumental role in achieving energy security and resource optimization for all the SAARC countries.

This handbook may assist as a ready reckoner for each country in setting up National power changes. The premise in which the suggestions are made are based on learnings from India. The Indian model of establishing power exchanges could be the easiest replicable model and I am sure SAARC Member States will make use of the handbook in the best way possible.

(Dr Nawaz Ahmad)
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Abbreviations

ADC	Aggregate Demand Curve
APTEL	Appellate Tribunal for Electricity
APOWER EXCHANGE	Amsterdam Power Exchange
ASC	Aggregate Supply Curve
ASCI	Administrative Staff College of India
ASX	Australian Securities Exchange
BEA	Bhutan Electricity Authority
BPS	Bhutan Power System
BSE	Bombay Stock Exchange
CBET	Cross Boarder Energy Trade
CEB	Ceylon Electricity Board
CERC	Central Electricity Regulatory Commission
CES	Centre for Energy Studies
CPPA-G	Central Power Purchasing Agencies
CROPEX	Croatian Power Exchange Limited
CTBCM	Competitive Trading Bilateral Contract Market
CVF	Climate Vulnerability Forum
DAM	Day Ahead Market
DISCOMS	Distribution Companies
DSDA	Deh Sabz City Development Authority
DSM	Demand Side Management
EECs	Energy Efficiency Certificate
GENCOS	Generation Companies
GTAM	Green Term Ahead Market
GW	Giga Watt
HUPOWER EXCHANGE	Hungary Power Exchange
IBEX	Independent Bulgarian Energy Exchange
IEX	Indian Energy Exchange
IGA	Inter-Governmental Agreement
IGFA	Inter-Governmental Framework Agreement
IPPS	Independent Power Producers
ISO	Indian Standard Organisation
JNNSM	Jawaharlal Nehru National Solar Mission
LMP	Locational Marginal Pricing
MEW	Ministry of Energy & Water, Afghanistan
MRRD	Ministry of Rural Rehabilitation and Development, Afghanistan
MU	Million Units
MVA	Million Volt Ampers
MW	Mega Watt
NDC	Nationally Determined Contributions
NEA	Nepal Electricity Authority
NEMO	Nominated Electricity Market Operator
NEPRA	National Electric Power Regulatory Authority
NLDC	National Load Dispatch Centre
NPEXs	National Power Exchanges
NSE	National Stock Exchange

NTPC	National Thermal Power Corporation
NVVNL	NTPC Vidyut Vyapar Nigam Limited
NZX	New Zealand Exchange
OMIE	Omi Exchange
OMIP	Omi Exchange Portugal
OTC	Over the Counter trading
PPAs	Power Purchase Agreements
PSMP	Power Sector Master Plan
RE	Renewable Energy
RECs	Renewable Energy Certificate
RLDC	Regional Load Dispatch Centre
RMC	Risk Management Committee
RPO	Renewable Purchase Obligation
RTM	Real Time Market
SDAC	Single Day-Ahead Coupling
SEBI	Securities and Exchange Board of India
SEC	SAARC Energy Centre
SGF	Settlement Guarantee Fund
SIDC	Single Intraday Coupling
SLDC	State Load Dispatch Centre
SMS	SAARC Member States
SPV	Solar Photo Voltaic
T&D	Transmission and Distribution
TAM	Term Ahead Market
TSOs	Transmission System Operators
TW	Terra Watt
UI	Unscheduled Interchange
USE	Unserved (Electricity) Energy
VGF	Viability Gap Funding
VPN	Virtual Private Networks

Executive Summary

An efficiently run power sector requires a well-functioning power market that provides efficient price signals for optimal capacity addition. The power market helps the planning agencies and policymakers to plan the network capacity addition, generation capacity addition and understand the consumer behaviours with large data sets. The power market requires a robust platform to facilitate competitive interaction of buyers and sellers which leads to the discovery of a fair, transparent & most efficient market-based price for electricity. This aids the development of efficient and well-functioning power exchanges. Power exchanges play a crucial role by having a larger balancing area in facilitating the integration of large-scale renewable generation as part of energy transitions.

The power markets in the SAARC countries are in the development stage. The information and data on the further development of power markets will help the countries in strengthening the sector. In this context, the SAARC Energy Centre has commissioned the work to prepare a "Handbook for setting up of National Power Exchanges in SAARC Member Countries" with the information and guidance required for the same.

This handbook captures the characteristics of a power exchange including the role of power exchange in a country's power market, advantages of having a power exchange, primary data of each SAARC Member State (SMS), the status of each SMS in terms of readiness in legal, policy, regulatory & technical requirements for each country and the way forward for each SMS for setting up a National Power Exchange (NPEX). The report also covers learnings from India's journey towards the development of power exchanges. The handbook shall be a useful guide to the policymakers in planning for the development and operationalization of power exchanges. This handbook is intended to set out the appropriate design for an NPEX and to enable each SMS to plan for the short term, medium-term, long-term, and assist in setting up such a power exchange. This will facilitate and foster cross border trade and enable the region to make efficient use of its energy resources, leading to an overall reduction in unserved electricity. The handbook covers the elements required for setting up of power exchange in terms of prerequisites and step by step guide to setup NPEX in SMS.

Pre-requisites for the establishment of a power exchange: With a hands-on experience of IEX (being one of the power exchanges in India) and desktop study of power exchanges in various European and other countries, the pre-requisites of establishing a power exchange have been identified and categorized primarily under four categories namely Policy, Legal, Regulatory and Technical. The categories cover aspects like competition & market signals, competitive neutrality, clear & durable rules, information asymmetries, cross-market integration etc. The enablers that are crucial for establishing and promoting NPEX are detailed in relevant sections of the handbook.

Readiness of SAARC Member States: All the countries in the SAARC region have similarities with India in the form of socio-economic conditions and growth story. With two fully operational power exchanges, India provides the most easily replicable model for SMS to adopt. The journey of India could be seen as an example for other SMS to endorse various reforms in the power sector and gradually transition towards the development of a competitive power market. In addition, countries such as the Netherlands, Sweden, New Zealand, Hungary, Croatia and Norway have been studied for this purpose to draw relevance with SMS in terms of the geography, market size, market players etc.

Apart from India, Pakistan and Bangladesh are comparatively more organized and ready for having an NPEX. Pakistan has a more functional institutional structure and further necessary structure for setting up a NEPX would be in operation in the near term. Pakistan currently has a policy framework on the promotion of merchant/ IPP generation capacity and promote trading of electricity. The country has to work on creating a conducive framework on policy, regulatory or legal aspects. The country needs to equip itself with policy provisions for the promotion of non-discriminatory access to transmission and distribution networks, facilitate licensing of the entities envisaged in the Act to ensure an increase in liquidity in the market and promote merchant power generation. Pakistan may ensure introducing true competition in the sector based on the provisions in the Electric Power Act 1997.

Bangladesh is currently equipped with provisions related to the independent system operator and dispute settlement. However, the country lacks certain provisions and frameworks required to have NPEX. Provisions pertaining to the non-discriminatory open access to transmission and distribution, policy to establish more merchant capacity, unbundling of utilities by separation of the generation, transmission and distribution functions are to be incorporated. It is suggested that unbundling should be encouraged as the government policy. Bangladesh also needs to establish the provisions for licensing and functions of Power Exchange, regulations for the establishment of power exchange, regulations for imbalance settlement in case of deviations from the schedules and the framework for transmission & wheeling tariff.

Pakistan and Bangladesh may gradually adopt a power exchange model among the models discussed in the handbook. Though, the other SMS like Afghanistan, Bhutan, Maldives, Nepal and Sri Lanka are not equipped with the required framework to have an NPEX in near future. With the suggested steps of (a) preparing SMS with policy, legal, regulatory and operational frameworks; (b) develop and nurture domestic power markets; (c) participate in CBET as deliberated in relevant sections, SMS may initiate the process of establishing efficient NPEX.

This handbook also captures the latest developments in the region's power sector that have highlighted the importance of NPEX viz. there is a compelling case for the integration of the short-term power market of SMS. SAARC Inter-Governmental Framework Agreement (IGFA) for Energy Cooperation, has been signed by the Foreign Ministers of the eight Member States on November 27, 2014. This agreement strives for adopting measures to enhance power trade in the region.

The sporadic demand-supply mismatch on an hourly, daily, and seasonal basis provides an excellent opportunity for a marketplace where surpluses and deficits can be managed synergically at the regional level on a real-time basis. Also, the SMS have constraints in terms of natural resources like oil, gas, coal, etc., imports from the resource-rich countries, making it prone to geo-politics to ensure energy security. With these prospects, CBET will prove a synergetic arrangement for optimum utilization of the resources and ensuring energy security. This might also act as a first step towards a mature and developed market in the region.

Chapter 01. Introduction

Historically, electricity was treated as a natural monopoly affecting reliability, cost-effectiveness and resource utilization. Electricity markets have provided solutions to address these issues. Electricity markets are designed to provide reliable and cost-effective electricity to consumers by bringing in competition in the sector. Power markets enable buyers and sellers of electricity to interact and transact at prices that are discovered through the market mechanism in a transparent manner. However, certain technical aspects involved in the transmission of electricity, which is subject to a complex series of physical interactions, demand that power markets need to be designed, developed, nurtured and monitored for optimum resource planning and utilization, rather than left to develop organically.

Competitive power markets are a combination of regulated segments (transmission & distribution networks) and competitive segments (wholesale & retail supply). The evolution of market competition is presented in Figure 1 using four models/ phases, which are further explained below.

a. **Monopoly/ Vertically integrated utility:** In this model, a single entity owns a vertically integrated generation, transmission and distribution business.
b. **Single buyer:** As the first step of introducing competition in the market, the traditional vertically integrated model is first restructured and unbundled into separate segments comprising generation, transmission and distribution (network & supply). Competition is fostered in the generation business to enable multiple generation entities to enter into Power Purchase Agreements (PPAs) with a single buyer, usually the transmission company or Transco.

   It is important to note that “Competition for the market” and “Competition in the market” are distinctive terms. In the latter, the competition starts in setting up generation capacity, which is in turn tied up in long-term PPAs and in “Competition for the market”, the capacity thus built is limited in terms of fostering “Competition in the market”. Fostering “Competition for the market” and “Competition in the market” is dealt by wholesale competition and retail competition explained as below.

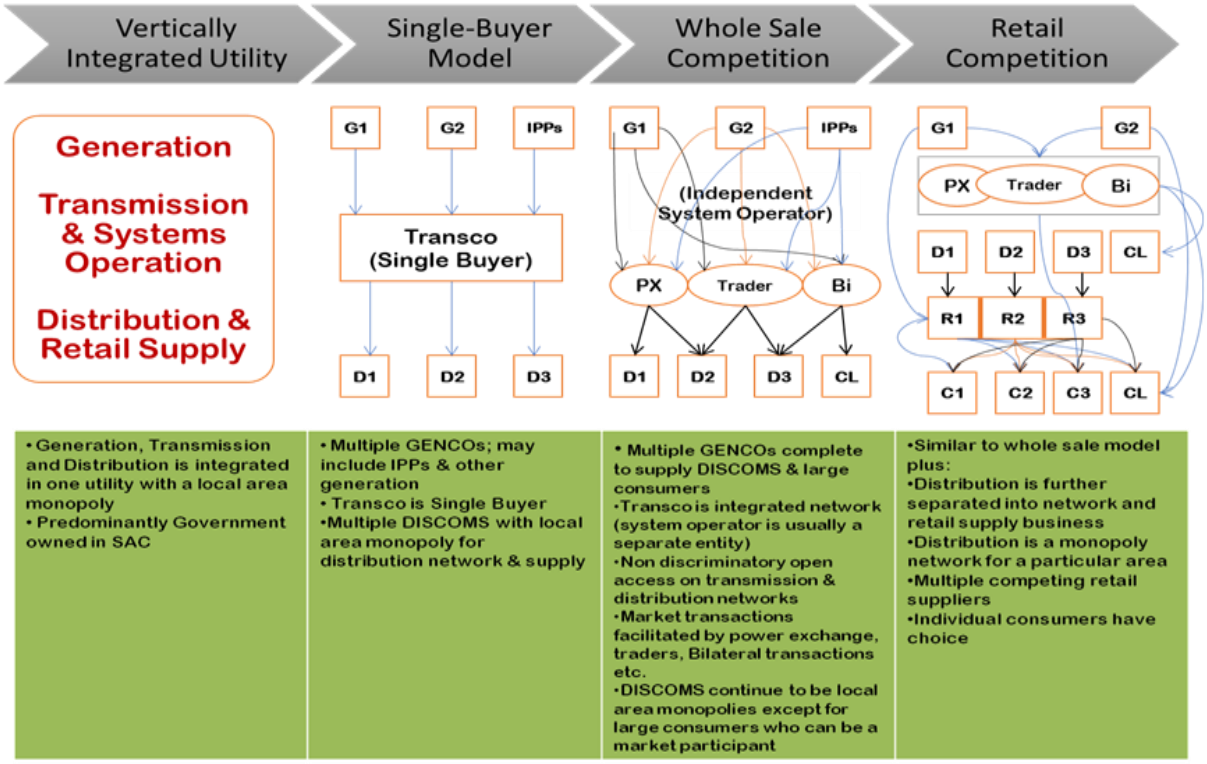


Illustration 1: Types of Power Markets[1]

Note: G: Genco, D: Distribution Company, IPP: Independent Private Producer, B: Bilateral Trader, R: Retailer, C: Retail Consumer, CL: Large Consumer (typically > 1MW)

c. **Wholesale competition:** The wholesale competition model is where the distribution companies (DISCOMs) compete with independent power generators to provide electricity to large industrial customers by way of cost-effectiveness and reliability. The necessary conditions required for the wholesale competition are non-discriminatory open access on transmission networks and independent system operator/ load dispatch centre.
d. **Retail competition:** The retail competition model enables all consumers, regardless of size, to have customer choice. This necessitates the separation of carriage and content i.e., the distribution wires business (which is a monopoly network and thus regulated) from the supply business which is competitive and non-discriminatory open access on distribution networks.

As markets develop and mature, markets for ancillary services for frequency regulations, spinning reserves, reserve shutdowns and black stars are introduced. Power exchanges are also referred to as Power Pools in some parts of the world.

1.1 Functioning of Power Exchange-driven Power Markets

A power exchange facilitates buying and selling of electricity. Also, power exchanges facilitate power markets to function more effectively by enabling buyers and sellers to trade in various segments of the market, ensuring price determination purely on market forces displayed by demand and supply dynamics, providing a balancing mechanism as well as an imbalance settlement. While it is true that

[1] ASCI

power markets can function in the absence of exchanges, power exchanges enable power markets to function more effectively by fostering “competition in the market”.

Power exchanges foster the development of more complex power markets such as spot markets, forward markets, real-time markets and enable market participants to use various risk management tools through futures or derivative markets. Thus, a modern power exchange framework provides a fair, efficient, robust and quick price discovery process across several market segments, creating an orderly market for all buyers and sellers.

Power exchange is not just confined to electricity trade but also facilitates the trading of other instruments like Renewable Energy Certificates (RECs) and Energy Efficiency Certificates (EECs). RECs are designed to facilitate the obligated entities to meet their Renewable Power Purchase Obligations (RPPO) without buying actual renewable power, which is set to meet a country’s RE targets as part of its climate change goals. EECs facilitates financing energy efficiency in energy-intensive industries through which it primarily compensates the EE measures in the industry by funding from industries who only want to meet the “obligation”.

Power exchanges may be expanded to cover other energy markets such as gas markets. In most countries, power exchanges are a voluntary platform and the proportion of transactions through the power exchange compared to total transactions varies and depends on:

a. Legacy obligations through existing PPAs;
b. The price differential between prices quoted on exchange vis a vis regulated prices;
c. Network availability; and
d. Policy and regulatory support to facilitate power exchange transactions.

1.2 Context of Study and Its Relevance to SAARC Countries

The power sector in the SAARC region, as a whole, is dominated by public sector government entities. Some private entities in generation viz. IPPs, also exist and are secured by long-term bilateral PPAs. Currently, it does not have mature intra-regional power markets and a strong inter-regional power market. As the sector evolves, it is important to facilitate short term exchanges of electricity as a first step towards introducing power markets. NPEXs in the SAARC Member states would enable buyers and sellers of electricity to interact and arrive at a market mechanism for price discovery. At this juncture, when the world and the region are undergoing an energy transition and are moving towards renewable sources of energy, it is important to put in place mechanisms to facilitate market growth in the power sector that would move the sector to optimal outcomes in terms of prices and fuel mix. Thus, a handbook on NPEXs would facilitate such a development.

The handbook will enable individual SAARC countries to articulate legal, policy, regulatory and technical prerequisites for fostering power markets and setting up an NPEX. These requirements can be dovetailed into national energy plans and the strategy for power market development plan. The handbook sets out the appropriate design for an NPEX to enable each country to plan for the short, medium or long-term, and assist in setting up such an exchange. This in turn will foster cross border trade and enable the South Asia region to make efficient use of its collective energy resources leading to an overall reduction in unserved electricity.

In the SAARC region, India has already framed the guidelines on CBET which allow SMS to participate in the Indian power exchanges for Term Ahead Market (TAM) contracts, Day Ahead Market (DAM) contracts, Intra Day contracts (to address contingency requirements). The guidelines also mentioned that other categories of contracts may be included based on review by the Ministry of Power, India in consultation with the CERC (Ministry of Power, 2016). Thus, establishing NPEX in each SMS will pave the way for integration at the regional as well as global level.

1.3 Rationale & Objective of the Handbook

The overall objective of the proposed study is to provide a step-by-step guide, with a clear rationale and detailed requirements, to help each SMS in establishing NPEX. This handbook attempts to cover the following aspects:

a. A detailed step-by-step guide for development, operation and management of NPEXs;
b. Technologies & processes involved, roles and responsibilities of parties, resources and their management;
c. Directions for the development of NPEX.

On the premise that SMS would be exploring ways of designing and fostering power markets in their respective countries, this handbook will help as a ready reckoner to facilitate the setting up of NPEXs which would enable the power market to function efficiently and transparently.

The handbook analyzes the current electricity markets, outlines the existing gaps and states the necessary prerequisites for setting up the NPEXs in terms of legal, policy, regulatory and technical requirements for each country. The handbook is a ready reckoner in providing a detailed step-by-step guide for the development, operation and management of NPEXs. The handbook would thus be a useful guide to policymakers and in the planning of the power sector in the SMS.

1.4 Approach and Methodology

The handbook on Setting up NPEXs in SAARC will be confined to the eight-member countries namely Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan and Sri Lanka. However, CBET will be examined to the extent that NPEXs can facilitate or support CBET or a regional exchange, should one be established in the near future i.e., within five years.

The approach to this study is based on the specific pillars of research & consulting namely:

a. Strategizing, identifying key components, protocols for the study and being aware of the context of the study.
b. Conducting exhaustive data collection, on underlying conditions in each SMS on the power sector, power markets and relevant legal, policy and regulatory framework.
c. Focus group discussions, with respective country stakeholders for primary inputs which are not documented in channels available to international audiences, insights and understanding the status of the country's preparedness.

1.4.1 Parameters Considered for the Study

The preparation of the handbook was based on several key parameters and data thereof. The data against identified key parameters were compiled through primary and secondary sources. The identified parameters are presented as below:

a. Structure of the Power Industry
    a. Legislative Bodies/ Ministry(ies) having jurisdiction;
    b. Regulatory Bodies;
    c. Jurisdiction (Federal/ Concurrent/ Provincial);
    d. Government Departments/ Boards/ Companies;
    e. Existing Legislation;
    f. Hierarchy Structure;
b. Supply Side
    a. Installed Capacity including Renewable Energy;
    b. Power Generation by source including RE;
    c. Generation tariff determination;
    d. Capacity Addition targets (conventional and RE);
c. Demand Side
    a. Distribution & Retail Supply ownership;
    b. Electricity Consumption – category wise – Domestic, Industrial, Commercial etc.;
    c. No of large consumers > 1 MW connected load;
    d. Total volume of consumption by large consumers;
d. Supply Demand Position
    a. Energy requirement/ Availability/ Surplus or Deficit;
    b. Peak demand, Peak met and Surplus/ Deficit;
e. Other Details
    a. Any other information key to assessing preparedness to set up power exchange;

1.4.2 Questionnaire Design

Primary data was collected and collated through the process of stakeholder interaction and the questionnaire designed for the purpose. The questionnaire is designed in two tiers:

a. Tier 1 is addressed to countries who are at the nascent stage of market development and perhaps, yet to formalize any initiative to design competitive power markets and thereby a power exchange.
b. Tier 2 is addressed to countries who already have power markets or are at more advanced stage in formulating power market design including the establishment of a NPEX.

The draft questionnaire is placed in **Annexure – A**.

1.4.3 Stakeholders and Interaction

Stakeholders in SMS comprise government officials (relevant departments or ministries), regulators, company or department executives and think tanks. Further virtual stakeholder consultations were held to understand the actual status of the country in terms of readiness in having a NPEX pertinent to the study.

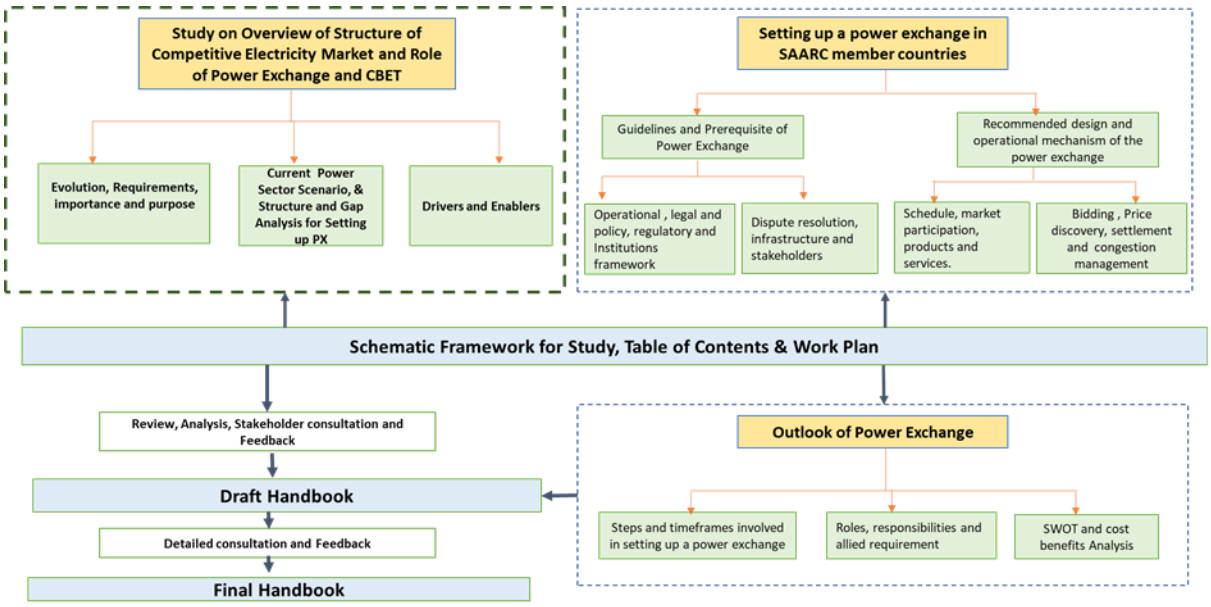


Illustration 2: Approach & Methodology for the Assignment

1.5 Limitations and Assumptions

The handbook is prepared by analyzing the current electricity markets and it outlines the existing gaps and states the necessary pre-requisites for setting up the NPEX. The assumptions made during the study and limitations are deliberated as below.

a. Approach & Methodology: The approach was designed based on the Indian experience. The team has also studied the characteristics of other power exchanges while making recommendations. The flow of the study, approach and methodology is also defined based on the understanding of the region and is built on the premise that the SMS share common socio-economic conditions and a common path of development and maturity in the sector.
   The pre-requisites required for setting up an NPEX were deliberated based on the learning curve experienced by India, with broad classification in terms of legal, policy, regulatory and technical requirements for each country. The pre-requisites were determined based on the hands-on experience of IEX and ASCI.
b. Data Availability: The analysis is done only for the information available in the public domain and based on the understandings from the focused group discussions with the country stakeholders.
c. Recommendations: The handbook is intended to be a ready reckoner in providing a detailed step-by-step guide for the development, operation and management of NPEXs. Each country is requested to do its own diligence on the frameworks and provisions when intended to setup an NPEX.

Chapter 02. Power Exchanges: Required Conditions, Global Experiences & Recommendations

In this chapter, the overall legal, policy and regulatory requirements have been identified taking into account, the various contours of setting up of power exchange and the essential market enablers required to achieve the desired objective of the power exchange.

The basic objective of power exchange is to rationalize prices by bringing efficiency through competition in the wholesale market of electricity. The role of power exchange depends on the market model. While there is no possibility of power exchange in a vertically integrated market, it plays an important role in liberalized energy markets. Power exchange has many functions in liberalized energy markets:

a. It enhances competition in the sector and ensures the quality of supply;
b. It provides a distribution channel for electricity producers;
c. It provides efficient and transparent price signals for investors;
d. It increases the security of supply for electricity wholesalers, retailers, and large end consumers;
e. It can also provide a marketplace for transmission capacity;
f. It can provide a pricing mechanism for both electricity and transmission capacity; Wholesale market may exist without electricity exchange however; it may lead to the absence of a reliable price index;
g. It facilitates the transfer and management of risk;
h. It increases the liquidity and transparency necessary for the efficient functioning of electricity markets.

The efficiency of markets depends on various factors. The most critical factor is liquidity in the market, as liquidity is the driving force behind competition and efficiency. Power exchange provides a platform for electricity trading that may not require a very complex legal and regulatory framework. However, bringing liquidity i.e., buyers and sellers on the platform requires various legal, policy and regulatory measures. Generally, these measures are executed gradually as they require major structural reforms involving huge capital.

Most of the countries in the region have a legacy structure as far as the power sector is concerned. The power sector has historically been dominated by public ownership with greater relevance for vertically integrated monopolies that generate, transmit and distribute electricity to consumers. While this has been a common feature across most of the SMS, systematic efforts were taken, as far as the approach to introducing competition is concerned. For example, the opening of the sector to competition in India has led to increased trading activities. This was supported with significant policy and regulatory reforms that reduced entry barriers and enabled open access to transmission & distribution networks. Recognition & Licensing for trading activities and setting up power exchanges have led to the creation of a competitive environment.

2.1 Contours of a Power Exchange

Electricity is a commodity and can be traded with various approaches. Globally, several tested approaches are followed and explained as below.

Electricity can be traded physically Over The Counter (OTC) or through power exchange. Power exchange is an organized venue to trade and transact the delivery of electricity. Contracts that are settled physically can be short-term contracts (spot contracts) or long-term contracts (forwards or other long-term contracts). The spot market is the market for exchange-traded short-term electricity contracts that are settled physically. There is a day-ahead market catering to each hour of the next day. Also, there is an intraday market enabling market players to balance their positions ahead of physical delivery.

All power exchanges across the globe have some common features as listed below:

a. Authorization to operate: A power exchange is a corporate body that operates an electronic marketplace for the trading of electricity in accordance with the approval granted by the Regulator/ Government.
b. Members & Clients: To access the power exchange platform for buying and selling electricity, an entity needs to be registered as Member or Client with a power exchange.
c. Contracts: The exchange provides standardized contracts for transactions on its platform, as approved by the Regulator/ Government.
d. Bidding: Buyers & sellers place their offers & bids with price, quantity and period in a pre-defined auction window. These bids are placed electronically using the internet.
e. Price discovery & matching: Based on the demand-supply curves, the price is discovered, and bids are matched as per the contract through a software-based algorithm. This matching is subject to the availability of transmission capacity, as provided by the system operator.
f. Delivery: The matched quantity is scheduled and both buyers and sellers are supposed to follow the schedule in their consumption and generation pattern for the specified time of the trading day. The scheduling is carried out by the system operator based on the application of power exchange. Once a quantity is scheduled, it is considered as deemed to be delivered.
g. Imbalance Settlement: Any deviations from the schedule for physical delivery of power are dealt in accordance with the mechanism by the system operator. This mechanism is operated outside the power exchanges. However, this mechanism is necessary to maintain the sanctity of the schedules given by power exchanges.
h. Clearing and Settlement: A power exchange acts as a counterparty to each transaction on its platform i.e., it acts as a buyer for every seller and seller for every buyer. It ensures to collect funds from buyers and make payments to each seller for the scheduled quantity promptly as per the contract. This process is called clearing and settlement. The clearing and settlement function is executed by power exchange through its empaneled clearing banks.

There are a few pillars on which power exchanges across the world have been created and have become preconditions to facilitate the development of power exchange.

Table 1: Power Exchange Development Pillars

Power Exchange Development Pillars		
Pillar 1	Competition and market signals	Response to market signals in a competitive environment from participants tends to promote better outcomes for participants and end consumers.
Pillar 2	Competitive neutrality	Markets that are technology-neutral and do not favour one technology or business model over another, show cost efficiency and promote innovation.
Pillar 3	Clear and durable rules	Markets that are durable across a range of credible future scenarios, and set clear and consistent rules, provide participants with the confidence to make decisions.
Pillar 4	Information asymmetries	For competitive markets to work as intended, market participants need accurate and timely information to make decisions. Without this, they may not be confident that they are competing on a level playing field.
Pillar 5	Cross-market integration	Costs to consumers will be minimised when markets complementary to energy, such as ancillary services and emissions, are formulated in line with the price discovery mechanism for electricity.

2.2 Prerequisites for a Power Exchange

The policy framework for setting up a power exchange requires interventions in the complete supply chain of electricity, which is outlined as under:

2.2.1 Policy

The policy framework provides a set of principles and long-term goals that form the basis of making a legal and regulatory framework, to guide the planning and development of the sector. The specific policy interventions required for the functioning of power exchanges in a country are listed below:

a. Promotion of non-discriminatory Third-party access (open access) to transmission and distribution infrastructure: The end-user should be able to choose his source of supply from available suppliers; such choice in the market creates competitiveness. The fundamental enabler to create such competitiveness is the ability of the end-user to source his power using the “wires” through open access. Therefore, it is a pre-requisite to creating an environment for non-discriminatory open access to the transmission and distribution networks to foster competition.

c. Multi-Buyer Multi-Seller Model: A large number of buyers and suppliers is an important precondition to have an efficient marketplace for power exchange. If the number of participants in a market is large enough, no parties can control a large proportion of production and consumption. In other words, suppliers who ask for more than the market price and consumers who offer less than the market price can simply be ignored as they can be easily replaced by other participants in a perfectly competitive market. However, if the number of participants is not large enough, there might be some producers and consumers that can control a sizeable share of the market to exercise market power.
d. Unbundling of Utilities: Ownership separation between generation, transmission and distribution eliminates the incentive to discriminate. Alternatively, the operational separation of transmission system operation from the ownership of transmission assets may also serve the purpose. To develop effective electricity markets, the operation of the transmission network needs to be effectively separated from the potentially competitive activities (e.g., generation & distribution)
e. Promotion of competition in Generation, Transmission & Distribution: Markets can work to the benefit of consumers only if the market has been structured to be competitive and the marketplace is efficient. When markets are not competitive, or the marketplaces are not efficient, they do not work to give the cheapest and the best results for consumers. Competition can only be ensured when there is demand and supply-side responsiveness from the stakeholders. The market must work competitively and, in a state, where the supply must match the demand. Market equilibrium happens at the point where the supply price offer matches with the demand bid viz. market-clearing price. The power procurement structure of utilities must be purely based on economic consideration rather than just security of supply consideration. There must be room for utilities to procure power from the open market for a short-term period. If the total demand of utilities is met by long term PPA then there may not be sufficient liquidity in the power exchange to operate.
f. Promote Trading of electricity: For the success of power exchange, it is essential that a clear policy direction to allow trading in electricity should be rendered.
g. Promotion of merchant Generation capacity: Having multiple buyers and sellers participating in the trading is essential for efficient power exchange. A generation station without PPA may sell on the power exchange, therefore, it is essential to promote merchant generation capacity to enable liquidity in power exchange.

2.2.2 Legal

The effective/ successful implementation of a policy depends on a strong legal framework. Across the globe, the electricity laws ensured a strong legal framework to bring innovative practices to introduce competition in the sector. Taking a cue from global practices of development of legal framework the following legal support is drawn to set up a power exchange, the legal support required to set up a power exchange is as follows:

a. Establishment of Independent Electricity Regulator: Electricity, being a public good, a tremendous amount of electoral pressure is exerted on the government thereby influencing the regulatory and policy development in the sector. Therefore, the presence of an independent and autonomous body to regulate the sector has been considered vital

towards enabling a competitive landscape. The presence of a regulatory commission also allows for better coordination between countries to undertake harmonization of regulations to support regional trade. In addition to the determination of Tariff, the regulators may also be mandated to facilitate the development of the market in electricity including power exchanges.

The reforms can be implemented successfully only if an effective and fast dispute resolution mechanism is provided to stakeholders. There should be an enabling framework to resolve and settle disputes. Electricity regulators can also be provided adjudicatory power to resolve electricity-related disputes in a fast and time-bound manner. Tribunals dedicated to electricity may be set up for handling appeals.

b. Establishment of a System Operator: The system operators have a very important role to play in the electricity trade as they have to identify the transmission capacities available for the transactions executed at power exchanges and also to handle any imbalance in the system.
c. Mandatory Third-Party Access to Transmission & Distribution Infrastructure: Competitive power market needs non-discriminatory 'right-to-use' of the physical electricity network. With most South Asian countries still operating under a single buyer model, enabling access to the transmission network will allow the distribution companies (bulk buyers) in choosing their suppliers and allow generators to sell their electricity to parties other than the single designated buyer thereby promoting competition. Similar access to the distribution network will give the end consumers the choice to enhance market participation and induce greater competition. It is often experienced that the Transmission and Distribution (T&D) utilities are not willing to give access to their network due to various reasons. Therefore, to foster competition, it is essential that an obligation should be cast on the T&D utilities to provide hassle-free access to its wires.

   Though open access to all end-users is an ideal scenario, the regulators and utility may not find it feasible thereby restricting open access. It may hamper participation at power exchanges. Therefore, considering technical and commercial feasibility, minimum threshold eligibility based on a load of an entity (say 1 MW) may be specified for availing of open access. The regulators may allow open access below such threshold also but beyond such threshold, open access should be provided mandatorily. The law should provide a mandatory determination of charges and losses for open access by regulators. It helps players of power exchange to take an informed decision.
d. Recognizing and Licensing Trading Activity: Electricity trading is required to be identified as a business activity under the electricity laws of the respective countries for enabling the market entities to trade in electricity. Thus, it is a fundamental necessity to start trading activity in a country. The transmission and distribution businesses are natural monopolies. To ensure non-discriminatory open access to the system of these utilities, regulatory governance is essential through licensing. Traders are the potential link between buyers and sellers; therefore, they are essential to bring liquidity and competition in the wholesale market. Licensing ensures the right of consumers to choose their suppliers.
e. Licensing (Legality) and functions of Power Exchange: The law should recognize power exchange as an entity and its licensing conditions. It is also essential to specify functions to be performed by a power exchange. This is necessary to ensure regulatory certainty to attract investors for power exchange.

2.2.3 Regulatory

The regulatory framework should cover the regulations or sub-ordinate legislations framed by the regulators. These regulations should deal with the implementation of the law and policy at the ground level. The regulatory framework required to set up a power exchange is as follows:

a. Power Exchange Regulations: These regulations should cover the aspects related to registration, net worth requirement, ownership and governance norms, management, membership in power exchange, requirements relating to IT infrastructure and trading system, information dissemination, market surveillance, revocation of registration, salient features of contracts relating to price discovery, scheduling and delivery of transactions, settlement conditions, contract approval process, approval of bye-laws & rules of power exchange, grievance redressal of members and their clients over power exchanges among others.
b. Procedure for third party access (Open Access) and connectivity in transmission and distribution: Third-party access to transmission and distribution system is the most critical component in the operationalization of power exchange and therefore, the procedure to seek third party access need to be specified for transparent allocation of capacity in the T&D network.
c. Scheduling of electricity transactions: Provisions of scheduling and dispatching of electricity transaction needs to be made for the operations of power exchange. In case of real-time curtailment, provisions of treatment should also be laid down.
d. Imbalance Settlement Mechanism: The transactions on power exchanges are considered as deemed to be delivered. However, in real-time, electricity production and consumption depend on various factors such as generation or transmission outages, fall in demand due to temperature variation, specific social events etc. Owing to these reasons, the deviations from schedules given by power exchanges are inevitable and at the same time, it needs to be ensured that these deviations do not impact the security of the grid. Therefore, an imbalance settlement mechanism is required to disincentivize market participants to deviate from the schedules and incentivize the support to the grid. This mechanism is separate from the power exchange transactions, it only deals with the deviations by entities and settlement of such deviations by the system operator.
e. Transmission pricing & Wheeling tariff framework: Proper tariff framework for use of transmission and distribution systems is necessary for wholesale market development. Transmission pricing should be linked to the use of transmission system i.e., it should also be linked to losses and network constrained and should be fully recovered from charges applied to the network users. The tariff framework should promote uniform market development.
f. Dispute Resolution: The various procedures established by regulators are not foolproof and always evolving, and it is a matter of fact that all contentious situations cannot be envisioned beforehand. These eventualities essentially lead to disputes between market participants, which in turn reduce the efficiency of the market. Therefore, a dispute resolution system must be in place for an effective and quick remedy to market participants.

2.2.4 Technical

a. Economically reliable transmission network with sufficient capacity: In addition to the regular use of the transmission system, and an economically reliable transmission network with sufficient capacity is required for the functioning of power exchange so that each location accommodates power sourcing from generators outside the local network without any congestion to ensure competition. SMS must ensure that a well-functioning adequate transmission grid is in place before setting the stage for power exchange.
b. Accounting & Settlement System: Energy accounting with a robust clearing mechanism is mandatory for the efficient operation of power exchanges within the grid. Energy accounting involves book-keeping of long-term, medium-term and short-term transactions that were scheduled and dispatched; computation of energy delivered into the grid, energy withdrawn from the grid by the entities and total transmission losses in the grid. The energy account statements prepared by the load dispatch centre is required by utilities for billing and settlement of their transactions.
c. Metering Infrastructure: A time interval-based metering system would enable a credible settlement mechanism for intra-day or real-time power transfers from licensees with surpluses to licensees experiencing deficits. This would also facilitate third-party access to transmission and distribution systems, wheeling of captive generation and power trading among entities, thereby, reducing the penalties on generating and drawing entities due to imbalances/deviations.
d. Development of support infrastructure:
    i. Robust banking network with online payment facility: A power exchange need to pay in and pay-out funds on daily basis through banks. Therefore, it is essential to have a robust banking network so that participants can remit and receive funds from any part of the country.
    ii. Robust telecom network with good internet connectivity: All the information exchange of a power exchange with the banks, market participants and system operators are based on the internet. Therefore, it is essential to have good internet connectivity available with the market participants, banks and system operators situated in different parts of the country.

2.3 Steps Involved in Setting Up a Power Exchange

The role of the System Operator and the Regulator is required to be well defined to facilitate the setting up and smooth operation of power exchange. In this context, the roles of System Operator and Regulator are described below:

a. Role of System Operator: The system operator is an apex body to ensure the integrated operation of the national power system. The system operator performs scheduling and dispatch of electricity over inter-regional links by specified grid standards. The system operator is also the coordinating agency to ensure optimal utilization of the power system and manage the outage without compromising the grid security. The system operator also provides operational feedback and inputs to the transmission planning agencies, thereby playing a key role in optimum transmission capacity addition.

b. Role of Regulator: The regulator has various responsibilities to frame regulations, procedures and specify the roles and responsibilities of various entities in the value chain. For setting up a power exchange, the regulator frames the relevant regulations specifying the eligibility criteria, operational guidelines, compliances requirements, surveillance, and market monitoring rules. The regulator also specifies the transmission charges and transmission losses applicable on buyers and sellers participating in power exchange. The regulator specifies/ approves the business rules for the power exchange. The regulator specifies the roles of the system operator, buyers and sellers participating in the power exchange. The regulator may also specify the ceiling limit of the transaction fee charges by power exchange, or the transaction fee may be left unregulated in a competitive market.

After taking care of prerequisites for setting up a power exchange, the next phase is the establishment of power exchange. It is essential that the framework for setting up a power exchange should be established gradually with utmost care in the selection of the elements at each stage.

2.3.1 Step 1: Selecting the Structural Design Aspects of Power Exchange

In a competitive market, competition forces suppliers to submit bids based on marginal costs. In a power exchange design, the most critical decision points requiring close examination are:

a. Single vs Multiple power exchanges: Power exchanges work on the principle of liquidity, which requires multiple buyers and sellers. At the same time, it needs to be ensured that the power exchange itself provides competitive services. Single power exchange has its advantages of ease of operation, good coordination with the system operator, the concentration of liquidity, single price, ease of allocation of transmission capacity etc. At the same time, it has disadvantages like it does not promote service efficiency or innovation in-market products, and may result in low customer satisfaction etc. On the other side, multiple power exchanges upkeep service level, innovation in products, and induce efforts for liquidity and investment etc. The decision should be commensurate with the local conditions of the country.
b. Mandatory vs Voluntary participation: If participation in power exchange is mandatory, all the transactions need to be through power exchange. On the other hand, in the case of voluntary participation, a buyer or supplier may carry out bilateral trading with or without some trading through power exchange. The advantage of voluntary participation in power exchange is that impact of price fluctuations[2] may be cushioned, to some extent, by negotiated bilateral trading taking place simultaneously. Further, prices of negotiated bilateral trading also act as a check on prices discovered in power exchange and vice versa. On the other hand, when supplies to power exchange are expected to be limited, which is the case in most SMS, mandatory participation may help in improving liquidity and reducing price fluctuations. Also, if it is mandated that cross-border trading will have to be

[2] Electricity price is inherently volatile due to ever changing supply and demand on momentarily basis as well as its dependence on many factors such as weather, time of day, system constraints etc. Such price fluctuations are more common in spot markets.

through power exchange, the complications of assigning transmission capacity to power exchange could be avoided.

c. Double side bidding vs Supply-side bidding: In supply-side bidding, only suppliers submit their offers to supply various quantities of electricity with corresponding prices. This type of design is usually adopted where centralized dispatch is in vogue. The demand is assessed by forecasting and it is price insensitive. One variant could be that buyers may be asked to submit their demand bids with price caps. Offers of all suppliers are aggregated to arrive at the Aggregate Supply Curve (ASC), which is a typically upward sloping curve (which means that suppliers are generally willing to supply higher quantities at higher prices). The Aggregate Demand Curve (ADC) is a steplike function with various steps appearing at the price caps indicated by individual buyers. Figure 1 depicts price determination in case of supply-side bidding without price cap while Figure 2 depicts price determination in case of supply-side bidding with price cap specified by individual buyers.

   On the other hand, in the case of double-side bidding, buyers also submit their demand at various prices. This means that in double side bidding, the buyer's demand is sensitive to prices. Double side bidding is more suited for markets where decentralized dispatch is in vogue. Figure 3 depicts price determination in the case of double-side bidding wherein the price is determined at an equilibrium point.

   The decision to adopt the type of bidding depends on the criterion of whether it is mandatory to meet demand irrespective of prices or the demand should be sensitive to prices. The latter option makes more commercial sense.

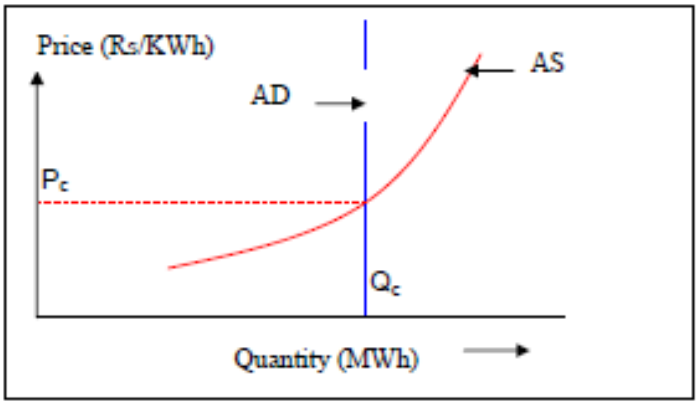


Figure 1: Price determination in case of supply-side bidding without price cap[3]

[3] IEX

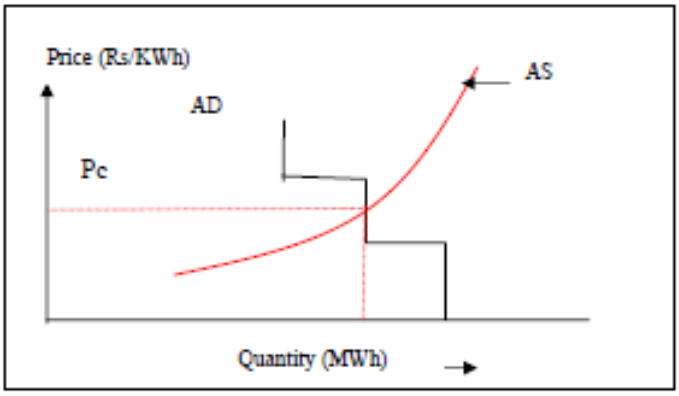


Figure 2: Price determination in case of supply-side bidding with price cap[4]

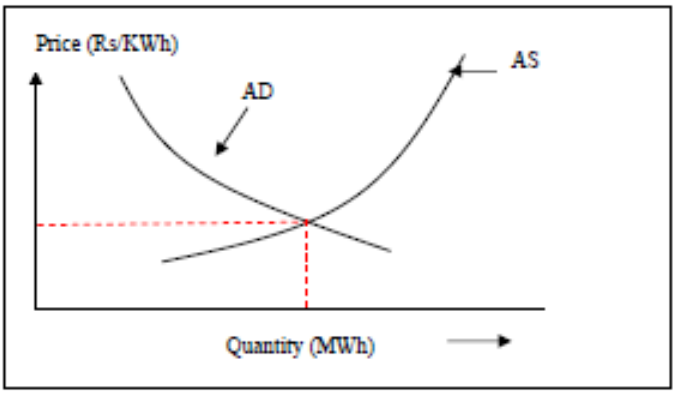


Figure 3: Price determination in case of double-side bidding[5]

d. Uniform pricing vs Discriminatory pricing: In the uniform pricing method, the clearing price and clearing volume of electricity corresponding to the point of intersection of the ADC and ASC as depicted in Figure 3. All the suppliers are paid based on the clearing price, irrespective of their offer. This means that price is set by the last accepted offer of supply. In the alternative approach, referred to as discriminatory pricing or the "pay-as-bid" method, each supplier is paid as per its bid. Each buyer pays a price, which is the weighted average of the price for all suppliers cleared by the power exchange.

In uniform pricing, suppliers are likely to submit their offers based on marginal cost. This is so because most of the suppliers are aware that the clearing price will be higher than the offer submitted by them and the difference between clearing price and offer price will set off their fixed charges.

On the other hand, in case of discriminatory pricing, the suppliers are likely to submit bids based on the average cost, covering fixed expenses as well. It is possible that in the case of "pay-as-bid" pricing, each supplier quotes prices that are not based on its costs but based on the anticipated clearing price of the marginal supplier. Such discriminatory pricing may lead to a higher price level but less volatility as compared to uniform pricing. In the case of a uniform pricing model, the chances of collusion or market manipulation are minimal, as this is an unconcentrated market (i.e. if there is liquidity in the market and there are multiple buyers and sellers). Further, since the buyers and sellers are unaware of the Price

[4] IEX
[5] IEX

and Volume bids of other participants, both buyers and sellers bid their best rate. On the contrary, in the “pay-as-bid” model, the sellers are aware of other sellers’ quantum and price and hence the seller would bid the rate to become L1 (bidder with lowest financial quote) in the lot. Thus, the chances of non-discovery of the most efficient price would be higher in the pay-as-bid model. Most of the power exchanges across the world work on the principle of uniform pricing.

Further, to ensure fair trading and genuine price discovery, a market surveillance system is put in place. The market surveillance committee is generally headed by an independent director of the power exchange board and power exchange sets up a market surveillance department, which is entrusted with the following responsibilities of analysis of the bidding patterns and transactions of participants:

i. Open position by clients;
ii. Pattern of transactions of members of power exchange over a specific time period;
iii. Daily, weekly, monthly volatility analysis of prices;
iv. Dominant participant and market concentration: The HHI (Herfindahl-Hirschman) Index is used as an indicator for market concentration. HHI below 0.01 indicates a highly competitive market, HHI above 0.25 indicates a highly concentrated market and HHI in between indicates moderate concentration; (Central Electricity Regulatory Commission, 2020)
v. Circular trading monitoring explanation: A fraudulent transaction to buy and sell the same quantity of a contract, at the same price and same time, without actual change of ownership. Generally, to avoid circular trading, each transaction is settled physically and there is no change of title or ownership of the transactions after it is cleared at exchanges;
vi. Analysis of sudden high transaction volumes or sudden increase in Open position of members of power exchange.

e. Time block for bidding (hourly/ half-hourly/ 15 min etc.): It is possible to have several variations in the bidding time blocks (i.e., the smallest period for which price - quantity bids are to be submitted) in case of the day-ahead market. The period could be a whole day, peak/ off-peak period, blocks of a few hours, one hour, half-hour etc. The smaller the time block, the better it will suit to take care of varying estimated demand. However, a smaller time block also means increased complexity for buyers and suppliers while submitting the bids as well as a large volume of data to be handled by the power exchange.
f. Products/ Contracts Type: A product can be thought of as a unique set of trading features – the most important of which is the delivery duration or period. A contract identifies the actual object of an order and a trade and can also be referred to as an instrument. 'Hourly' would be an example of a product: it is the product for which the delivery period lasts exactly one hour. Products have a trading unit i.e., MW and a trading currency of the country. Products also have a minimum and maximum contract quantity and a minimum and maximum price.
    i. Forward Contracts: In forward contracts, the delivery period ranges from daily, weekly, any day (as defined by the user), fortnightly, monthly, quarterly, and up to a year. The daily contracts for delivery in a calendar day are available on a rolling basis starting from T+2 day onwards. Here, "T” represents the trading day. Similarly, the weekly contracts will be available for calendar weeks from Monday

to Sunday, weekdays from Monday to Friday and Weekends from Saturday to Sunday on a rolling basis. Further, fortnightly, monthly & yearly contracts are also available on a rolling basis. Any day contract is a user-defined contract for "n" number of days. These contracts are traded on T-day for delivery from T+2 onwards as per the contract. The bid matching is done through a continuous auction mechanism or reverse auction depending on the contract type. In this contract, the buyers can place bids as per their requirements i.e., delivery can be from T+2 or T+3 and so on. Generally, in forwarding contracts, the delivery periods are kept T+2 and beyond as T+1 is covered in the Day-Ahead Market.

ii. Day-Ahead Market (DAM): In this market, the bidders place bids a day before the physical dispatch of electricity. The bidding quantity is defined in blocks of "n" minutes in a day and the day is divided into "24 X 60 / n" blocks. To participate in this market, the bidder firms up a price for every unit of electricity generated for the whole day. Bidders have a firm choice up to their price through hourly contracts or block contracts.

iii. Intraday and Real-Time Markets: To allow market participants to immediately resolve forecasting errors for their operating plans, intraday markets allow continuous trading almost until delivery. Trade orders can be placed at any time and are executed at once. A typical bidding process of Real-Time Market at IEX is described in Annexure – B for reference.

g. Scheduling & Dispatching: Procedures should be defined w.r.t applications made for scheduling of collective transactions by availing of short-term open access for use of the transmission lines or associated facilities with such lines on the interstate transmission system (CERC, 2008). A few of them are presented as below:

i. State utilities and entities proposing to participate through the power exchange should be permitted by the power exchange after the "No Objection Certificate" is received from the concerned system operator.

ii. Power exchange shall ensure that the necessary infrastructure for data exchange/communication with dispatch centres (At the national/regional/state level) is put in place prior to commencement of the operation.

iii. Power exchange shall furnish the interchange on various interfaces/control areas/regional transmission systems as intimated by system operator (Dcm Shriram Limited vs Rajasthan Electricity, 2020).

iv. The system operator shall check for congestion. If there is no congestion, the power exchange shall submit the results accordingly. However, system operator shall inform the power exchange about the period of congestion and the available bandwidth for scheduling of collective transactions on respective interfaces/control areas/transmission system during the period of congestion through that respective power exchange (Power System Operation Corporation Ltd. , 2011).

v. Power exchange shall ensure that scheduling request for a transaction is within the limits as intimated by the system operator.

vi. After getting the nod from the regional agencies for power system operation, the system operator shall convey the confirmation of scheduling of transactions to

power exchange. Concerned regional agencies shall accommodate the schedule of transactions in the respective inter-regional schedules.

vii. The individual transactions shall be scheduled by the respective system operator.

h. Congestion management: Some of the common methods used for handling congestion in the electricity market are:

i. Re-dispatch: In case of re-dispatch, the system operator issues suitable dispatch instructions to costlier suppliers, located in the area downstream of the congested corridor, to meet demand in this area.

ii. Explicit auction of transmission capacity: In this case, everyday transmission capacities of the congested corridors are auctioned first. The participants of the power exchange then take part in the auction for the supply of energy with transmission rights in hand. These transmission rights are available on a "use-or-lose" basis. Thus, if the transmission right holder gets supply less than what should be commensurate with transmission right, the unused transmission capacity is made available to other participants. This type of auction induces some element of uncertainty and therefore may not be favoured.

iii. Nodal pricing and market splitting: Nodal pricing and market splitting methods are based on the bundling of transmission services with electricity products. In the case of market splitting, the market is divided into two or more sub-markets with congested links acting as boundaries (Central Electricity Regulatory Commission, 2006). The clearing price for each sub-market is determined separately based on the ADC and ASC of each submarket taking into account limitations of flow over the congested corridor. In the case of nodal pricing, each node of the power system has a separate price depending on the cost of energy, cost of transmission including cost attributable to congestion and appropriate transmission losses. Thus, it is a limiting case of market splitting where each node becomes a separate sub-market (Central Electricity Regulatory Commission, 2006). It is generally recognized that the nodal pricing method is more efficient compared to other methods of handling congestion. However, it is also complex to implement. It also generates surplus funds due to the difference in the prices of different nodes.

iv. Locational marginal pricing: Locational Marginal Price (LMP) reflects the value of electricity at different locations, accounting for the patterns of load, generation, and the physical limits of the transmission system. LMP reflects the cost of serving the next increment of load. The generator with the lowest-cost offer available would serve that incremental megawatt of load. LMP differs generally among locations because transmission and reserve constraints prevent the next-cheapest megawatt (MW) of electric energy from reaching all locations of the grid. Even during periods when the cheapest megawatt can reach all locations, the marginal cost of physical losses will result in different LMPs across the system. The LMP has three components: energy, congestion and loss. The cost of congestion is inbuilt in the LMP, therefore, no separate treatment for congestion is required (ISO New England , 2021).

v. Transmission capacity allocation: The transmission capacity may be allocated through explicit or implicit methods as discussed above. The explicit method,

where power exchange or its participants participate in the transmission auctions, leads to sub-optimal utilization of the transmission capacity owning to the condition of 'use or lose'. Also, it will increase the landing price of electricity. In the implicit method, the transmission capacity may be allocated by way of reservation for power exchanges or based on the availability at the time of market clearing. In the former method, again the 'use or lose' will apply, however, the same may be avoided by way of allocating remaining capacity to other bilateral transactions or socializing the cost of remaining capacity within the users. This method has the advantage of less congestion in the Day- ahead market. In the latter method, the only disadvantage is that the market may face frequent congestion in case of inadequate transmission capacity.

i. Imbalance Settlement: Due to the nature of electricity, generators may generate more or less energy than they had sold & buyers may consume more or less energy than their supplier had purchased on their behalf and traders may buy more or less energy than they had sold (Ofgem, 2017). Such circumstances are regarded as being 'an imbalance' and the 'energy imbalances' i.e., the amounts of energy generated or consumed and not covered by contracts, have, in effect, been bought or sold from or to the national grid transmission system. Primary objectives of any Imbalance settlement mechanism should be to:

    i. Maintain the grid frequency to normal;
    ii. Restore the grid frequency within the allowable band;
    iii. Relieve congestion in the transmission network.

    To ensure a level playing field for all sector participants, it is important to devise an imbalance settlement and energy accounting framework. Since most SMS have a monopolistic structure, there are no penalties associated with imbalances arising out of variation in injection by generation and draw against the schedule. The presence of such a mechanism is also essential to ensure grid security.

    Demand supply match in line with frequency management leads to the balancing of the system. Supply/ demand balance and the system frequency are affected by various factors. Balancing can either be done by controlling small mismatches between load & generation or by making up for generation deficiencies if there is a loss of huge generation.

    Under the imbalance settlement mechanism, deviation or imbalance in actual generation from scheduled generation and actual draw from scheduled drawl can be settled through two possible mechanisms: frequency linked mechanism and ancillary services-based mechanism. The rate under the imbalance mechanism is linked to the grid frequency.

    The frequency linked imbalance mechanism works on the following principles:

    i. Enhancing the output capability of power plants linking with incentives; enables more consumer load to be met during peak load hours;
    ii. Generators are paid to back down during off-peak hours if the frequency rose above the specified levels (Andhra Pradesh State Load Dispatch Centre, 2011);
    iii. In the case of over-drawl, suppliers (distribution companies) pay at a higher rate during peak load hours, which discourages them from over-drawing further. This

payment goes to the beneficiaries which received less energy than was scheduled and acts as an incentive for assisting the grid in maintaining the load-generation balance, as well as compensation for energy paid for but not received.

The rate under the frequency linked mechanism can be linked with the day ahead market prices or the real-time market prices of the exchange.

The other mechanism to manage the imbalances could be through the ancillary services mechanism. A generating station or an entity having energy storage resource or demand-side resource, connected to a transmission system are eligible to provide ancillary service. This mechanism works on the principle that all grid-connected entities shall adhere to their schedule and deviation/ imbalance if any, shall be managed by the system operator through ancillary services and charges for such imbalances are linked to the cost of ancillary services utilized to balance the load. Further, the cost of ancillary services could be either declared by the system operator (through regulation) or as discovered in the ancillary service market.

2.3.2 Step 2: Finalization of the Broad Framework/Fixation of Responsibilities of Stakeholders

To kick off the process of setting up a power exchange, it is essential that all stakeholders of the sector are on board to implement the modifications required in the prevailing conventions. This objective can be achieved by initiating a discussion by way of a draft framework proposed by the government or regulator to establish power exchange in the country. The broad consensus should be achieved on the roles and responsibilities of the stakeholders and legal & structural enablers for setting up a power exchange. The broad consensus should, but is not limited to, include:

a. Role of Government: Setting up of power exchange is largely dependent on the incumbent government. Therefore, the responsibility of the government should be fixed regarding the creation of enabling laws and a conducive environment by policy interventions. The government will also be responsible for setting up institutional infrastructures such as Regulator and System Operator.

b. Role of Regulator: The Regulator shall be responsible to create regulations for the establishment of power exchange and all supplementary regulations for enabling transactions of power exchange. The Regulator will also be responsible for granting authorization and monitoring of power exchanges including dispute resolution if any.

c. Role of System Operator: power exchange transactions are compulsorily deliverable. The delivery of electricity is ensured through the scheduling process. Therefore, the system operator shall be responsible to establish the scheduling process, energy accounting and management of imbalance settlement for deviations for schedules.

d. Role of power exchange: The entity setting up power exchange shall be responsible to arrange funding requirements and seeking approval from the regulator for setting up power exchange. It is also responsible to establish trading facilities and clearing and settlement of transactions in coordination with banks and system operators. It also regulates its members and clients through bye-laws and market rules.

e. Role of Sellers and Buyers: The role of sellers and buyers is the most critical element in the establishment and operation of power exchange as these entities are responsible for the actual transactions. To transact on power exchange, these entities will be required to incorporate flexibility in their process of selling & buying electricity and gear up their infrastructure and human resources for daily bidding at power exchange.

2.3.3 Step 3: Modifications in Existing Laws

As per settled roles and responsibilities, the government should endeavour to initiate the implementation of the framework by identifying the gaps in existing laws and incorporate required amendments by way of the legislative process. The laws should inter-alia include following enablers:

a. Establishment, functions, and powers of Independent Electricity Regulator;
b. Establishment, functions, and powers of System Operator;
c. Mandatory third-party access to transmission & distribution infrastructure;
d. Recognizing and licensing trading activity;
e. Licensing and functions of power exchange.

2.3.4 Step 4: Establishment of Regulatory Framework

The next step is to frame enabling regulations by Electricity Regulator. The regulatory framework should be comprehensive and clear for minimal disputes and smooth functioning of the market. The following regulations are essential for setting up and operations of power exchange:

a. Power exchange regulations;
b. Procedure for third party access (open access) and connectivity in transmission and distribution;
c. Scheduling of electricity transactions;
d. Imbalance settlement mechanism;
e. Transmission pricing and wheeling tariff framework;
f. Dispute resolution.

2.3.4.1 Transmission and Other Components of Pricing

Transmission is a common carrier, and its charges should be distributed among the users in a reasonable way, which ensures the market based economic signal. Like any other commodity or service, transmission prices should reflect its marginal cost. Efficient transmission pricing is essential to facilitate economic dispatch of existing generation capacity and delivery of electricity to consumers at its minimum cost. If transmission prices do not accurately reflect the costs of transmission, including transmission constraints, participants in the market will not be able to correctly determine whether those constraints are best addressed through expansion of transmission capacity or the installation of new generation capacity closer to the load. Some of the desirable features of a transmission pricing framework are listed below (S.K Soonee, 2012):

a. Economic efficiency through equitable sharing of the transmission charges between the transmission systems users, according to benefits derived;

b. Ensures that the planned development/ augmentation of the transmission system, which is otherwise beneficial, does not get inhibited;
c. Non-discriminatory between the customers buying or selling electricity at the same place and time;
d. Should not inhibit merit-order dispatch of generating stations;
e. Provides appropriate commercial signal for optimal location of new generating stations and loads;
f. Ensures that the owners of the transmission assets are fully compensated, and the compensation should not depend on dispatch decisions and actual power flows. Sufficient incentives to transmission system owners to enhance the availability of the transmission system should be provided;
g. Transmission charges should be known ex-ante and no retrospective adjustment.
h. Simple and transparent;
i. Dispute-free implementation on a sustainable basis.

2.3.5 Step 5: Proposal by a Company/Nominated Entity for Setting Up a Power Exchange

After the establishment of the regulatory framework, an entity who wishes to set up a power exchange or an entity nominated by the government may submit its proposal as per the power exchange regulations which inter-alia includes a business plan, net worth, human resource, expertise, resources, incorporation of company, shareholding etc.

2.3.6 Step 6: Bye-laws and Market Rules of Power Exchange

The Company/ Nominated Entity is also required to submit draft bye-laws and market rules of the power exchange which inter-alia contain:

a. Functions of Exchange
    i. Facilitate online transactions;
    ii. Regulate the functioning and activities of the power exchange members, their authorized persons, approved users, clearing house, clearing banks etc.

b. Powers to frame rules/ issue directions on:
    i. Transaction on the power exchange;
    ii. Risk management;
    iii. Clearing and settlement of transactions;
    iv. Setting up Settlement Guarantee Fund, and other funds.

c. Management of the power exchange Constitution and/or reconstitution of committees by Board to undertake various functions of the power exchange:
    i. Risk Management Committee (RMC);
    ii. Market Surveillance Committee;
    iii. Settlement Guarantee Fund (SGF) Management Committee.
d. Contracts: Trading days & hours, contract specification, delivery point, order management, treatment of transmission charges and losses, modification and cancellation of orders,

matching rules, margin requirements, transaction fee, Day-ahead market operations, delivery procedure, risk management system, surveillance.

e. Trading on the exchange: Trading system, clearing and settlement, margins, reports and accounts
f. Settlement Guarantee Fund: A fund is created by power exchange to deal with the default by any entity.
g. Membership of the Exchange
    i. Categories of membership;
    ii. Criteria for a power exchange member;
    iii. Membership application / admission fee /security deposit;
    iv. Grounds for expulsion or disqualification;
    v. Certificate of admission to membership of the power exchange;
    vi. Dealing with the client, member service charges;
h. Inspection and disciplinary actions
i. Conciliation and arbitration
j. Governing law and jurisdiction

2.3.7 Step 7: Grant of Authorization to Setup Power Exchange

Based on a proposal by the incumbent Company/Nominated entity in steps 4 & 5, the regulator after examination of the proposal grants authorization for setting up power exchange for a period as it may deem fit. Generally, such authorization is valid for 25 years.

2.3.8 Step 8: Software to Run the Operation

The online trading platform should be accessible to power exchange participants via feature-rich easy-to-use terminals, over a nationwide private network through Multiprotocol Label Switching (MPLS) leased lines and the internet over secure Virtual Private Networks (VPN). The electronic platform should be supported by in-house infrastructure and advanced technology, allowing fast trade execution, low latency, anonymity between counterparties, price transparency, prompt and reliable order routing, trade reporting, market data dissemination and market surveillance. Technology is a key component of operations and business strategy (IEX, 2021). Some of the desirable features of the software platform for running power exchange are provided below:

a. Robustness: Efficiently handles online bidding, bid matching, trading, scheduling & settlement of trades;
b. Security and integrity: Maintain the anonymity of bids, the integrity of the price discovery mechanism and implementation of risk management procedures;
c. Scalability: System must be able to handle any number of participants.

2.4 Associated resources and timeframes

Associated resources for setting up a power exchange are mentioned along with the rules in general also deliberated in the context of each country in the subsequent sections. The time frames vary from country to country based on the level of preparedness and constitutionality of electricity in each country.

2.5 Comparative study of select Countries with Power Exchanges

The region already has experience of the matured Indian power market and operational power exchanges in India to learn from. All the countries in the SAARC region have similarities in the form of socio-economic conditions and growth stories. India provides the most easily replicable model for SMS to adopt. The development of power exchange and the power market in India has evolved through a series of policy and regulatory reforms spread across more than two decades. The journey of India could be seen as an example for other SAARC countries to endorse various reforms in the power sector and gradually transition towards the development of a competitive power market.

Pre 2003, power sector in India had vertically integrated generation, transmission and distribution business within the state electricity boards having a single buyer model. The electricity contracts were mainly long-term contracts and had two-part tariffs. During this era, there were a lot of inefficiencies in the sector both in terms of operational aspects as well as financial performance. During this era, the generating stations were acting as a captive generating unit for the distribution companies. Further, there was no concept of open access.

In the year 2003, India enacted Electricity Act which was a landmark step to reform the power sector in India. The electricity act paved way for un-bundling the vertically integrated state electricity board, thereby, separating financial & operational accountabilities of the generation, transmission, and distribution business. The unbundling also created a multi-buyer and seller market. The Act also paved way for Open Access which is open and non-discriminatory access to the transmission and distribution system.

The Electricity Act recognised “Trading” as a licensed activity and trading of power was allowed. Further, the Electricity Act also paved way for the development of power markets and the Regulators were entrusted with the responsibility to promote competition and development of the power market.

Subsequently, driven by the enabling provisions under the Electricity Act 2003, the Central Electricity Regulatory Commission (CERC), came up with Open Access Regulations for transactions through power exchanges in 2008. India’s first power exchange (Indian Energy Exchange Limited) went live in June 2008 and in October 2008 India’s second power exchange PXIL went live.

To create a formal framework for setting up Power Exchanges in India, CERC came up with Power Market Regulation 2010. This Regulation puts in place the aspects related to setting up and operation of power exchanges in India. Further, this regulation also creates strong risk management and market surveillance mechanisms to ensure the transparent and fair operation of power exchanges.

The power exchanges began their operation through the launch of Day-Ahead Markets which also serves as a major market in today’s scenario. Subsequently, the exchanges launched Term Ahead Market which facilitates the trade of power for physical delivery up to 11 days.

Further for the trade of green attributes, the Renewable Energy Trading (REC) market was launched in February 2011. This market has helped power distribution companies (DISCOMs) and other obligated entities to fulfil their renewable purchase obligation.

Subsequently, with the large-scale addition of renewable capacities in India (installed capacity of non-fossil fuel-based generation > 40% of total capacities), a need was felt to create a market near term to the delivery. Therefore, in the year 2020, Real-Time Market was launched wherein the delivery of power is possible within almost 1 hour of bidding at the exchange.

The Real-Time Market has been helping the DISCOMs to a great extent to absorb the variable renewable generation by selling or buying power through Real-Time Market on an hour ahead basis. This has also reduced the cost of renewable energy integration and load balancing.

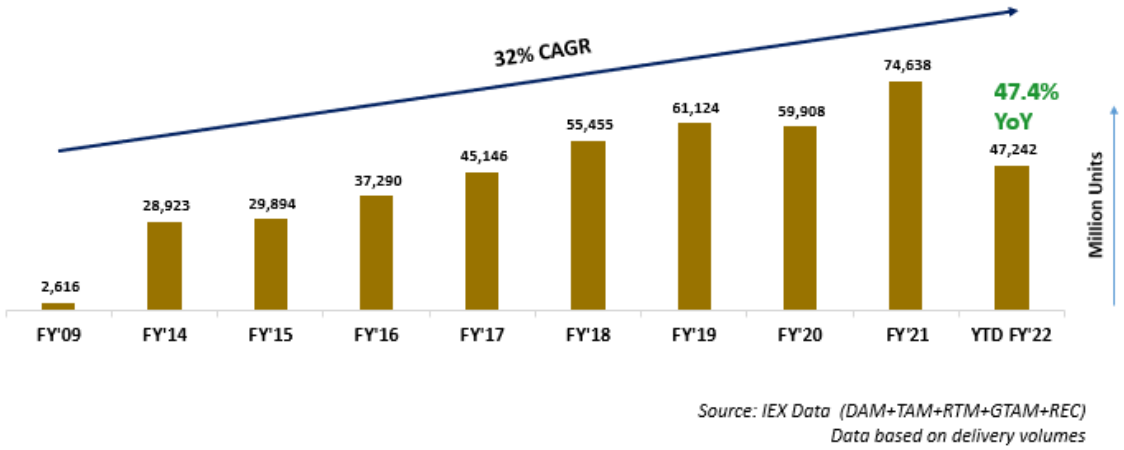
Further, In India, the majority of renewable generation is purchased through long term PPAs and the need was felt to create green markets for competitive trade of renewable power. Thus, Green Term Ahead Market was launched in September 2020 and this market has been well received by the participants. The renewable surplus states have been participating to sell surplus RE generation and the DISCOMs and commercial & industrial consumers are participating to fulfil their RPO (Renewable Purchase Obligation) targets in a competitive manner.

In order to further deepen the participation of renewable in the exchanges, Green Day Ahead Market was launched in the Year 2021. The Green Day Ahead market provides an opportunity to buy or sell renewable power on a day-ahead basis and the buyers get RPO benefits. This reduces curtailment of excess RE generation in states with surplus RE generation.

Further, it is expected few more products such as longer duration contracts, which shall facilitate delivery up to one year shall be launched shortly. Also, the derivative instruments for the trade of power through the spot market shall be launched which will help the market participants to hedge price volatility of the spot market and will further increase the share of market traded electricity.

Thus, the power exchanges in India have seen a long journey of evolution of policies and market dynamics and have grown over the decades. Currently, 6-7% of the total power consumption in India is purchased competitively through the power exchanges and Govt. of India has set a target that by 2024, the share of the power market to be increased to around 25%.

The journey of growth of traded volumes at Indian Energy Exchanges is as below:



Source: IEX Data (DAM+TAM+RTM+GTAM+REC)
Data based on delivery volumes

Illustration 3: Traded volumes of IEX in the last 9 years

In addition to detailed analysis and drawing learnings from India, a total of 13 Power Exchanges from outside the SAARC region have been studied to understand if any country's power exchange model can be replicated considering similarities with SAARC countries in terms of geographical area, size of power markets, a major source of power, geographic conditions, ownership patterns, seasonal variations in power scenario etc. Six number of power exchange equipped countries have been chosen that match with the SAARC countries. A brief account on the power sector of each country and the details of major power exchange in each country have been captured in the respective section. This chapter is only intended to draw inspiration for SMS to work towards enabling the power sector to adopt reforms in power markets and establish power sector irrespective of the size of transactions and size of the power sector. Though SMS would find the Indian story and transition more relatable and replicable, it is worth understanding the power sector and the working of power exchanges in other countries.

Table 2: Summary of Select Power Exchanges

Country	Major Elec. Source	Power Exchange	Traded Volumes (as on 2015)	Shortest Trade Unit	No. of Participants	Basis of Comparison
Netherlands	Natural Gas & Oil	APOWER EXCHANGE Power	-	Day + 1	180	Source of Power (Bangladesh)
Sweden	Hydro-electric power	NORD pool spot	23,946 MWh	Day basis	360	Self-production Capacity
New Zealand	Hydro-electric power	ASX	-	Monthly basis	-	Situation of Hydroelectric power in dry winters (Bhutan)
Hungary	Nuclear	HUPOWER EXCHANGE	25,235 GWh (2020) (HUPX, 2021)	Hourly Basis	105	Total Power Consumption (Bangladesh)
Croatian	Hydro Thermal	CROPEX	94.87 MWh	Hourly basis	28	Ownership (Pakistan)
Norway	Hydro-electric power	NORDPOOL SPOT	23,946 MWh	Day basis	360	Geographic and Major source (Nepal)

2.5.1 Netherlands

Despite its long interaction with water, the Netherlands has little potential for hydropower due to its flat topography. It uses natural gas, oil, coal, biofuels and waste, and small shares from nuclear, wind, solar, hydropower and geothermal for generating electricity. In total, 32,843.9 GWh were traded on the Dutch spot market (2019: 38,751.8 GWh). The short-term power market in the Netherlands has seen a healthy activity on the newly launched Intraday auction, with 36.0 GWh traded. Continuous trading rose by 29.9% on the year and reached 4,262.8 GWh. (EPEX SPOT Annual Market Review 2020, 2020)

Power companies in the Netherlands used to be bundled entities which owned the network and also sold the electricity till 1998. This resulted in discriminatory access of the network only to a few players, which resulted in an unfair disadvantage to the electricity retail companies. This situation was addressed by way of introducing the Electricity Act in 1998, which resulted in the restructuring of the sector. This legislation forced the separation of entities into electricity network companies and electricity supply companies. Despite of above efforts, the system operator and utilities enjoyed a monopoly position in the energy market and to regulate the companies an authority for Consumers and Markets was formed in 2013, paving way for efficient power markets and thus power exchanges.

Amsterdam Power Exchange (APX) is the major power exchange of the country. It was the first electricity exchange market in Continental Europe. APX Group is an energy exchange operating the spot markets for electricity in the Netherlands, the United Kingdom, and Belgium. Set up in 1999, APX has more than 180 individuals from more than 15 nations. In 2014, an all-out volume of 92TWh of energy was exchanged or cleared by APX. It also offers trade exchanging, focal clearing and settlement, and data distribution services just as benchmark information and industry records. (Gong Li, 2011). Some vital metrics on APX are provided as below:

Total Trade Volume (2014)	:	92 TWh
Products	:	Day-Ahead-Auctions, Continuous Intraday
EPEX SPOT's estimated annual revenue	:	Currently $36.8m per year

Bangladesh with over 250% of the geographical area as that of the Netherlands and with immense need & potential to increase its per capita electricity consumption and prospects for inter-country power trade, Bangladesh can relate itself with the Netherlands in having strengthen the power sector and can have power exchange.

2.5.2 Sweden

Renewable energy occupies the king's share in Sweden's electricity generation with 66%. Sweden's power exports exceed its power purchase from other countries making it a power surplus country. The country exports electricity to Norway, Denmark, Finland, Germany, Poland. Nord Pool Spot (Nord Pool AS) is one of the major power exchanges operating in the country.

Nord Pool AS is a European Power Exchange owned by Euronext and the continental Nordic and Baltic countries' Transmission system operators (TSOs). Nord Pool delivers power trading across Europe. Nord Pool offers day-ahead and intraday trading, clearing and settlement, data, and compliance, as well as consultancy services. More than 360 customers trade on Nord Pool today (Rishabh Abhinav, 2018)

Nord Pool delivers efficient, simple, and secure power trading across Europe. The company offers day-ahead and intraday trading, clearing, settlement, and associated services such as REMIT-reporting, power system and market data transparency and distribution services, and power market training, to its many customers and stakeholders, regardless of their size or geographic location (Europex, 2021).

Nord Pool is a key player in both the Single Day-Ahead Coupling (SDAC) and the Single Intraday Coupling (SIDC) European market coupling projects. In 2019, Nord Pool had a total turnover of 494

TWh of power traded. (Europex, 2021). 'Nord Pool ASA' replaced 'Statnett Marked AS' as TSO with Sweden and Norway transmission utilities owning 50%. This contributed to the unification of the two countries' electricity markets.

Nord Pool operates the Physical Markets in accordance with its Rulebook and is responsible for the Clearing of all Transactions in accordance with its Clearing Rules. Transactions concluded on a Trading System are automatically and mandatorily subject to Clearing in accordance with the Clearing Rules (Nordpool, 2017).

The Nord Pool markets are divided into several bidding areas. The available transmission capacity may vary and congest the flow of power between bidding areas, and thereby different area prices are established. When all customers have submitted their orders, equilibrium between the aggregated supply and demand curves is established for all bidding areas. System and area prices are calculated and published (Nordpool Group, 2021). Nord Pool offers day-ahead and intraday trading, clearing and settlement, data, and compliance, as well as consultancy services.

Pakistan with approximately 77% larger geographical area than Sweden and comparable total electricity consumption in a year, Pakistan can relate itself with Sweden in having strengthened the power sector and can have power exchange. Pakistan with huge prospects for an increase in per capita consumption of electricity and with huge potential for renewable energy can aspire to become a power surplus country and play a significant role in Inter-country power trade through exchanges.

2.5.3 New Zealand

Nearly 50% of the total electricity is generated from hydropower plants in New Zealand. The dry winter problem is the main concern and hindrance in the country's transition towards a zero-carbon economy as it depends heavily on hydroelectricity generation. With frozen water and the lower availability of other renewable sources of electricity, coal and gas are required to meet the winter electricity demands – a significant setback for New Zealand's climate commitments. New Zealand must continue to build and diversify renewable energy generation capacity for a range of climate conditions, along with long-term energy storage options such as hydrogen or pumped hydro storage.

Table 3: Particulars of Power Exchange of New Zealand

Underlying Commodity	Electrical energy bought and sold in a region of the wholesale electricity market operated by AEMO (NSW, QLD, VIC, SA)
Contract Period	Calendar quarters – March (H), June (M), September (U), December (Z). Calendar months contracts are also available
Settlement Price	The arithmetic average of the NEM final base/peal load spot prices during the contract period rounded to two decimal places. Provisional Settlement Price will be declared on the first Business Day after expiry and confirmed on the third Business Day after expiry.
Trading Hours	10:00 am – 4:00 pm (AEST) Block Trades may be agreed upon at any time except during the pre-open period (09:45 am – 10:00 am on exchange business days)

Underlying Commodity	Electrical energy bought and sold in a region of the wholesale electricity market operated by AEMO (NSW, QLD, VIC, SA)
Base Load Contract Unit	1 Megawatt of electrical energy per hour during the baseload profile (00”00 hours Monday to 24:00 hours Sunday (AEST)) bought and sold in a region over the contract period. The size (in Megawatt-hours) of each contract will vary depending on the number of days and baseload hours within the contract period
Peak Load Contract Unit	1 Megawatt of electrical energy per hour during the peak load profile (07:00 – 22:00 hours (AEST) Monday to Friday, excluding public holidays) bought and sold in a region over the contract period. The size (in Megawatt-hours) of each contract will vary depending on the number of days and peak load hours within the contract period.

ASX is one of the major power exchanges in New Zealand that deals with short-term power market contracts. Its futures and options are standardized contracts structured as cash-settled Contracts for Difference (CFD) against two grid reference nodes: Otahuhu (OTA) and Benmore (BEN) (Australian Securities Exchange, 2021). The contracts are termed as strips and each strip is made up of four consecutive electricity contract months in a particular region, traded at an average price. The price of each strip in the defined market window is the MWH-weighted average price of the quarterly futures contracts in the strip.

Bhutan can compare itself with New Zealand in terms of power sources, which are dominated by hydropower sources but faces difficulties during harsh winters. Though the electricity market size of Bhutan does not support an independent commercially viable power exchange, the country can explore participating in Indian Power Exchanges or neighboring countries’ power exchanges. Alternatively, it may explore the options of having an extension of one of the Indian Power Exchanges in Bhutan.

2.5.4 Hungary

50% of the electricity in Hungry comes from nuclear power plant followed by coal and other fossil fuels. Hungary was one of the EU’s most coal-dependent member states. Nuclear power shall remain to be the primary source of electricity for the country in the coming years but renewable is expected to grow as well. Hungary is shifting its focus to renewables as its principal power source and planning to phase out coal by 2030. The Hungarian government targets to generate 20 percent of their energy from renewable sources by 2030.

As an important part of the energy market liberalization in Hungary, the national TSO MAVIR has established the Hungarian power exchange (HUPX), a company limited by shares, as its subsidiary in 2010. HUPX Ltd. is the operator of the organized Hungarian spot power market with a leading position in Central and Eastern Europe. HUPX is licensed as a NEMO (Nominated Electricity Market Operator) by the National Regulatory Authority of Hungary (MEKH) (HUPX, 2021).

The trading at the Hungarian power exchange is done in standard hourly and block day-ahead electricity products. The next day's Hungarian power exchange market is part of the so-called 4M

MC market interconnection, which connects the markets of the Czech Republic, Slovakia, Hungary and Romania. The 4M MC is an ATC (Available Transfer Capacity) -based day-ahead implicit allocation process that seeks the greatest possible compatibility with the EU target model. The power exchange also practices a similar process of trading as that of India and other leading power exchanges in the world.

Figure 4: Process of Trading in HUPX

Hungarian electricity market as the plan of the learning curve, ventured into the free-market trade and transmission take place as close to each other as possible and created a new Intraday Market (IDM), which started operating on March 9, 2016. In order to increase the efficiency of Intra-Day Market trading, the Hungarian power exchange is participating in the XBID project, which joined the Single Intraday Coupling (SIDC) on 19 November 2019. This resulted in an immediate significant increase in the intraday volume of the Hungarian power exchange, with the generated trading volume in the first half-hour being approximately three times higher than on an average trading day of IDM prior to joining XBID.

Geographical area-wise, Bangladesh is 60% and Pakistan is 800% larger than Hungary, in terms of total power consumption, Bangladesh is around 30% and Pakistan is around 250% higher than Hungary. Pakistan and Bangladesh can relate itself with Hungary in having strengthen the power sector by enabling the features required for setting up of power exchange and enhance the efficiency of the power market in the country.

2.5.5 Croatia

Croatia is a European country situated in the Balkan region. As on 2020, the total installed capacity in the country is 4,999.5 MW, over 3,687 MW of the capacity, which is 26.27% is small hydro and renewable power (NEF, 2021). The remaining comes from thermal and nuclear power plants. Croatia does not have a nuclear power plant in its territory but co-owns a nuclear power plant in Slovakia. In 2004, Croatia has enacted a law allowing the customers to choose their preferred distributor. However, the state-owned largest power distribution company HEP is the largest distributor catering to both industry and households.

Croatian Power Exchange is the only power exchange in the country and is dedicated to facilitating electricity trading to the market participants in a safe, reliable and transparent way. Croatian Power Exchange acts as mediator/ clearing house between sellers and buyers of electricity and takes the risks of buying and selling electricity for all day-ahead and intraday trades concluded on the trading platform. It is equally owned by Croatian Energy Market Operator Ltd. and Croatian Transmission System Operator Ltd. Major particulars of Croatian Power Exchange are presented as below. Croatian Power Exchange primarily caters to two markets Day-ahead market and Intra-day market with a minimum trading lot of 0.1 MW and 0.1 Euro/MWh. In the Day-ahead market, the

Croatian Power Exchange accepts Hourly orders, Block Orders, Linked Block Orders, Profile Block Orders (Croatian Power Exchange, 2021).

Countries like Sri Lanka, Pakistan, Bangladesh have installed capacity significantly higher than Croatia. Considering the total number of consumers eligible for open access (as per Indian norms) the countries may have more than 30 customers (Participants in Croatian Power Exchange) who will be eligible for power exchange. The power sector structure of Croatia is similar to that of Pakistan in terms of ownership. The three countries can take a cue from Croatia to have a power exchange to cater to the needs of the power sector and increase the efficiency of the sector.

2.5.6 Norway

Norway is the country with the highest share of electricity coming from renewable energy in Europe. As on December 2020, the total installed capacity of Norway was 37.7 GW of 88% share comes from Hydro Power Plants and 10% comes from Wind Power sources. Norway is probably the only country with an Energy Storage capacity of over 70% of its electricity consumption. (Energy, 2020)The Norwegian power system is closely integrated with the other Nordic systems, both in physical terms and through market integration. Nord Pool AS and EPEX Spot are two power exchanges operating in the country and Nord Pool is the dominant player in the country.

Nord Pool is one of the leading power markets in Europe. Nord Pool offers end to end services related to power market operation including trading, clearing, settlement and associated services in both day-ahead and intraday. Nord Pool operates in 16 European countries. Nord Pool provides liquid, efficient and secure day-ahead and intraday markets to our customers. Just like any Power exchange, it acts as a counterpart for every trader for all trades; guaranteeing settlement and delivery.

Nord Pool AS is licensed by the Norwegian Water Resources and Energy Directorate (NVE) to organize and operate a marketplace for trading power, and by the Norwegian Ministry of Petroleum and Energy to facilitate the power market with foreign countries (Nordpool Group, 2021). It accommodates over 360 companies from around 20 countries that trade in the Nordic region of Europe and the Baltic region of Europe. It is appointed as a Nominated Electricity Market Operator (NEMO) in Austria, Belgium, Denmark, Estonia, Finland, France, Germany, Great Britain, Ireland, Latvia, Lithuania, Luxembourg, the Netherlands, Poland and Sweden which signifies Nord Pool's ability to meet the new Network Guidelines on Capacity Allocation and Congestion Management (CACM), which came into force on 14 August 2015 (Nordpool Group, 2021).

All the power exchanges deliberated above have similarities and the same approaches adopted in terms of participation, congestion management, pricing etc. All the power exchanges strictly comply with congestion management system and allow the transaction of power which can be physically delivered. Participation is voluntary in all the power exchanges and Nodal – uniform pricing is adopted in all the power exchanges.

Chapter 03. Power Sector Overview & Readiness for Power Exchanges in SAARC

3.1 Power Sector Overview of Afghanistan in the Context of Power Exchange Development

Afghanistan is located between Central and South Asia. It is a land-locked country with a total area of 652,864 square kilometers (Central Statistics Office Afghanistan). The country hosts Hindu Kush mountains, which hold mountainous and plain terrain. The country hosts a population of over 31.4 million. Kabul is the capital city of the country.

3.1.1 Power Generation, Installed Capacity and Technologies

The total installed capacity for power generation is 1,467 MW as on December 31, 2019, dominated by Hydro Power Capacity at 426 MW, followed by Gas based power generation capacity at 376 MW, Renewables Energy at 365 MW and Coal based power generation at 300 MW. (Afghanistan Statistical Year Book, 2017-2021)

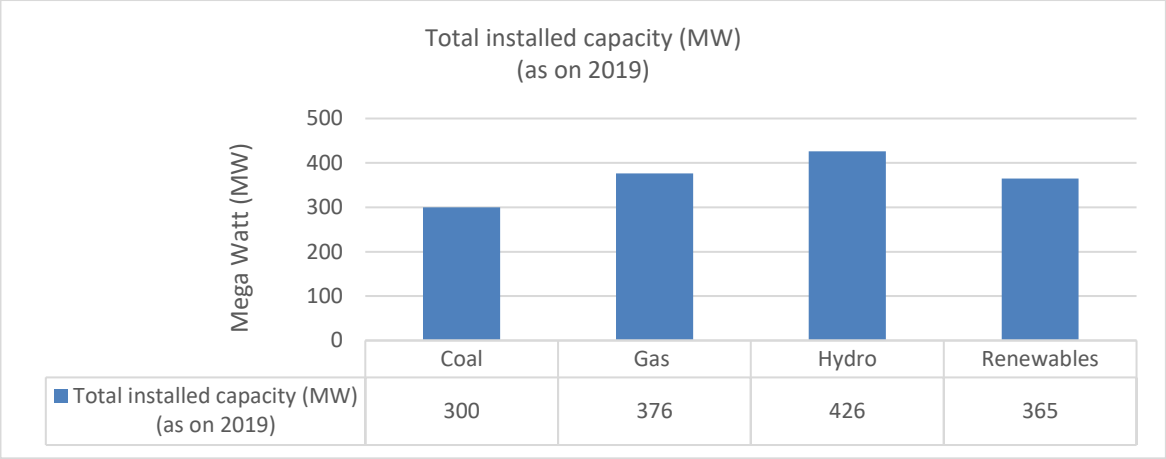


Illustration 4: Source wise installed capacity as on 2019 in Afghanistan

The actual Power generation is dominated by Hydro Power in FY 2019, FY 2020 and FY 2021 with a total power generation of 1,172 MUs, 1,265 MUs and 999 MUs respectively. The net imports in the same year were recorded at 4,986 MUs, 4,932 MUs and 5,152 MUs respectively. (Afghanistan Statistical Year Book, 2017-2021)

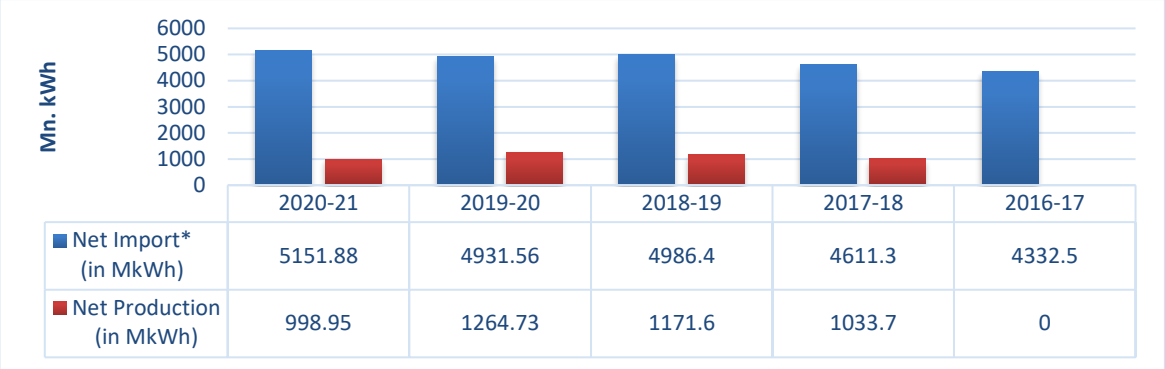


Illustration 5: Net Import & Production of Electricity in Afghanistan (FY2016-17 to FY2020-21)

The electricity generation is dominated by hydropower sources with consistently over 850 MUs every year from FY 2018.

Table 4: Electricity Production in Afghanistan from FY2017-18 to 2020-21

Generation Type	2020-21	2019-20	2018-19	2017-18
Hydro	880.67	1088.04	978.7	889.5
Thermal	80.62	128.07	151.4	111.1
Diesel	37.66	48.62	41.5	33.1
Total	**998.95**	**1264.73**	**1171.6**	**1033.7**

The Afghanistan Renewable Energy Policy sets a target for deploying 4,500 – 5,000 MW of renewable energy capacity by 2032, as per the targets of the Power Sector Master Plan. The scope of the policy covers all renewable energy resources and technologies that can be deployed in techno economically and environmentally sustainable manner in Afghanistan (Energy Transistion Platform, 2021).

3.1.2 Structure of Power Sector

Ministry of Energy & Water is the legislative body in the country and is responsible for the formulation & notification of legislation on electricity & energy in Afghanistan.

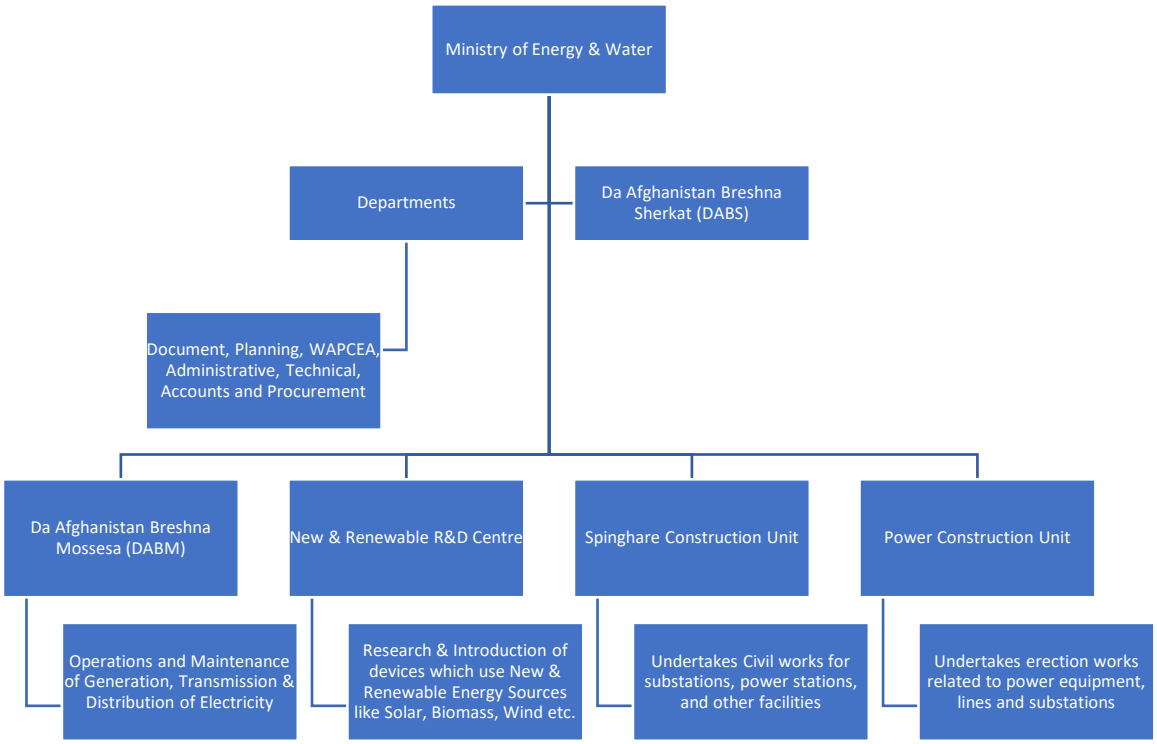


Illustration 6: Structure of Power Sector in Afghanistan[6]

In addition to the Ministry of Energy & Water (MEW), the Ministry of Rural Rehabilitation and Development (MRRD) and Deh Sabz City Development Authority (DSCDA) also is involved in the Electrification works of a few regions.

3.1.3 Institutional, Legal, Regulatory Framework and Operational Structure

The power exchange provides a platform for electricity trading which may not require a very complex legal and regulatory framework, however, to bring liquidity i.e., buyers and sellers on this platform, various legal, policy and regulatory measures are required. These measures are generally executed gradually as they require major structural reforms and huge capital. The current status of regulatory, legal & policy framework required for setting up of a power exchange in Afghanistan is provided below:

Table 5: Status of required Frameworks for setting up of Power Exchange in Afghanistan

S. No	Particular	Status (Yes/ No)
1	**Policy Framework**	
a	Promotion of Competition in Generation and Distribution	No
b	Promotion of Competition in Transmission	No
c	Multi-Buyer Model – unbundling of utilities	No
d	Promotion of merchant/IPP Generation Capacity	Yes
e	Promote Trading of Electricity	Yes

[6] Asian Development Bank

S. No	Particular	Status (Yes/ No)
f	Promotion of Open Access	No
g	Reasonable tariff for Open Access	No
h	Promote competitive power procurement by utilities	No
i	Adequacy of transmission and distribution system	No
j	Development of support infrastructure	No
	Robust banking network with online payment facility	Yes
	Robust Telcom network with good internet connectivity	Yes
2	**Legal Framework**	
a	Recognizing Trading Activity	No
b	Mandatory open access in transmission & Distribution	No
c	Threshold for eligibility for open access to customers	No
d	Determination of charges and losses for open access	No
e	Licensing and functions of power exchange	No
f	Licensing for transmission, distribution & Trading	No
g	Establishment, function & Power of system operators	No
h	Establishment, function and power of electricity regulator	No
i	Adjudicatory power to regulatory and appeals	No
3	**Regulatory Framework**	
a	Grant of license / Authorization for setting up power exchange	No
b	Governance and market operation of power exchanges	No
c	Scheduling of transactions by power exchange	No
d	Market surveillance and reporting by power changes	No
f	Authorization of contracts on power exchanges	No
g	Electricity Gride Code – scheduling of electricity transactions	Cannot be Ascertained with available information
h	Procedure for open access and connectivity in transmission and distribution	Cannot be Ascertained with available information
i	Transmission and Wheeling tariff framework	Cannot be Ascertained with available information
j	Imbalance settlement Mechanism	Cannot be Ascertained with available information
k	Dispute Resolution	Cannot be Ascertained with available information

3.1.4 Current Framework and Gap Analysis

This sub-chapter attempts to summarize the sufficiency of the existing framework and determine the gaps in the framework for the establishment of power exchange in the country. Afghanistan currently has a policy framework on the promotion of merchant/IPP generation capacity and trading of electricity and has not worked on policy, regulatory or legal aspects of a conducive framework.

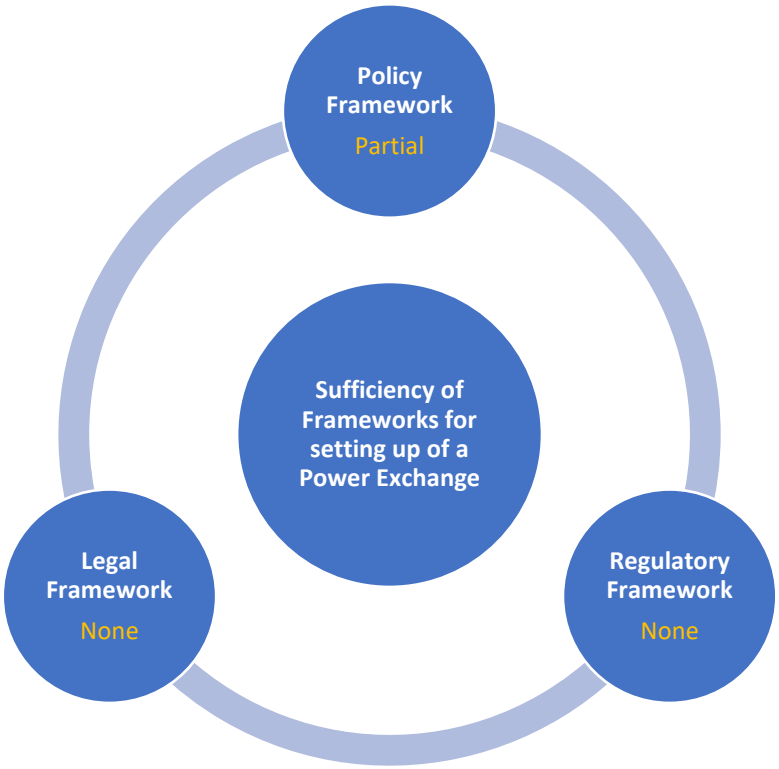


Illustration 7: Summary of sufficiency of frameworks in Afghanistan

3.1.5 SWOT Analysis

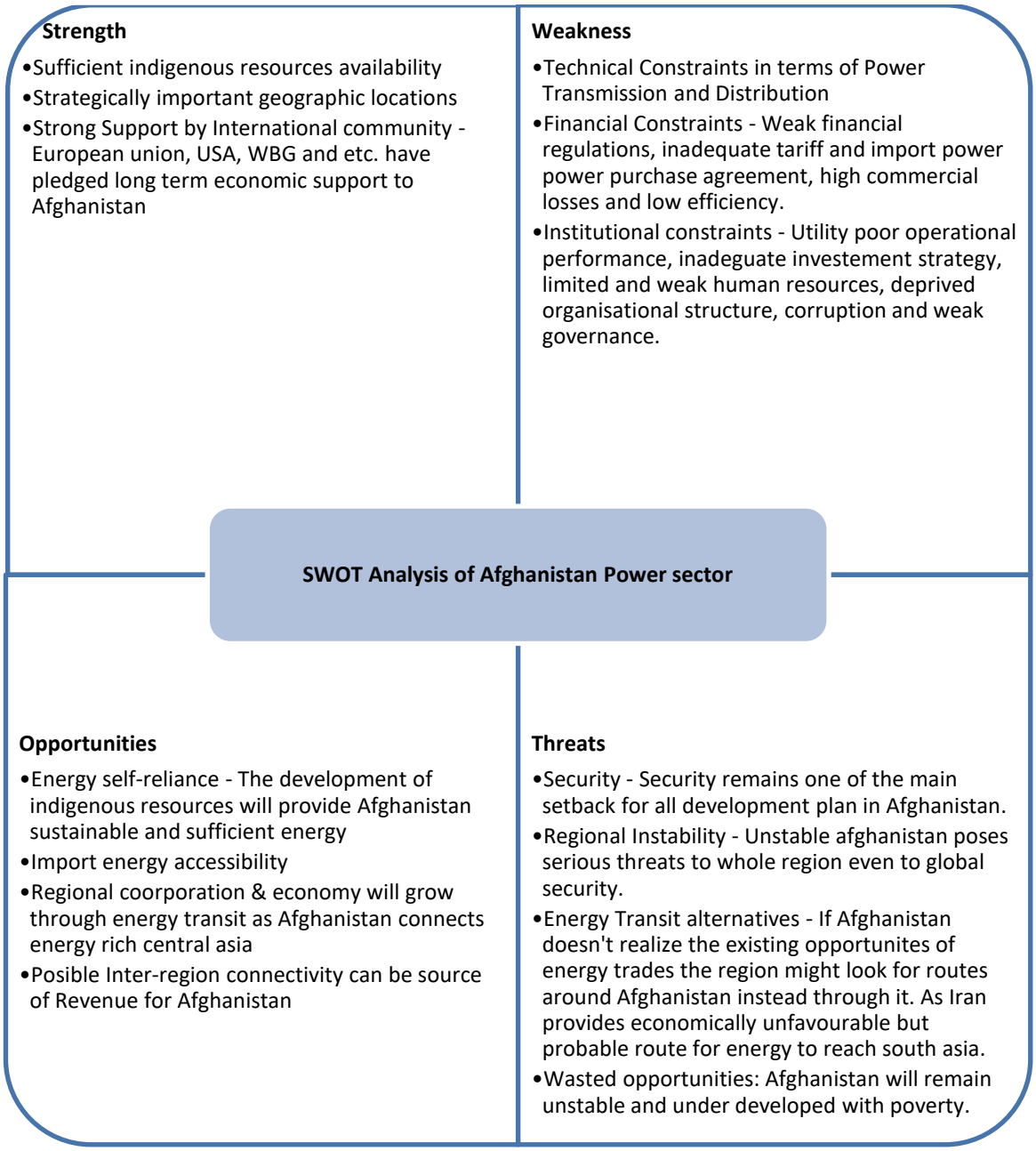


Illustration 8: SWOT Analysis of Afghanistan's Power Sector[7]

[7] (Saadatullah Ahmadzai, 2018)

3.2 Power Sector Overview of Bangladesh in the Context of Power Exchange Development

Bangladesh is located in the Southern part of Asia with India, Myanmar and the Bay of Bengal forming its borders. Bangladesh houses over 163 million people with a total area of 148,560 square kilometers. Dhaka is the capital city of the country.

3.2.1 Power Generation, Installed Capacity and Technologies

The total installed capacity for power generation is 22,023 MW as of 2019 dominated by Gas at 11,402 MW, Furnace Oil at 6,044 MW, Coal at 1,768 MW, other includes Diesel Gen. Sets at 1,290 MW, Hydropower at 230 MW, and renewable includes Solar, Wind, Biogas and Biomass at 129 MW. Bangladesh is importing 1,160 MW of power from its neighboring countries. (Bangladesh Power Development Board, 2020).

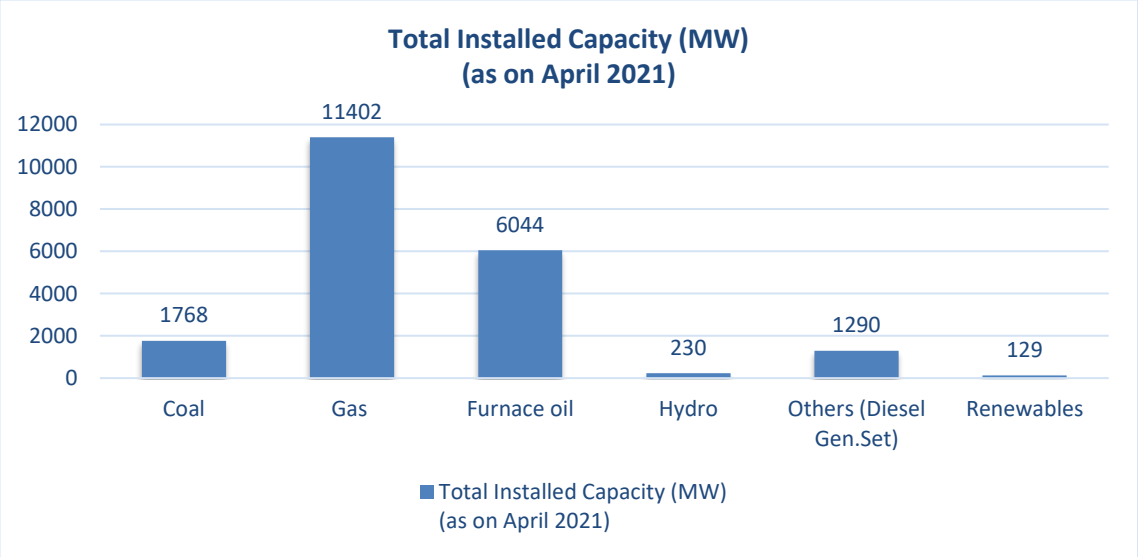


Illustration 9: Source wise installed capacity as on 2019 in Bangladesh

The actual generation is dominated by Gas based power at 51,293 MUs in the FY 2019-20 with a total power generation of 66,284 MUs. Furnace Oil, Coal, Diesel Sets, Hydro and Renewable are contributing at 9,463 Mus, 2,971 Mus, 1,357 Mus, 1,143 Mus, and 57 Mus respectively. Bangladesh is importing 1,160 MW of power from India through HVDC and Tripura i.e., 1,000 MW and 160 MW respectively (Bangladesh Power Development Board, 2020).

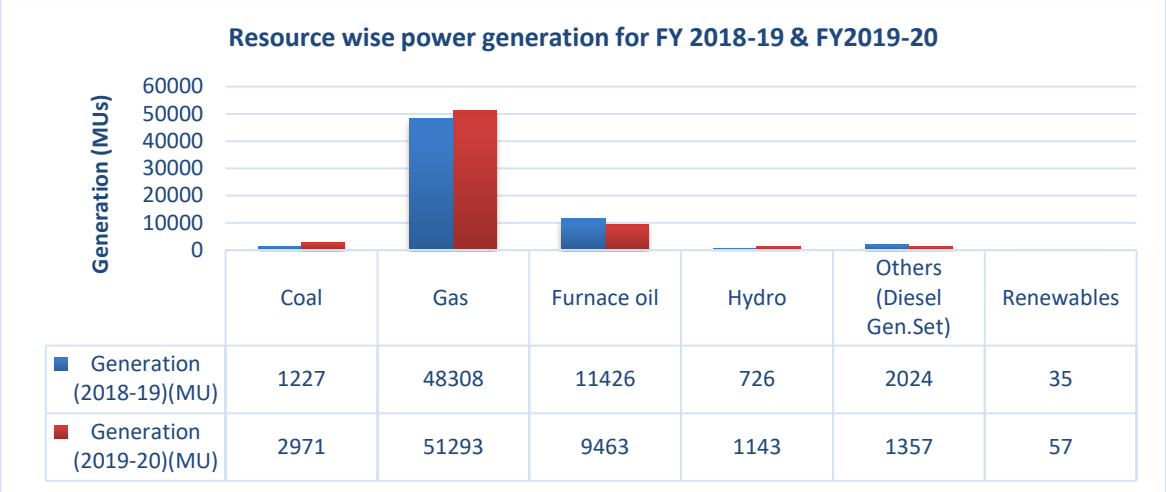


Illustration 10: Resource wise power generation for FY 2018-19 and FY 2019-20

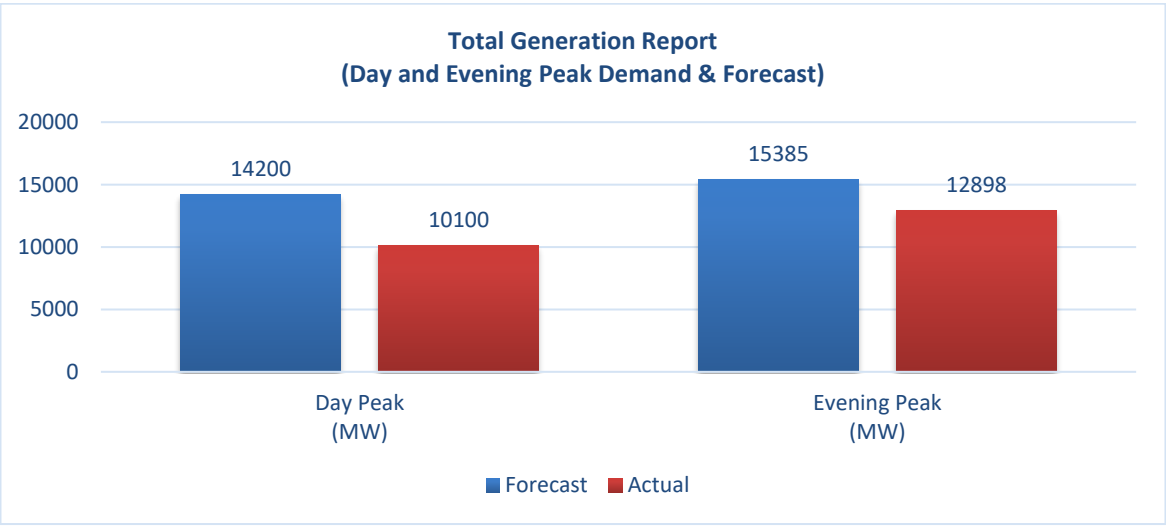


Illustration 11: Total Generation Report (Day and Evening peak demand and forecast[8]

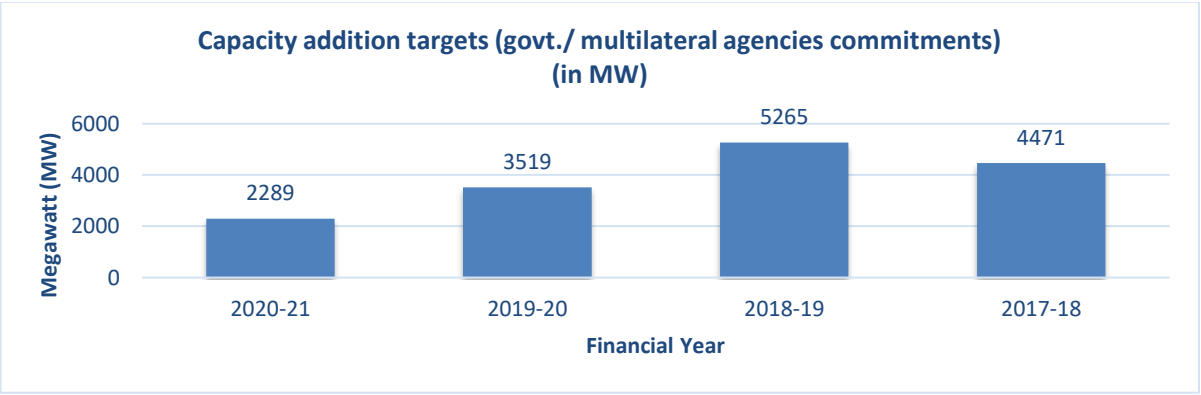


Illustration 12: Capacity Addition Targets from 2017 to 2021 for Bangladesh[9]

[8] BPDP 2021
[9] BPDP 2021

The total renewable energy installed capacity is 766.45 MW as on 2021 considering both off-grid and on-grid at 349.79 MWp and 416.66 MWp respectively. The following table represents the technology wise installed capacity in Bangladesh.

Table 6: Renewable Energy installed Capacity (as on July, 2021)[10]

RE Technologies	Off-grid (MWp)	On-grid (MWp)	Total (MWp)
Solar	346.7	185.76	532.46
Wind	2	0.9	2.9
Hydro	0	230	230
Biogas to Electricity	0.69	0	0.69
Biomass to Electricity	0.4	0	0.4
Total	**349.79**	**416.66**	**766.45**

3.2.2 Structure of Power Sector

Ministry of Power, Energy and Mineral Resources is the legislative body in the country and is responsible for the formulation and notification of legislation on Electricity & Energy in Bangladesh. The structure of the power sector in Bangladesh is illustrated as below:

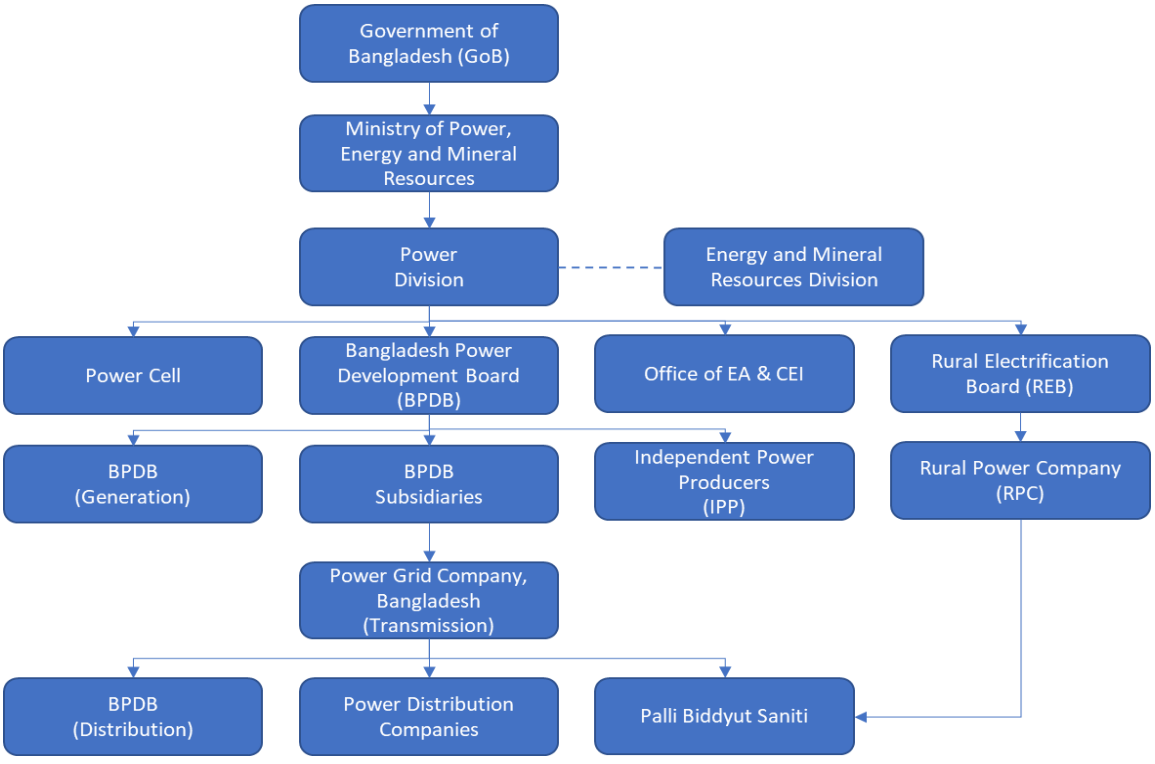


Illustration 13: Structure of Power Sector in Bangladesh

[10] (SREDA, 2021)

3.2.3 Institutional, Legal, Regulatory Framework and Operational Structure

The power exchanges provide a platform for electricity trading which may not require a very complex frameworks, however, to bring liquidity i.e., buyers and sellers on this platform require various legal, policy and regulatory measures. These measures are generally executed gradually as they require major structural reforms and huge capital. Bangladesh, one of the fastest growing economies can benefit a lot with a functional power exchange, which can bring-in efficiencies in power procurement and sale. The current status of the Regulatory, Legal & Policy Framework required for setting up of a power exchange in Bangladesh is provided below:

Table 7: Status of required Frameworks for setting up of Power Exchange in Bangladesh

Sno.	Particular	Status (Yes/No)
1	**Policy Framework**	
a	Promotion of Competition in Generation and Distribution	Yes
b	Promotion of Competition in Transmission	No
c	Multi-Buyer Model – unbundling of utilities	No *(USEA, 2011)*
d	Promotion of merchant/IPP Generation Capacity	Yes *(DATABD, 2021)*
e	Promote Trading of Electricity	Yes
f	Promotion of Open Access	Yes
g	Reasonable tariff for Open Access	No
h	Promote competitive power procurement by utilities	No
i	Adequacy of transmission and distribution system	Yes
j	Development of support infrastructure	No
	Robust banking network with online payment facility	Yes
	Robust Telcom network with good internet connectivity	Yes
2	**Legal Framework**	
a	Recognizing Trading Activity	No
b	Mandatory open access in transmission & Distribution	No
c	Threshold for eligibility for open access to customers	No
d	Determination of charges and losses for open access	No
e	Licensing and functions of power exchange	Yes
f	Licensing for transmission, distribution & Trading	Yes
g	Establishment, function & Power of system operators	Yes
h	Establishment, function and power of electricity regulator	Yes
i	Adjudicatory power to regulatory and appeals	No
3	**Regulatory Framework**	
a	Grant of license / Authorization for setting up power exchange	Yes
b	Governance and market operation of power exchanges	Yes
c	Scheduling of transactions by power exchange	Yes
d	Market surveillance and reporting by power changes	No
f	Authorization of contracts on power exchanges	Yes
g	Electricity Gride Code – scheduling of electricity transactions	Yes
h	Procedure for open access and connectivity in transmission and distribution	Yes
i	Transmission and Wheeling tariff framework	No

Sno.	Particular	Status (Yes/No)
j	Imbalance settlement Mechanism	No
k	Dispute Resolution	No

3.2.4 Current Framework and Gap Analysis

This sub-chapter attempts to summarize the sufficiency of the existing framework and determine the gaps in the framework for the establishment of power exchange in the country. Bangladesh currently has a policy framework on Promotion of merchant/IPP Generation Capacity and Promote Trading of Electricity and partially worked on the many parts of a conducive frameworks on Policy, Regulatory or Legal aspects.

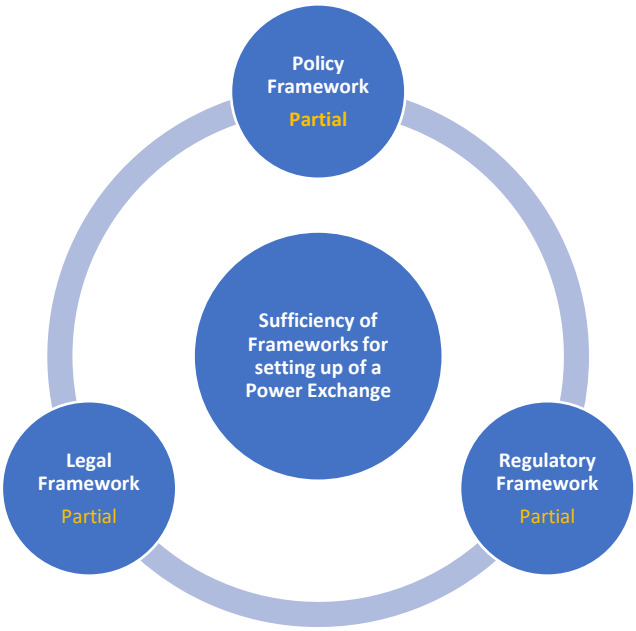


Illustration 14: Summary of sufficiency of frameworks in Bangladesh

3.2.5 SWOT Analysis

SWOT Analysis of Bangladesh Power Sector

Strength

- Government Incentives - promotion of the foreign investment in power sector
- High Electricity Demand
- High GDP growth

Weakness

- Low Access to Power
- Weakening Gas supply security
- Poor Electricity Infrastructure
- Participation of private sector
- Huge system losses
- Delay in completion of new plant
- Low competition in Power Sector

Opportunities

- JV with India for development of Power Projects
- Interconnection with India
- Renewable Energy Potential to be tapped for energy security

Threats

- Extra Dependence on Gas for power supply entity for electricity generation
- Increasing in price of Gas
- Low Coal reserves

Illustration 15: SWOT Analysis of Bangladesh's Power Sector

3.3 Power Sector Overview of Bhutan in the Context of Power Exchange Development

Bhutan is a landlocked country in the southern part of Asia lying in the Eastern Himalayan region. The country shares borders with India and Tibet. Bhutan houses a population of over 754,000 with a total area of 38,394 square kilometers.

3.3.1 Power Generation, Installed Capacity and Technologies

The total installed capacity of Bhutan is 2,335 MW as on 2019. Hydropower is the major contributor in the country with an installed capacity of 2,334 MW followed by DG sets of 18 MW and Renewables (Wind) of 1 MW. (Bhutan, 2020)

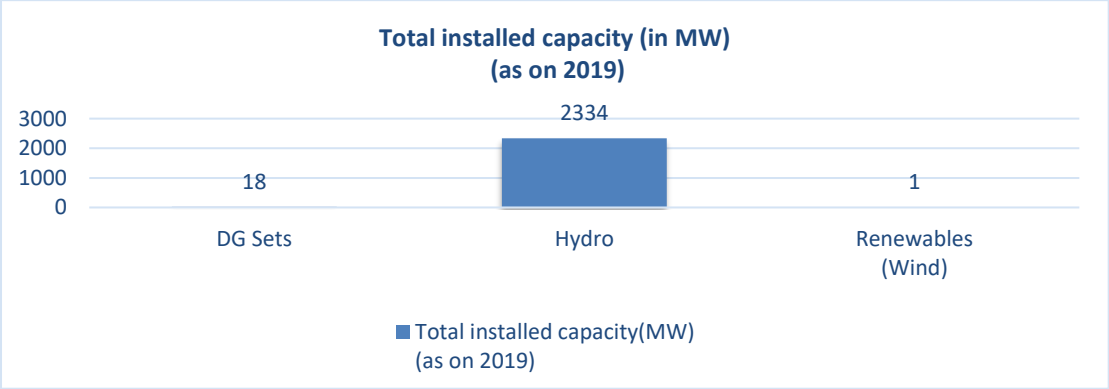


Illustration 16: Resource wise total installed capacity (in MW)

The actual generation is dominated by hydropower with 6,959 GWh followed by DG sets and Wind of 5,605 GWh and 1 GWh respectively for the FY 2019-20. (Bhutan, 2020)

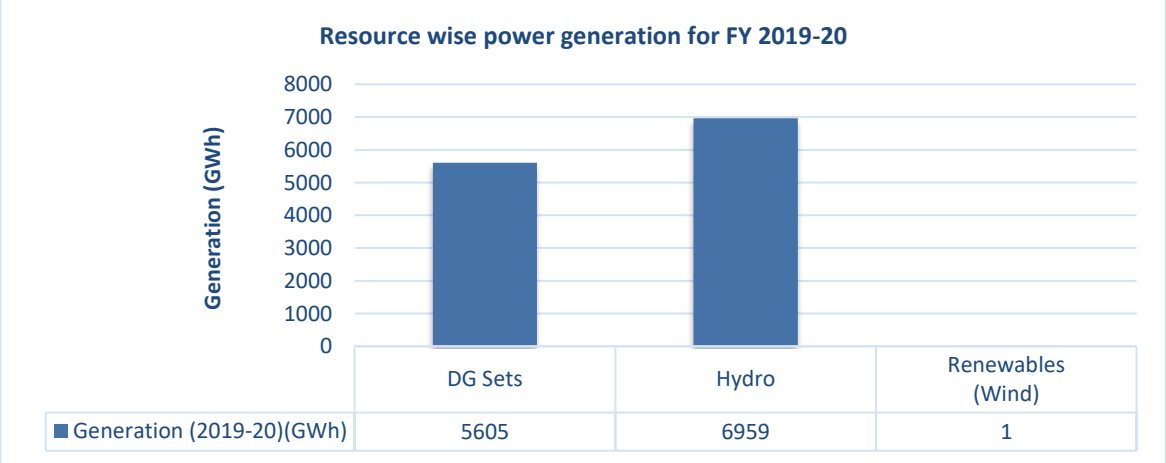


Illustration 17: Resource wise power generation for FY 2019-20 (in GWh)

Hydropower remains the chief resource for renewable energy in Bhutan. The Lhuntse, Mongar and Wangdue dzongkhags (districts) are considered to have excellent hydropower power potential. The theoretical potential of hydropower is estimated at more than 41 GW, whereas the restricted technical potential is estimated at 26.6 GW (IRENA, 2019).

As per the DRE–MOEA (2016b) estimates theoretical solar potential at 6 terawatts (TW) and close to 760 MW of wind energy. Pico-Hydro/ Marine and bioenergy are the two main renewable energy technologies which are contributing to the tune of 34% and 66% share in RE generation as on 2017. In the year 2019, installed 1 MW of solar and wind energy respectively (IRENA, 2019).

3.3.2 Structure of Power Sector

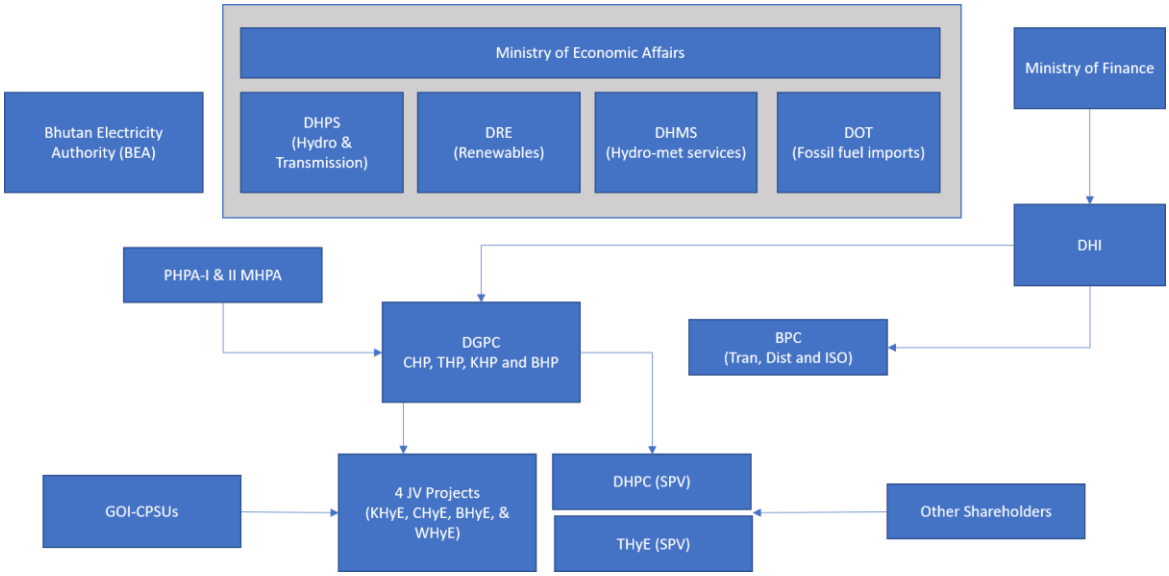


Illustration 18: Power Sector Structure of Bhutan

BEA = Bhutan Electricity Authority, BHP = Basochhu Hydropower Plant, BHYE = Bunakha Hydro Electric, BPC = Bhutan Power Corporation, CHP = Chhukha Hydropower plant, CHYE = Chamkharchhu-I Hydro Electric, CPSU = Central Public Sector undertaking, DGPC = Druk Green Power Corporation, DHI = Druk Holding and Investments, DHMS = Department of Hydro-Met Service, DHPC = Dagachuu Hydro Power Corporation Limited, DHPS = Department of Hydropower and Power Systems, DRE = Department of Renewable Energy, MHPA = Mangdechhu Hydroelectric Project Authority, PHPA = Punatsangchhu Hydroelectric Project Authority, TPT = Tala Hydropower plant, THYE = Tangsibiji Hydro Energy Limited (Harmonizing electricity laws in south asia, 2019)

3.3.3 Institutional, Legal, Regulatory Framework and Operational Structure

The importance of having legal policy and regulatory provisions and safeguards in power exchange is widely known. These measures are generally executed gradually as they require major structural reforms and huge capital. Bhutan, a landlocked country and with limited conventional resources and significant renewable energy resources can benefit the stakeholders not only for domestic transactions but for energy trade with neighbouring counterparts. The current status of the Regulatory, Legal & Policy Framework required for setting up of a power exchange in Bhutan is provided below:

Table 8: Status of required Frameworks for setting up of Power Exchange in Bhutan

Sno.	Particulars	Yes / No
1	Policy Framework	
a	Promotion of Competition in Generation, transmission and Distribution	No
b	Multi-Buyer Model – unbundling of utilities	No
c	Promotion of merchant Generation Capacity	No
d	Promote Trading of Electricity	Yes
e	Promotion of Open Access	Yes
f	Reasonable tariff for open access	No
g	Promote competitive power procurement by utilities	No
h	Adequacy of transmission and distribution system	No
i	Development of support infrastructure	Yes
	Robust banking network with online payment facility	Yes
	Robust Telcom network with good internet connectivity	Yes
2	**Legal Framework** (USAID, 2021)	
a	Recognizing Trading Activity	No
b	Mandatory open access in transmission & Distribution	No
c	Threshold for eligibility for open access to customers	No
d	Determination of charges and losses for open access	No
e	Licensing and functions of power exchange	No
f	Licensing for transmission, distribution & Trading	No
g	Establishment, function & Power of system operators	No
h	Establishment, function and power of electricity regulator	No
i	Adjudicatory power to regulatory and appeals	No
3	**Regulatory Framework**	
a	Grant of license / Authorization for setting up power exchange	No
b	Governance and market operation of power exchanges	No
c	Scheduling of transactions by power exchange	No
d	Market surveillance and reporting by power changes	No
f	Authorization of contracts on power exchanges	Yes
g	Electricity gride code – scheduling of electricity transactions	Yes
h	Procedure for open access and connectivity in transmission and distribution	No
i	Transmission and Wheeling tariff framework	Yes
j	Imbalance settlement Mechanism	No
k	Dispute Resolution	No

Table 9: Current State of Power Exchange and Available Features in Bhutan

	Competition	Openness of Market	Access to Infrastructure
High	Fully Competitive Market Determined by Market Forces	De-licensed Market	**Open Access Implementation (Provision is available in transmission)**
Medium	Semi-Competitive Market Regulated	**Licensing Required, but independent Regulator**	Open Access provision available but not implemented
Low	**No Competition/ Monopoly**	Stringent Licensing Requirements	No Provision for Open Access

(Review of Electricity Laws and Regulations of SAARC member states, 2015)

Key Points (Energy Technological Solutions International, 2015)**:**

a. BE Act 2001 provides for the development of hydropower as a revenue generator through power exports;
b. The Act clearly lays down the rules and procedures with regard to:
    a. Duties and obligations of the developer;
    b. Licensing norms;

Provision of open access on transmission systems;

a. Role and responsibilities of system operator including that for power exports;
b. Designating bulk supplier including import/export of power; and
c. Lay down rules and procedures relating to private sector participation
d. BEA 2001 is one of the Acts in South Asia that sets out legal/ regulatory framework to promote cross border power trade.
e. Electricity flows from Bhutan has to be facilitated by India.
f. IGA between India and Bhutan provides for Bhutan to export the surpluses energy to India.
g. Since existing plants are committed new plants have to be set up for supply of power to other countries

(Review of Electricity Laws and regulations of SAARC Members states DN Raina, President, ENTEESOL International, 2015)

3.3.4 Current Framework and Gap Analysis

This sub-chapter attempts to summarize the sufficiency of the existing framework and determine the gaps in the framework for the establishment of power exchange in the country. Bhutan currently has a policy framework on Promotion of merchant/IPP Generation Capacity and Promote Trading of Electricity and haven't worked on the many parts of a conducive frameworks on Policy, Regulatory or Legal aspects.

Illustration 19: Summary of sufficiency of frameworks in Bhutan

3.3.5 SWOT Analysis

Strengths
- High Hydro Power Potential
- Access to Natural Resources
- Carbon Negative Country
- Interconnection with India

Weakness
- Low Readiness in terms of Legal framework for Open Access
- Low Readiness in terms of Regulatory framework for Open Access
- Low Readiness in terms of Institutional framework for Power Trading
- Zero Competiton in Power Sector

SWOT Analysis on Bhutan Power Sector

Opportunities
- Significant Solar Energy Potential
- Scope for Decentralized Distribution

Threats
- Climate Change
- Heavy reliance on Diesel Power Generation

Illustration 20: SWOT Analysis of Bhutan's Power Sector

3.4 Power Sector Overview of India in the Context of Power Exchange Development

India is located in the southern part of Asia. India is bordered by Pakistan, Afghanistan, Bangladesh, Nepal, Tibet and China. India houses a total population of over 1392 million in a total area of 3,287,240 Square kilometers.

3.4.1 Power Generation, Installed Capacity and Technologies

The total installed capacity of India is 383,325.95 MW as on August 2021. Thermal is the major contribution, which includes coal, lignite, gas and diesel with an installed capacity of 202,204.5 MW, 6,620 MW, 24,924.01 MW, 509.71 MW respectively. Secondly, Hydropower is the major contributor in the country with an installed capacity of 46,412.22 MW and Nuclear of 6,780 MW and Renewables consists of Wind, Solar, Biomass & Bagasse, Waste to Energy, Small Hydro with an increased installed capacity of 39,691.15, 45,611.91 MW, 10,170.61 MW, 401.84 MW, 4,807.81 MW respectively (CEA, 2021).

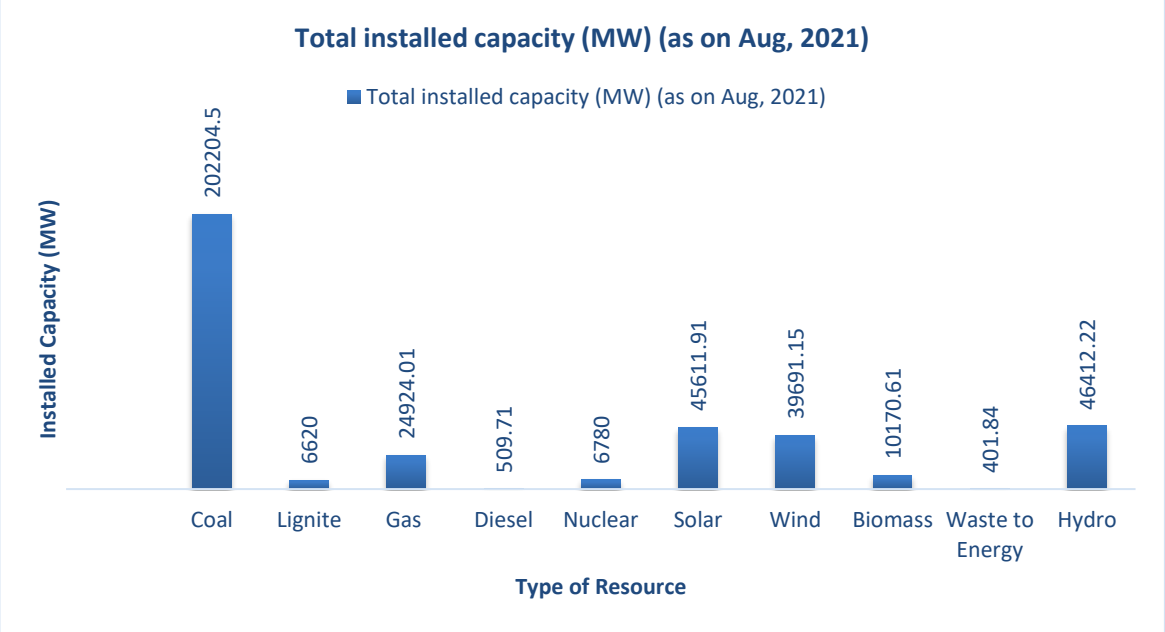


Illustration 21: Resource wise total installed capacity (in MW)[11]

The actual generation is dominated by thermal power with 92,430 MUs followed by Solar, Wind, Nuclear, respectively for the FY Aug 2021. Along with the above, India is importing electricity from Bhutan with an amount of 1,200 MUs on annual basis. Thermal, Hydro and Nuclear are the base loads for the country power generation (Central Electricity Authority, 2021).

The electricity generation target of conventional sources for the year 2021-22 has been fixed as 1,356 Billion Units (BUs) i.e., growth of around 9.83% over an actual conventional generation of 1,234.608 BUs for the previous year (2020-21). The conventional generation during 2020-21 was 1,234.608 BUs as compared to 1,250.784 BUs generated during 2019-20 (Ministry of Power, India, 2021).

[11] CEA 2021

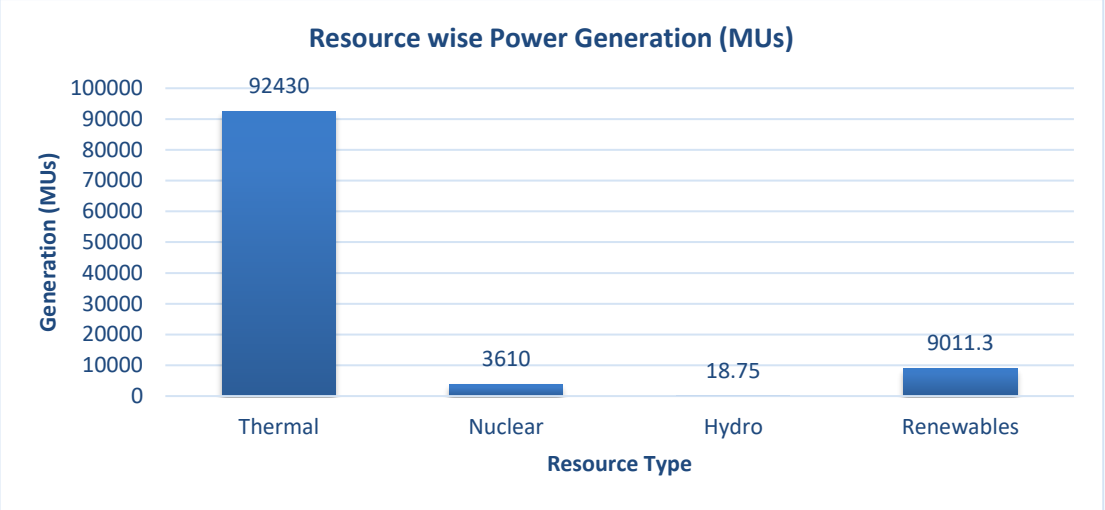


Illustration 22: Resource wise power generation for FY 2019-20 (in GWh)

Renewable energy sources have a combined installed capacity of more than 96 GW. As of 31 June 2021, the total installed capacity for Renewables is 96.95 GW. The following is the breakup of total installed capacity for Renewables, as of 31 May 2021:

Type of Renewable Energy	RE Potential	Units
Wind Power	39.44	GW
Solar Power	41.09	GW
Bio Power	10.34	GW
Small Hydro Power	4.79	GW

Wind energy capacity in India has increased by 2.2 times from FY 2016-17 to FY 2020-21. Solar power capacity has increased by more than 5 times in the last five years from 6.7 GW to 40 GW in March 2021. The government of India further targets to increase the total Renewable Energy Capacity to 450GW by 2030. 42 solar parks of aggregate capacity of 23,499 MW have been approved in 17 states up to March 2019. Solar Parks in Pavagada (2 GW), Kurnool (1 GW) and Bhandla-II (648 MW) are included in the top 5 operational solar parks of 7 GW capacity in the country. The world's largest renewable energy park of 30 GW capacity solar-wind hybrid project is under installation in Gujarat. (Industry Scenario of Renewable Energy, 2021).

India has released different policies and schemes to increase installed capacity with a thrust on renewables to fulfil its commitment to the global community to reduce its carbon emissions and achieve the given targets by 2022 and 2030.

3.4.2 Structure of Power Sector

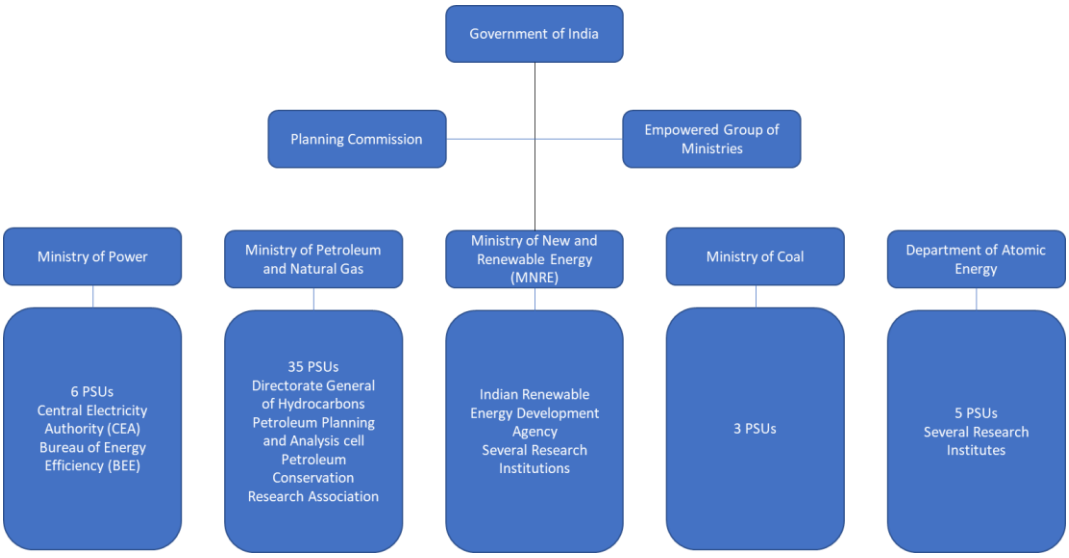


Illustration 23: Basic Hierarchy of India's Energy Sector

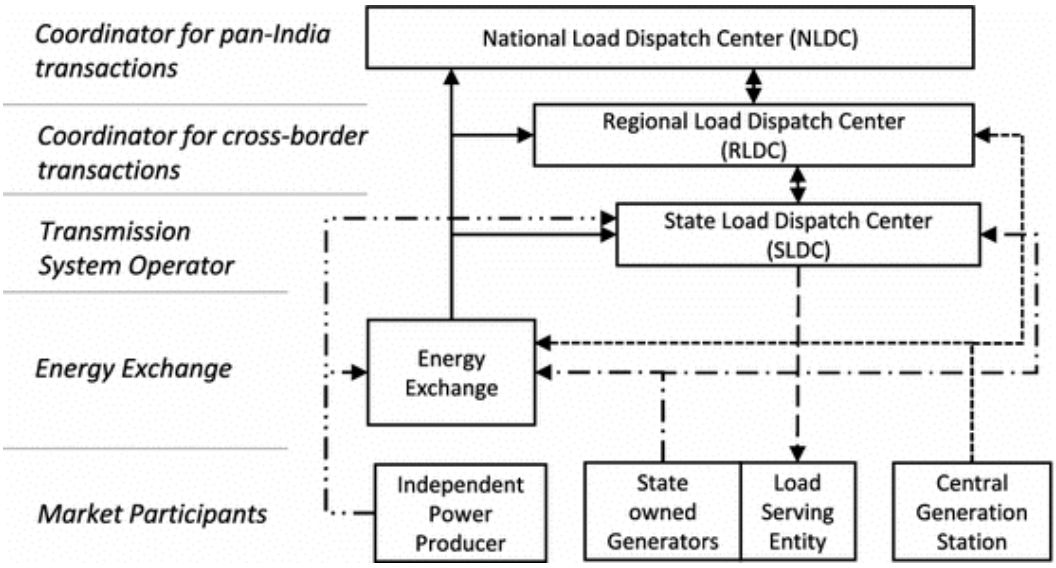


Figure 5: Basic Flow chart of Power Exchange in India

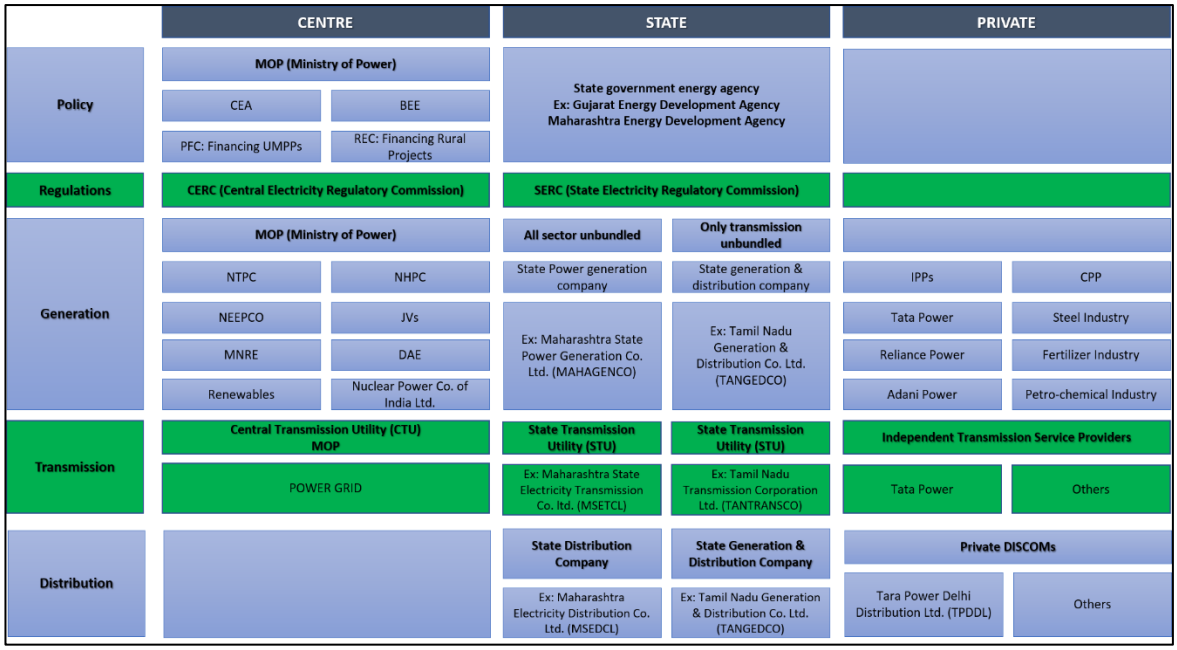


Figure 6: Structure of Indian Power

3.4.3 Institutional, Legal, Regulatory Framework and Operational Structure

The power exchanges provide a platform for electricity trading equipped with the required legal and regulatory framework and the system is established in India with all desired standards. Generally, these measures are executed gradually as they require major structural reforms and huge capital. The current status of Regulatory, Legal & Policy Framework adopted in India facilitating power exchange is provided below:

Table 10: Status of required Frameworks for setting up of Power Exchange in India

Sno.	Particulars	Yes / No
1	Policy Framework	
a	Promotion of Competition in Generation, transmission and Distribution	Yes
b	Multi-Buyer Model – unbundling of utilities	Yes
c	Promotion of merchant Generation Capacity	Yes
d	Promote Trading of Electricity	Yes
e	Promotion of Open Access	Yes
f	Reasonable tariff for open access	Yes
g	Promote competitive power procurement by utilities	Yes
h	Adequacy of transmission and distribution system	Yes
i	Development of support infrastructure	Yes
	Robust banking network with online payment facility	*Yes*
	Robust Telcom network with good internet connectivity	*Yes*
2	**Legal Framework**	
a	Recognizing Trading Activity	
b	Mandatory open access in transmission & Distribution	Yes
c	Threshold for eligibility for open access to customers	Yes
d	Determination of charges and losses for open access	Yes
e	Licensing and functions of power exchange	Yes
f	Licensing for transmission, distribution & Trading	Yes

Sno.	Particulars	Yes / No
g	Establishment, function & Power of system operators	Yes
h	Establishment, function and power of electricity regulator	Yes
i	Adjudicatory power to regulatory and appeals	Yes
3	**Regulatory Framework**	
a	Grant of license / Authorization for setting up power exchange	Yes
b	Governance and market operation of power exchanges	Yes
c	Scheduling of transactions by power exchange	Yes
d	Market surveillance and reporting by power changes	Yes
f	Authorization of contracts on power exchanges	Yes
g	Electricity gride code – scheduling of electricity transactions	Yes
h	Procedure for open access and connectivity in transmission and distribution	Yes
i	Transmission and Wheeling tariff framework	Yes
j	Imbalance settlement Mechanism	Yes
k	Dispute Resolution	Yes

Table 11: Current State of Power Exchange and Available Features in India

	Competition	Openness of Market	Access to Infrastructure
High	**Fully Competitive Market Determined by Market Forces**	**De-licensed Market**	**Open Access Implementation (Provision is available in transmission)**
Medium	Semi-Competitive Market Regulated	Licensing Required, but independent Regulator	Open Access provision available but not implemented
Low	No Competition/ Monopoly	Stringent Licensing Requirements	No Provision for Open Access

3.4.4 Current Framework and Gap Analysis

This sub-chapter attempts to summarize the sufficiency of the existing framework and determine the gaps in the framework for the establishment of power exchange in the country. India currently has policy framework on Promotion of merchant/IPP generation capacity and promote trading of electricity and worked on the many parts of a conducive frameworks on policy, regulatory or legal aspects.

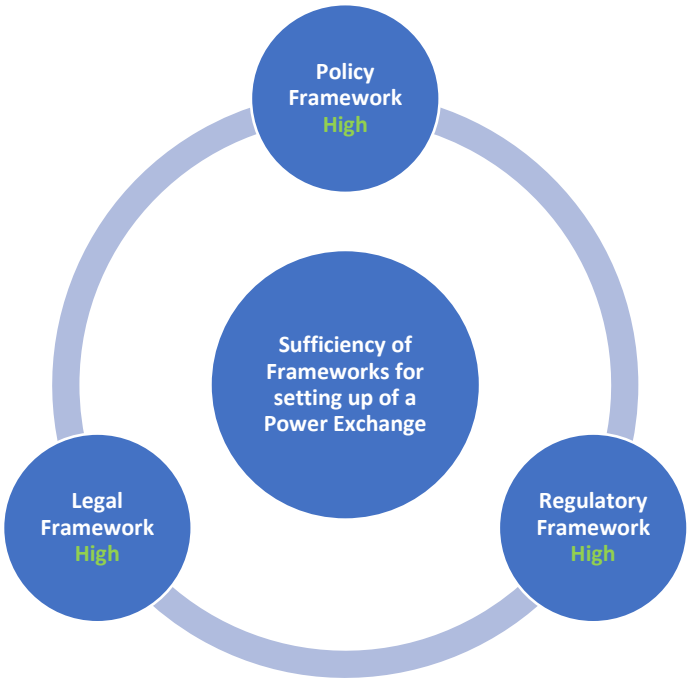


Illustration 24: Summary of sufficiency of frameworks for setting up Power Exchange in India

3.4.5 SWOT Analysis

SWOT Analysis on Indian Power Sector

Strengths
- High RE Potential
- Power Surplus
- Increasing Electricity Demand
- Interconnection with Nepal and Bhutan

Weakness
- Dependance on import of Gas
- Poor Planning on Coal Resources
- Poor Financial Strength of DISCOMs

Opportunities
- Increase in domestic Manufacturing capacity for new RE technologies
- Faster Exploration of domestic gas field for reduce in Gas imports

Threats
- Dependance on other countries for Battery Storage technology adoption
- Prone to Geopolitical risks pertaining to Solar Module and other Technology imports

Illustration 25: SWOT Analysis of India's Power Sector

3.5 Power Sector Overview of Maldives in the Context of Power Exchange Development

3.5.1 Power Generation, Installed Capacity and Technologies

State Electric Company Limited (STELCO) is a Maldivian Government owned company, with over 70 years of history. As on 2017, the total installed capacity of 87.7 MW, it is accounted that 60% of the total electricity generation of all inhabited islands with a consumption of 375 MUs compared with 285 MUs of Outer islands. It is estimated that the power demand for Maldives has grown at 6.8% CAGR from 1,010 MU in 2012 to 1,400 MU in 2017. As on 2017, the total power demand at Maldives is 1405 MUs, the major power consumption is break down as Male and Outer Islands is 628 MUs, Tourist Resorts is 671 MUs, Water Purification is 35 MUs and others is 71 MUs. By 2030, is expected to be at faster rate, and capacity may reach to 140 – 150 MW. (CRISIL, 2018).

In order to decrease the dependency on fossil fuels and benefit the environment, STELCO has successfully implemented renewable energy projects. The country has abundant renewable energy resources, including solar, wind, and ocean, and the potential to produce green hydrogen fuel with the surplus of renewable energy produced in the islands. The Maldives also has the possibility to substitute part of its diesel consumption with less expensive, more efficient, and less polluting small-scale liquefied natural gas (LNG) (Asian Development Bank, 2020). Being a tropical country with plenty of sunshine, the best fit renewable energy technology has been solar photovoltaics. STELCO was the first company to introduce solar photovoltaics to the Maldives on a commercial scale. By 2023, the nation of islands aims to more than triple its renewable energy capacity to 85 MW of which 75MW would be solar (Hassan, 2020).

3.5.2 Institutional, Legal, Regulatory Framework and Operational Structure

One of the challenges of the Maldives electricity sector is existing electricity networks in the islands. Maldives do not have a national grid. The Maldives is geographically fragmented, so each island has its own (separate) power generation and distribution system. These systems are not properly designed and are very old. They require upgrades and replacements to connect solar systems (Hassan, 2020). The power exchanges provide a platform for electricity trading which require a certain legal and regulatory framework. In Maldives, the system needs to be developed and established with all desired standards. Generally, these measures are executed gradually as they require major structural reforms and huge capital. The current status of Regulatory, Legal & Policy Framework required for setting up of a power exchange in the Maldives as provided below:

Table 12: Status of required Frameworks for setting up of Power Exchange in Maldives

Sno.	Particulars	Yes / No
1	Policy Framework	
a	Promotion of Competition in Generation, transmission and Distribution	Yes
b	Multi-Buyer Model – unbundling of utilities	No
c	Promotion of merchant Generation Capacity	No
d	Promote Trading of Electricity	No
e	Promotion of Open Access	Cannot be ascertained with available information

Sno.	Particulars	Yes / No
f	Reasonable tariff for open access	Cannot be ascertained with available information
g	Promote competitive power procurement by utilities	Cannot be ascertained with available information
h	Adequacy of transmission and distribution system	Cannot be ascertained with available information
i	Development of support infrastructure	Cannot be ascertained with available information
j	Robust banking network with online payment facility	Cannot be ascertained with available information
k	Robust Telcom network with good internet connectivity	Cannot be ascertained with available information
2	**Legal Framework**	
a	Recognizing Trading Activity	Cannot be ascertained with available information
b	Mandatory open access in transmission & Distribution	Cannot be ascertained with available information
c	Threshold for eligibility for open access to customers	Cannot be ascertained with available information
d	Determination of charges and losses for open access	Cannot be ascertained with available information
e	Licensing and functions of power exchange	Cannot be ascertained with available information
f	Licensing for transmission, distribution & Trading	Cannot be ascertained with available information
g	Establishment, function & Power of system operators	Cannot be ascertained with available information
h	Establishment, function and power of electricity regulator	Cannot be ascertained with available information
i	Adjudicatory power to regulatory and appeals	Cannot be ascertained with available information
3	**Regulatory Framework**	Cannot be ascertained with available information
a	Grant of license / Authorization for setting up power exchange	Cannot be ascertained with available information
b	Governance and market operation of power exchanges	Cannot be ascertained with available information
c	Scheduling of transactions by power exchange	Cannot be ascertained with available information
d	Market surveillance and reporting by power changes	Cannot be ascertained with available information
f	Authorization of contracts on power exchanges	Cannot be ascertained with available information
g	Electricity gride code – scheduling of electricity transactions	Cannot be ascertained with available information
h	Procedure for open access and connectivity in transmission and distribution	Cannot be ascertained with available information

Sno.	Particulars	Yes / No
i	Transmission and Wheeling tariff framework	Cannot be ascertained with available information
j	Imbalance settlement Mechanism	Cannot be ascertained with available information
k	Dispute Resolution	Cannot be ascertained with available information

3.5.3 Current Framework and Gap Analysis

This sub-chapter attempts to summarize the sufficiency of the existing framework and determine the gaps in the framework for the establishment of power exchange in the country. The Maldives currently has a policy framework on the Promotion of merchant/IPP Generation Capacity by way of allowing captive power plants for consumers, where SLETCO is not providing services. Other provisions required for setting up power exchanges haven't been formulated in terms of frameworks on Policy, Regulatory or Legal aspects.

Illustration 26: Summary of sufficiency of frameworks for setting up Power Exchange in Maldives

3.5.4 SWOT Analysis

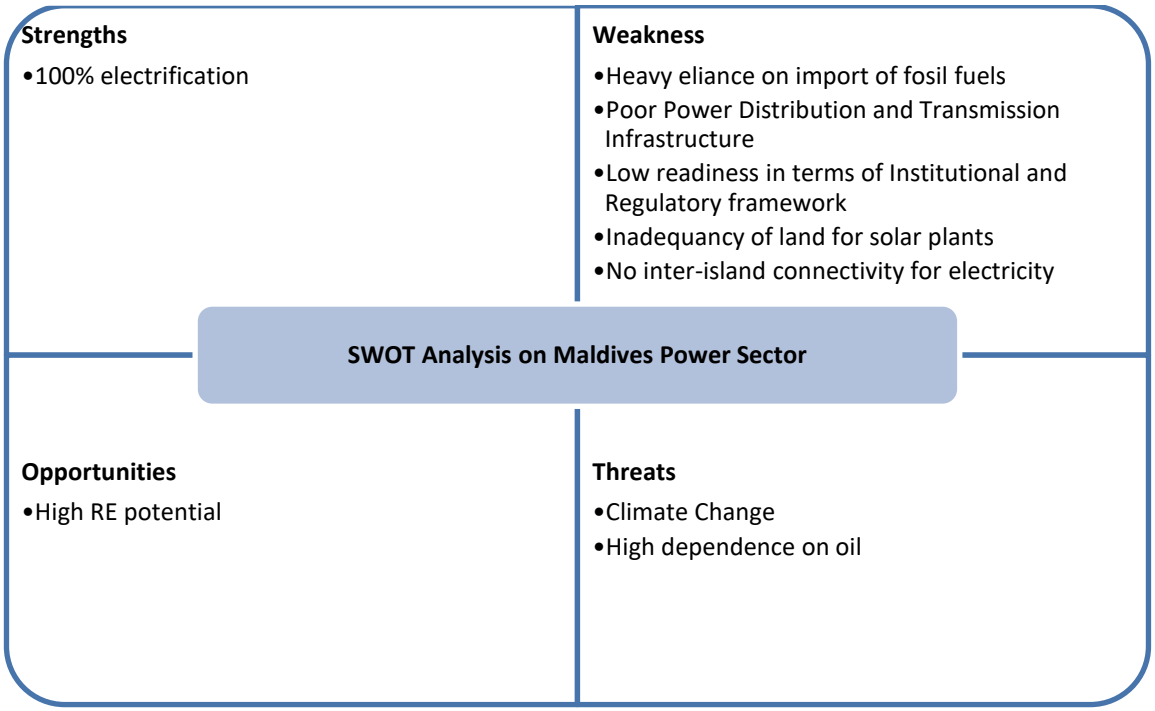


Illustration 27: SWOT Analysis of Maldives' Power Sector

3.6 Power Sector Overview of Nepal in the Context of Power Exchange Development

Nepal is a landlocked country located in Southern Asia. It is primarily covered by the Himalayas and Indo-Gangetic Plain. Kathmandu is the capital of Nepal. Nepal houses a population of around 30 million with a total area of 147,516 square kilometers.

3.6.1 Power Generation, Installed Capacity and Technologies

The total installed capacity for power generation is 1,377.99 MW as on 2021. Dominated by hydro by 1,290.16 MW (more than 1 MW), thermal by 53.41 MW, renewables (Solar) by 20.18 MW, Mini hydro by 11.24 MW and co-generation by 3 MW respectively. (Platform, 2021)

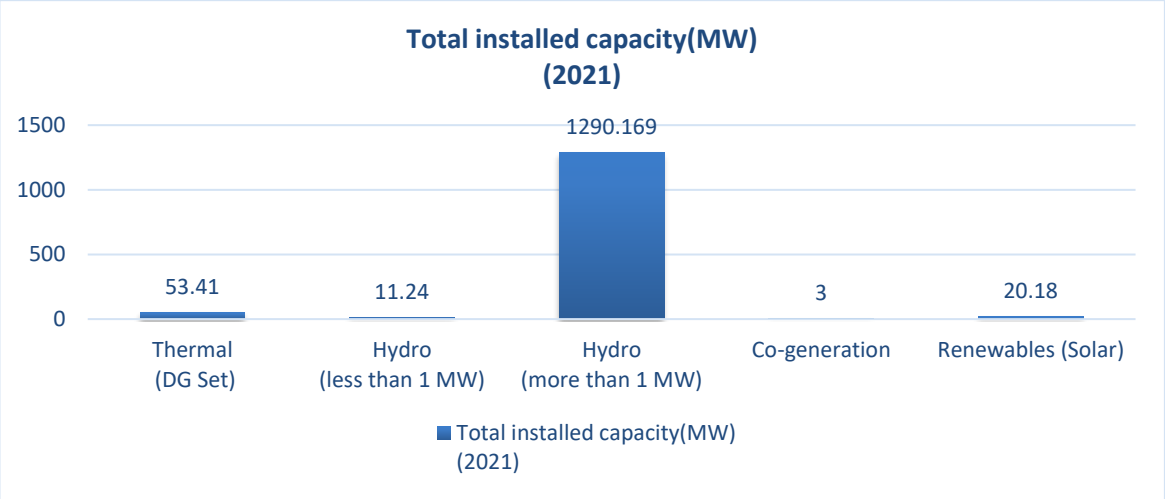


Illustration 28: Total installed capacity

Nepal is having the installations of power generators using the technologies like hydro, thermal (DG-sets), Solar, and co-generation plants. Major hydropower plants (98), Mini hydropower (15), Solar power plants (4), thermal-DG sets (2) and Co-generation plants (1) respectively in the country.

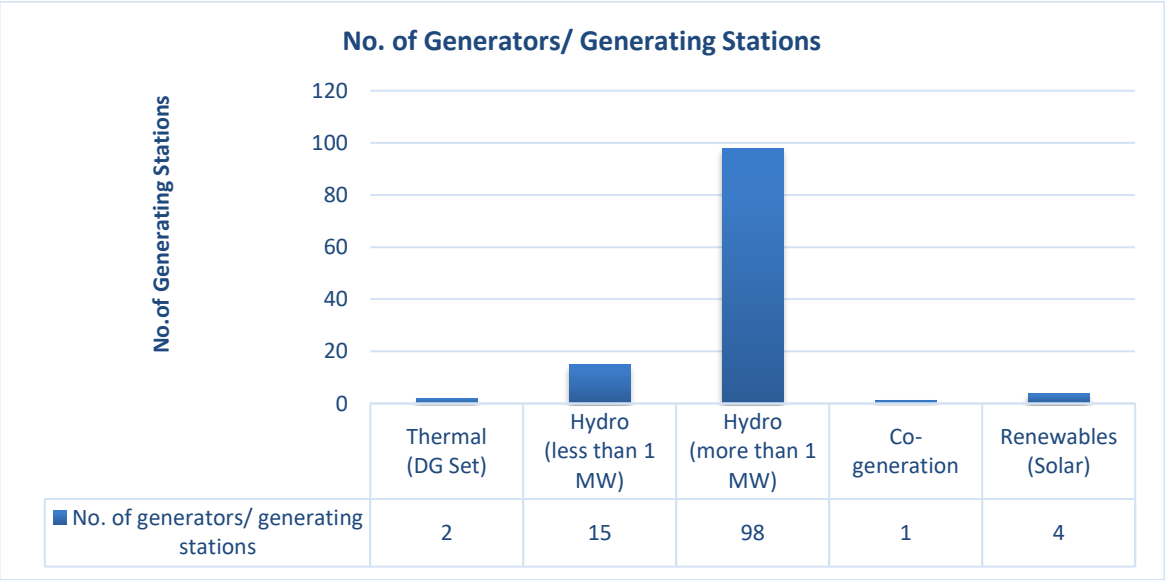


Illustration 29: Resource wise number of generating stations

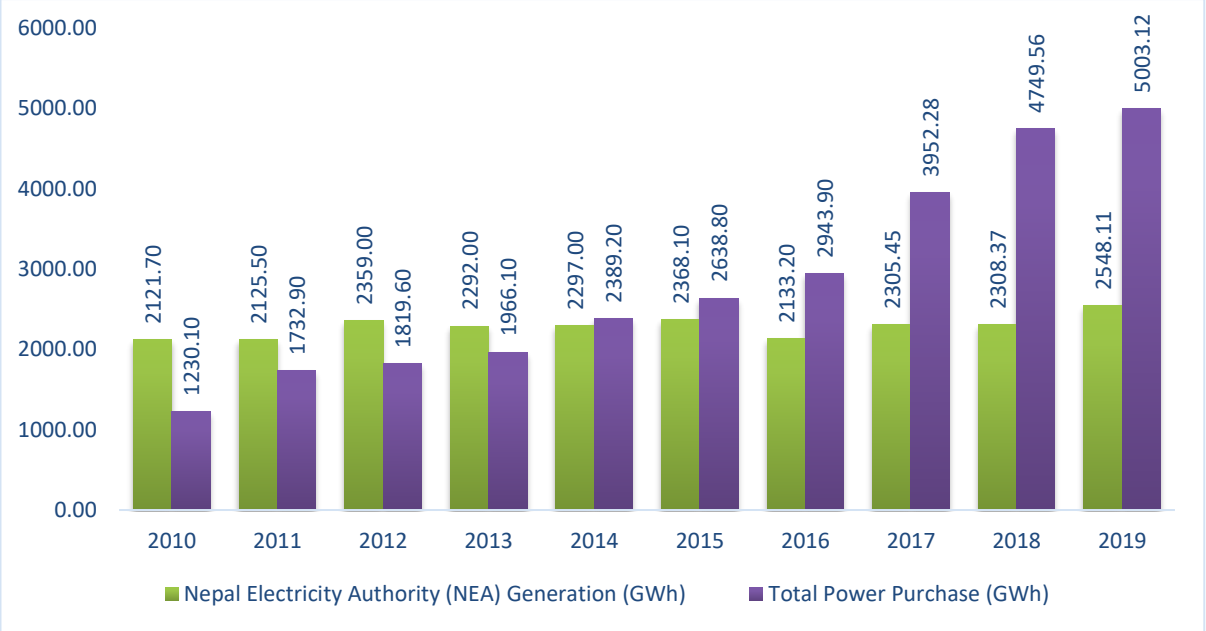


Figure 7: Electricity Generation and Total Power Purchase of Nepal from 2010-19

3.6.2 Structure of Power Sector

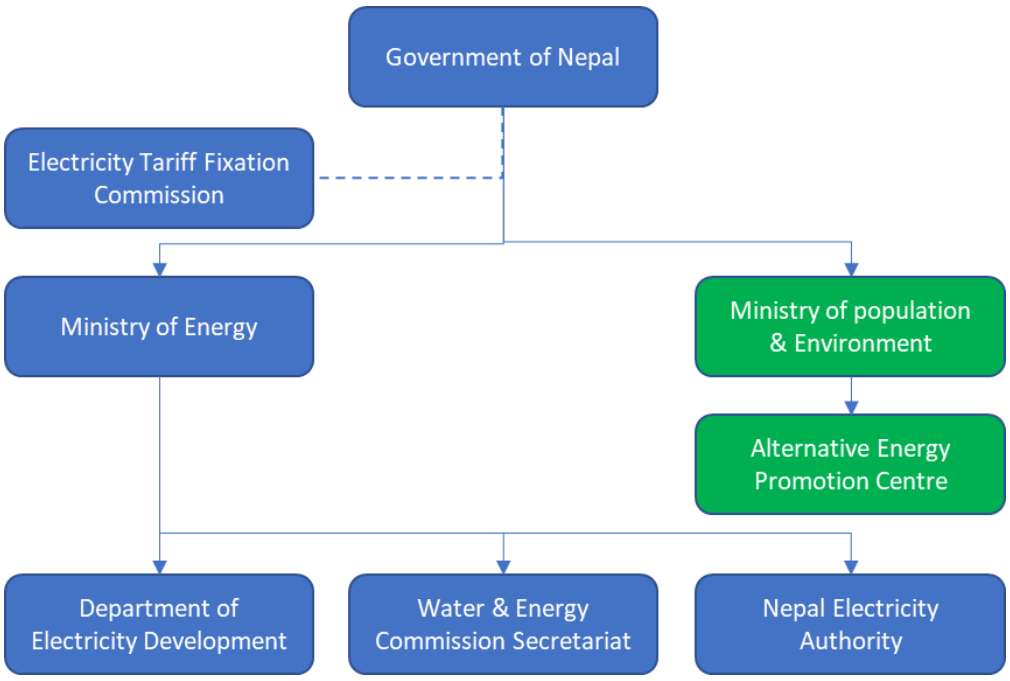


Illustration 30: Power Sector Structure in Nepal

3.6.3 Institutional, Legal, Regulatory Framework and Operational Structure

Table 13: Institutional, Legal, Regulatory framework of the power markets in Nepal

Sno.	Particulars	Yes / No
1	**Policy Framework**	
a	Promotion of Competition in Generation, transmission and Distribution	Yes
b	Multi-Buyer Model – unbundling of utilities	No

Sno.	Particulars	Yes / No
c	Promotion of merchant Generation Capacity	No
d	Promote Trading of Electricity	Yes
e	Promotion of Open Access in transmission	No
f	Promotion of Open Access in distribution	No
g	Reasonable tariff for open access	No
h	Promote competitive power procurement by utilities	Yes
i	Adequacy of transmission and distribution system	No
j	Development of support infrastructure	Yes
	Robust banking network with online payment facility	*Yes*
	Robust Telecom network with good internet connectivity	*Yes*
2	**Legal Framework**	
a	Recognizing Trading Activity	No
b	Mandatory open access in transmission & Distribution	No
c	Threshold for eligibility for open access to customers	No
d	Determination of charges and losses for open access	No
e	Licensing and functions of power exchange	No
f	Licensing for transmission,	Yes
g	Licensing for distribution & Trading	Yes
h	Establishment, function & Power of system operators	No
i	Establishment, function and power of electricity regulator	Yes
j	Adjudicatory power to regulatory and appeals	No
3	**Regulatory Framework**	
a	Grant of license / Authorization for setting up power exchange	No
b	Governance and market operation of power exchanges	No
c	Scheduling of transactions by power exchange	No
d	Market surveillance and reporting by power changes	No
f	Authorization of contracts on power exchanges	No
g	Electricity grid code – scheduling of electricity transactions	Yes
h	Procedure for open access and connectivity in transmission and distribution	No
i	Transmission and Wheeling tariff framework	No
j	Imbalance settlement Mechanism	No
k	Dispute Resolution	No

Table 14: Current State of Power Exchange and Available Features in Nepal

	Competition	Openness of Market	Access to Infrastructure
High	Fully Competitive Market Determined by Market Forces	De-licensed Market	Open Access Implementation
Medium	Semi-Competitive Market Regulated	**Licensing Required, but independent Regulator**	**Open Access provision available but not implemented**
Low	**No Competition/ Monopoly**	Stringent Licensing Requirements	No Provision for Open Access

3.6.4 Current Framework and Gap Analysis

This sub-chapter attempts to summarize the sufficiency of the existing framework and determine the gaps in the framework for the establishment of power exchange in the country. Nepal currently has a policy framework on the Promotion of merchant/IPP Generation Capacity and Promote Trading of Electricity and has not worked on the many parts of a conducive frameworks on Policy, Regulatory or Legal aspects.

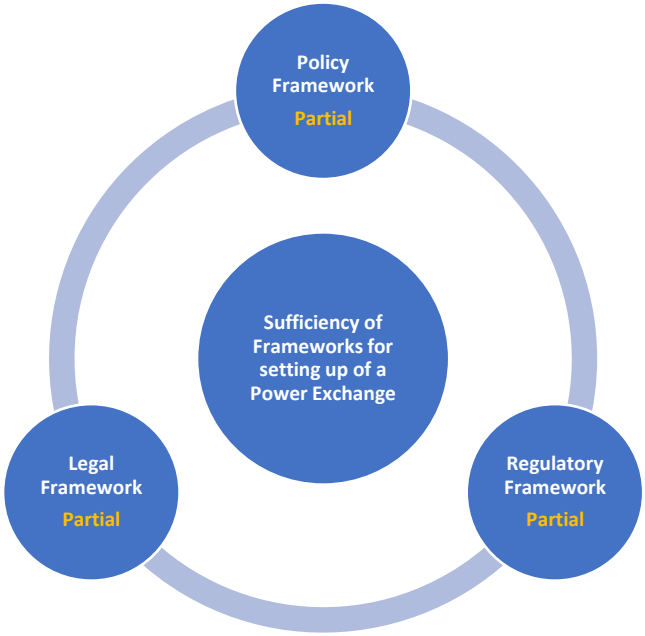


Illustration 31: Summary of sufficiency of frameworks for setting up Power Exchange in Nepal

3.6.5 SWOT Analysis

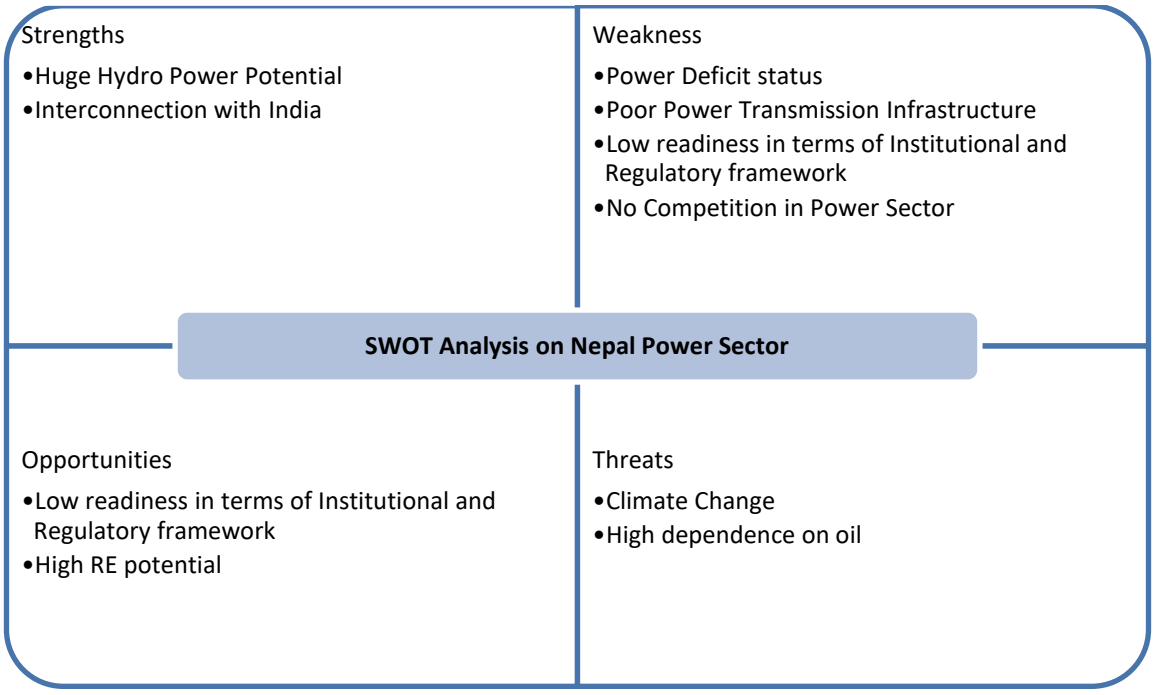


Illustration 32 SWOT Analysis of Nepal's Power Sector

3.7 Power Sector Overview of Pakistan in the Context of Power Exchange Development

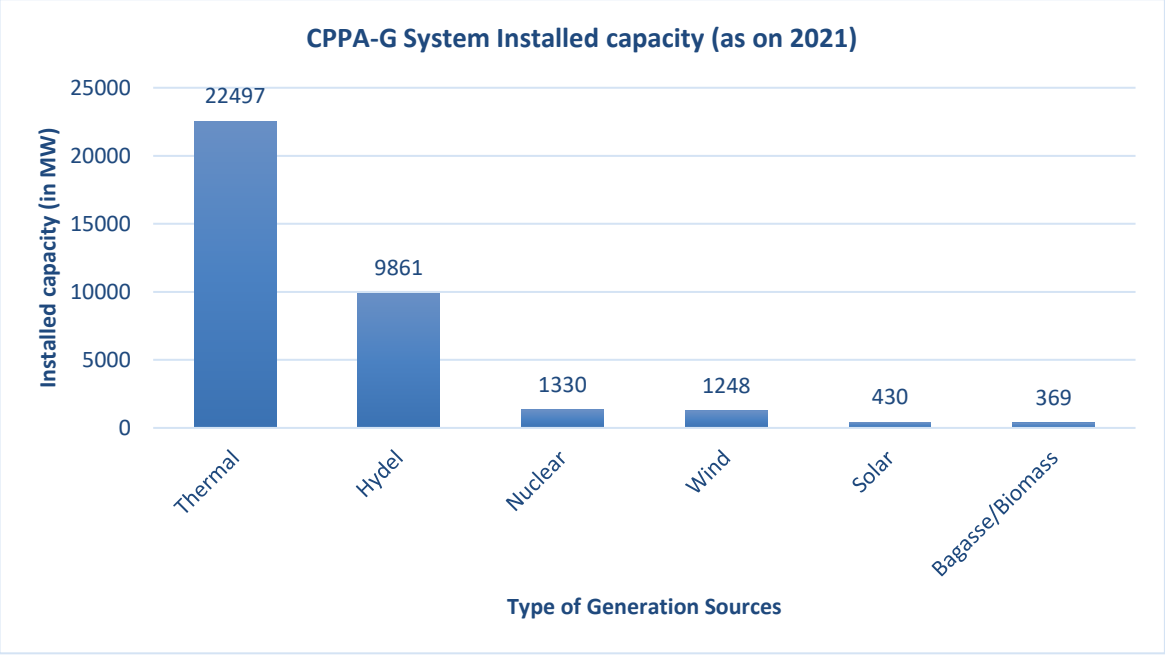
Pakistan is a country located in the Southern part of Asia. It houses a total population of over 225.2 million in a total area of 881,913 square kilometers. Islamabad is the capital city of Pakistan.

3.7.1 Power Generation, Installed Capacity and Technologies

Pakistan has a total installed capacity of 38573 MW as on 30 June 2021. Natural gas is the major source of electricity with 32% followed by hydro at 26%. (Government of Pakistan, Finance Division, 2019-20) Furnace oil and coal cumulatively form 30% of the installed capacity. The total installed capacity of power plants in CPPA-G System and KE Systems as on 30-06-2021 was 36,934 MW and 2,838 MW respectively.

The total installed generation capacity of public sector power plants in the country as on 30-06-2021 was 20,820 MW while the installed generation capacity of private sector power plants, including KE, was 18,952 MW. Out of 39,772 MW, 25,098 MW is thermal (GENCOs, IPPs, SPPs & KE), 9,915 MW hydroelectric, 1,248 MW wind, 530 MW solar, 369 MW bagasse and 2,612 MW nuclear. The addition of 1,145 K-2 Nuclear Power Plant in May, 2021 has significantly increased the nuclear power generation capacity in the country. The installed capacity of public sector and private sector power plants in CPPA-G system as on 30-06- 2021 was 20,683 MW and 16,251 MW respectively.

The total installed capacity of KE's own power plants as on 30-06-2021 was 2,084 MW. KE's own generation capacity is not sufficient to meet the demand in its area. Therefore, besides its own generation, KE also purchased electric power from external sources including 366 MW IPPs, 151 MW SPPs/CPPs, 137 MW KANUPP and 100 MW solar power plants connected with KE System. (NEPRA, 2021)



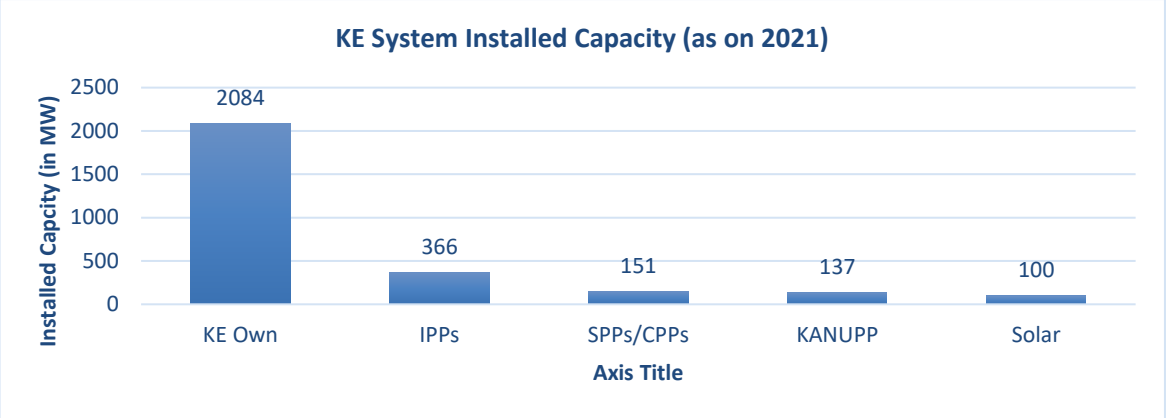
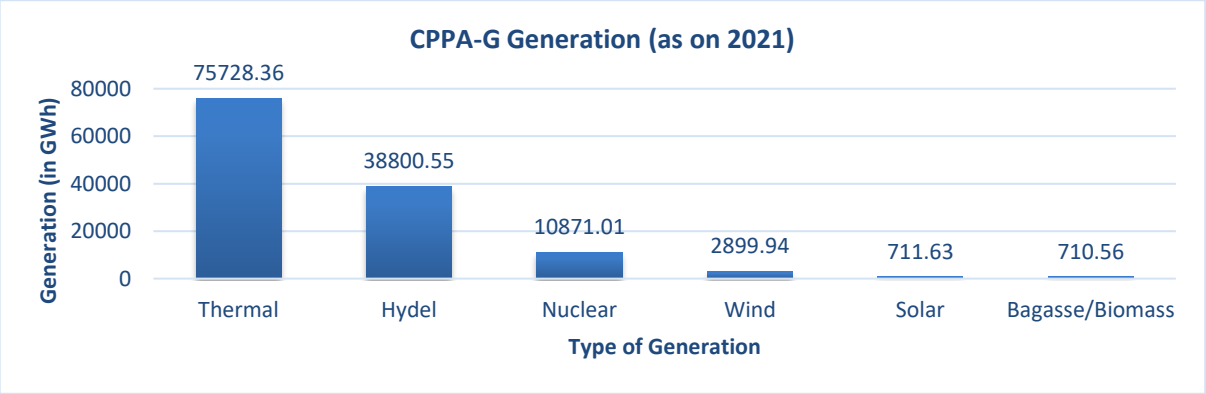


Illustration 33: Source wise installed capacity (in MW) of Pakistan for 2020-21

During FY 2020-21, the generation of thermal IPPs in CPPA-G System has shown a significant increase of 13.16% over the last year's generation with the same generation capacity. Similarly, the generation from hydel IPPs, and RE power plants also recorded increase of 0.26% and 4.10% respectively. However, the generation from GENCOs decreased by 13.97% over the last year's generation. During FY 2020-21, KE's own generation increased by 5.78% over the last year's generation. In KE's basket, the lower utilization of KE's comparatively efficient gas based power plants (BQPS-II, KCCPP, Site and Korangi Gas Engines) was noted at various occasions. Operation of less efficient power plants of BQPS-I by using the pipeline quality gas was also noted during FY 2020-21. The purchases from IPPs also increased during the period; major chunk coming from the RFO based power plants of Gul Ahmed and Tapal Energy which increases the per unit cost of electricity in KE system. During FY 2020-21, Gul Ahmed and Tapal Energy supplied 673 GWh and 37 GWh of electricity to KE respectively.



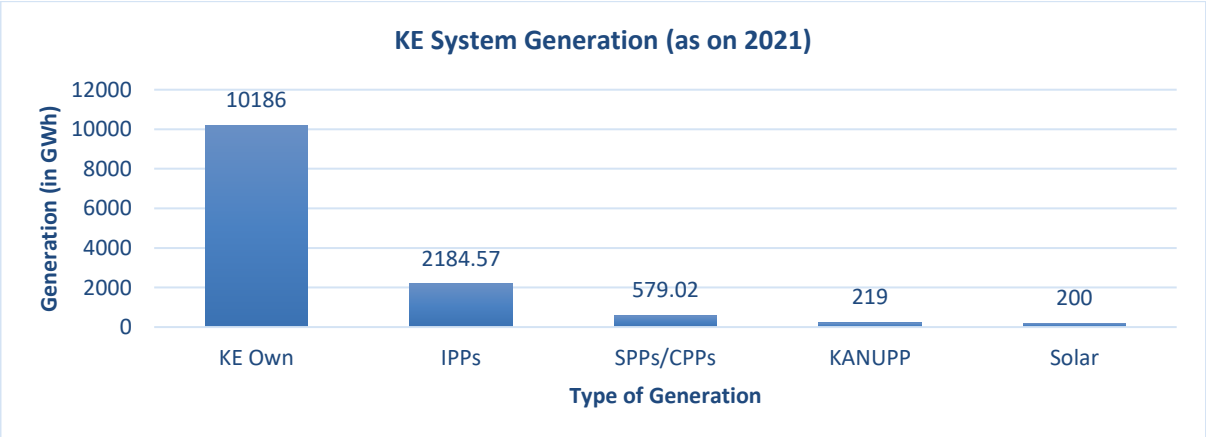


Illustration 34: Technology-wise Electricity Generation (GWh) for 2020-21

Pakistan is targeting to have 30% renewable energy generation with the total energy mix (RE Targets, Pakistan, 2015).

3.7.2 Structure of Power Sector

Ministry of Water and Power is the legislative body in the country and is responsible for the formulation and notification of legislation on electricity and energy in Pakistan. The structure of the power sector in Pakistan is illustrated as below:

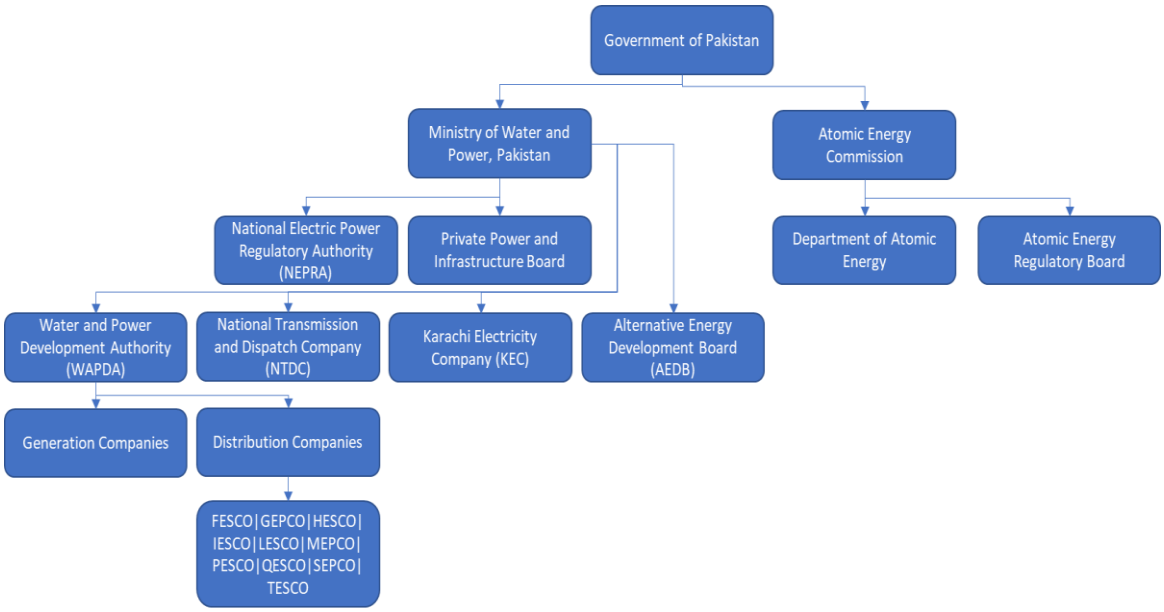


Illustration 35: Power Sector Structure in Pakistan

The following legislation and policies are formulated for the purpose of development and regulation of the power sector in Pakistan:

a. Renewable Energy Policy, 2019
b. Electric Vehicle Policy, 2019
c. National Energy Efficiency and Conservation Act, 2016
d. Pakistan Net Metering Policy for Solar PV and Wind Projects, 2015
e. Power Generation Policy, 2015
f. National Power Policy, 2013
g. Pakistan 2025: One Nation, one Vision, 2013

Pakistan has adopted reforms to increase the efficiency of the sector by way of unbundling and corporatization and inviting private participation. Water and Power Development Authority (WAPDA) was unbundled into 16 entities with the responsibility of thermal power generation, transmission and distribution. The hydropower plants were retained by WAPDA and corporatized as WAPDA Hydroelectric. The unbundled entities were corporatized as 11 distribution companies, 04 thermal power generation companies and a transmission company, the National Transmission and Dispatch Company. Pakistan's power generation is dominated by private IPPs.

3.7.3 Institutional, Legal, Regulatory Framework and Operational Structure

The power exchanges provide platform for electricity trading, to bring liquidity i.e., buyers and sellers on this platform, requires various legal, policy and regulatory measures. These measures are generally executed gradually as they require major structural reforms and huge capital. Pakistan, one of the aspiring and developing countries in the region can bring in efficiencies in the region by having functional power exchange in the country in terms of electricity transactions. The current status of Regulatory, Legal & Policy Framework required for setting up of a power exchange in Pakistan is provided below:

Table 15: Status of required Frameworks for setting up of Power Exchange in Pakistan

Sno.	Particulars	Yes / No
1	Policy Framework	
a	Promotion of Competition in Generation, transmission and Distribution	Yes
b	Multi-Buyer Model – unbundling of utilities	Yes
c	Promotion of merchant Generation Capacity	Yes
d	Promote Trading of Electricity	No
e	Promotion of Open Access	No
f	Reasonable tariff for open access	No
g	Promote competitive power procurement by utilities	No
h	Adequacy of transmission and distribution system	Yes
i	Development of support infrastructure	Yes
	Robust banking network with online payment facility	Yes
	Robust Telcom network with good internet connectivity	Yes
2	**Legal Framework**	
a	Recognizing Trading Activity	No
b	Mandatory open access in transmission & Distribution	No
c	Threshold for eligibility for open access to customers	No
d	Determination of charges and losses for open access	No
e	Licensing and functions of power exchange	No
f	Licensing for transmission and distribution	Yes
g	Licensing for trading	No
h	Establishment, function & Power of system operators	No
i	Establishment, function and power of electricity regulator	No
j	Adjudicatory power to regulatory and appeals	No
3	**Regulatory Framework**	
a	Grant of license / Authorization for setting up power exchange	Yes
b	Governance and market operation of power exchanges	Yes
c	Scheduling of transactions by power exchange	No
d	Market surveillance and reporting by power changes	No
f	Authorization of contracts on power exchanges	No
g	Electricity gride code – scheduling of electricity transactions	Yes
h	Procedure for open access and connectivity in transmission and distribution	No
i	Transmission and Wheeling tariff framework	Yes
j	Imbalance settlement Mechanism	No
k	Dispute Resolution	No

Table 16: Current State of Power Exchange and Available Features in Pakistan

	Competition	Openness of Market	Access to Infrastructure
High	Fully Competitive Market Determined by Market Forces	De-licensed Market	Open Access Implementation
Medium	Semi-Competitive Market Regulated	Licensing Required, but independent Regulator	Open Access provision available but not implemented
Low	No Competition/ Monopoly	Stringent Licensing Requirements	No Provision for Open Access

3.7.4 Current Framework and Gap Analysis

This sub-chapter attempts to summarize the sufficiency of the existing framework and determine the gaps in the framework for the establishment of power exchange in the country. Pakistan currently has policy framework on Promotion of merchant/IPP Generation Capacity & Promotion of Trading of Electricity and has not worked on the many parts of a conducive frameworks on Policy, Regulatory or Legal aspects.

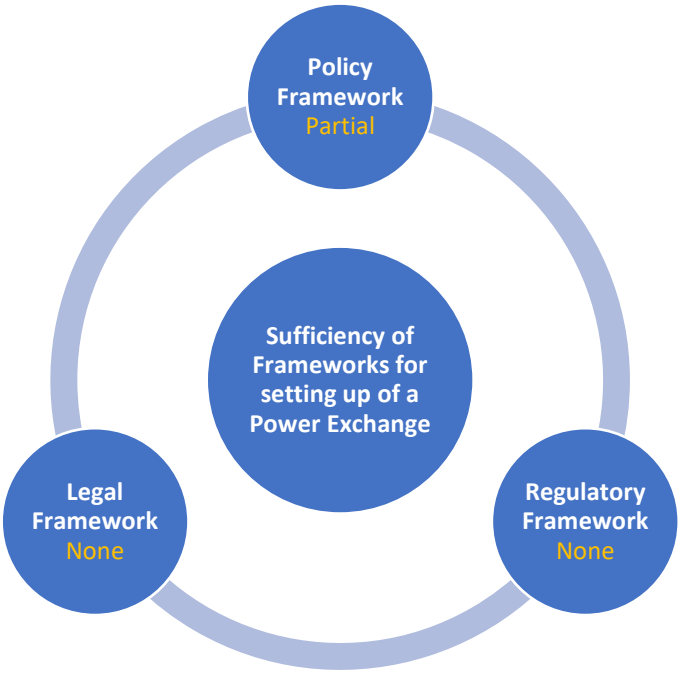


Illustration 36: Summary of sufficiency of frameworks for setting up Power Exchange in Pakistan

3.7.5 SWOT Analysis

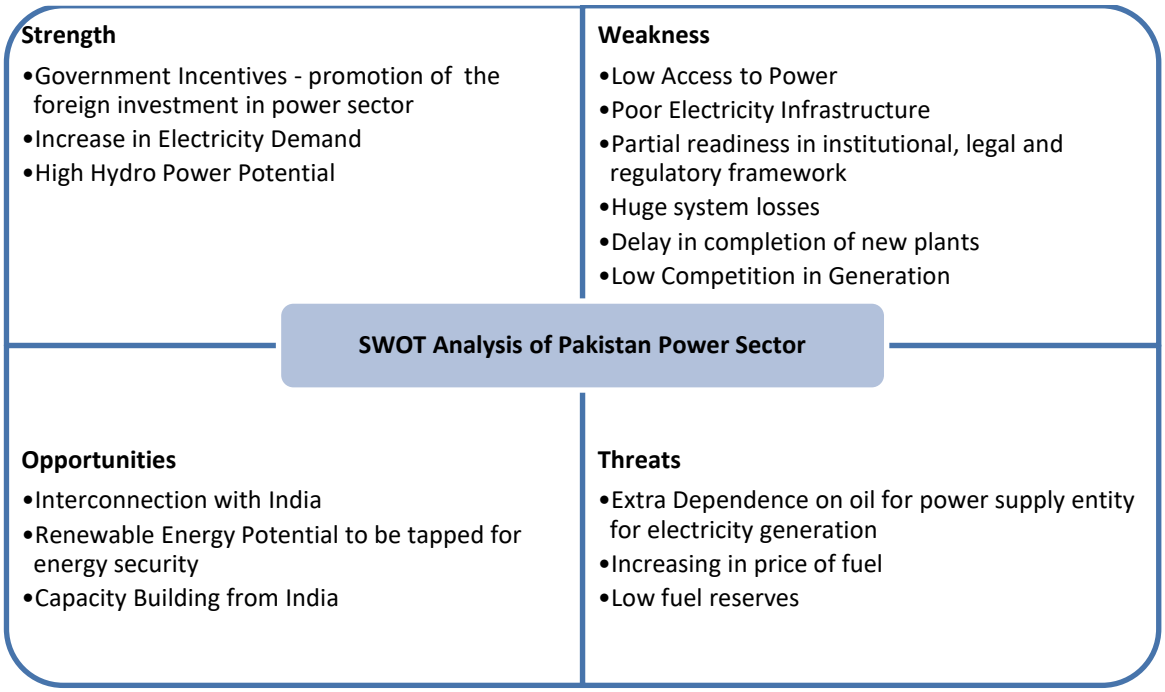


Illustration 37: SWOT Analysis of Pakistan's Power Sector

3.8 Power Sector Overview of Sri Lanka in the Context of Power Exchange Development

Sri Lanka is an island country located in the southern part of Asia. It is located in the Indian Ocean, southwest of the Bay of Bengal. Sri Jayewardenepura Kotte is the administrative & legislative capital and Colombo is the economic capital of Sri Lanka. Sri Lanka houses a population of around 21 million (Registrar General's Department. "Mid-year Population Estimates by Age Group and Sex, 2014 - 2019") with a total area of 65,610 square kilometers.

3.8.1 Power Generation, Installed Capacity and Technologies

The total installed capacity for power generation is 4265 MW as on 2020 dominated by thermal at 2168 MW, followed by hydropower capacity at 1793 MW, Wind power by 179 MW and renewables (Solar, Mini-hydro, Dendro (wood), Biomass) at 125 MW respectively (Statistical Digest 2020, 2020).

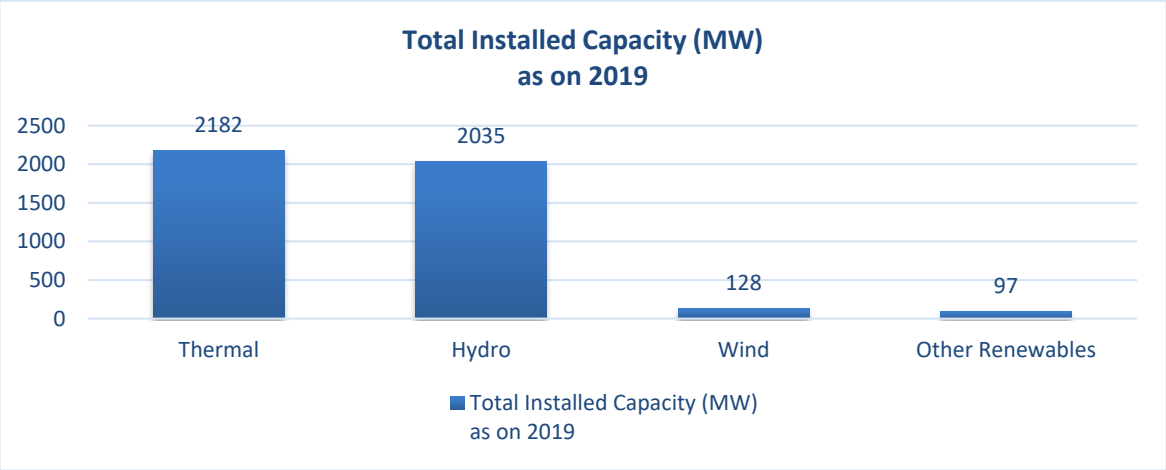


Illustration 38: Source wise installed capacity as on 2019 in Sri Lanka

The actual power generation is dominated by thermal, hydro, wind and other renewable energy resources as on 2019. Out of 16486 GWh total power generation, 10373 GWh come thermal which includes coal and oil, 5545 GWh from hydropower, 348 GWh from Wind and 220 GWh from other renewables (Solar, Mini-hydro, Dendro (wood), Biomass). (Statistical Digest 2020, 2020)

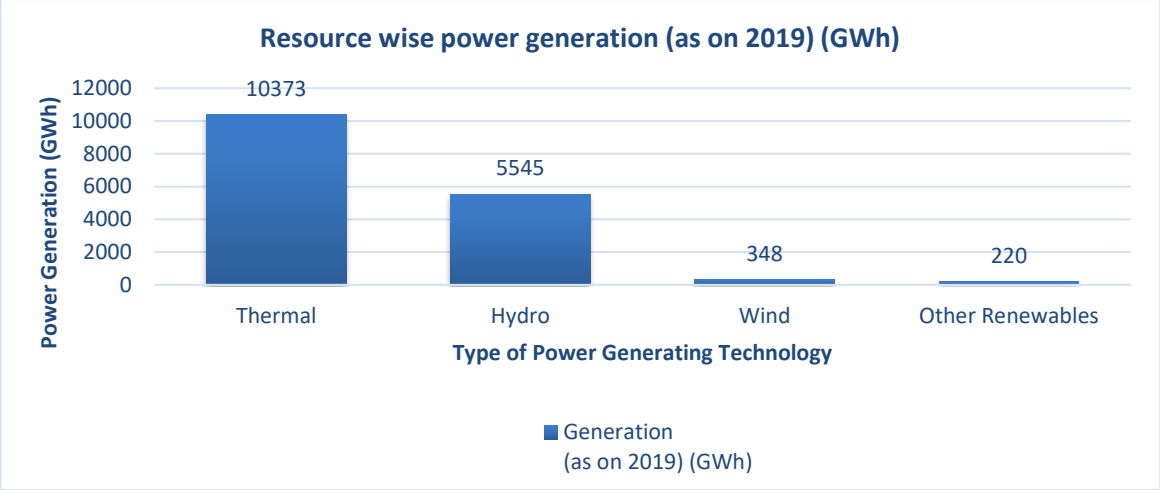


Illustration 39: Resource wise power generation (GWh) (as on 2019) in Sri Lanka

Sri Lanka is a member of Climate Vulnerability Forum (CVF) which has pledged to become carbon neutral by 2050. The Renewable Energy Development Plan Phase I, (2019-2025) prepared by the Sustainable Energy Authority of Sri Lanka, plans to add new installed solar capacity of 1,564MW (including 330MW of rooftop PV and 200MW of floating solar), 805MW of wind, 56MW of Biomass, 110MW mini hydro by 2025. (Ministry of Power, Sri Lanka, 2021) (Ministry of Power, Sri Lanka, 2021).

Table 17: Cumulative Capacity of Renewable Energy

Renewable Energy	Cumulative Capacity (MW) (as on 2020)
Small Biomass Projects	153
Mini Hydro Projects	873
Small Solar Power Projects	161
Small Wind Power Projects	401
Total	**1588**

(Ministry of Power and Energy, 2021)

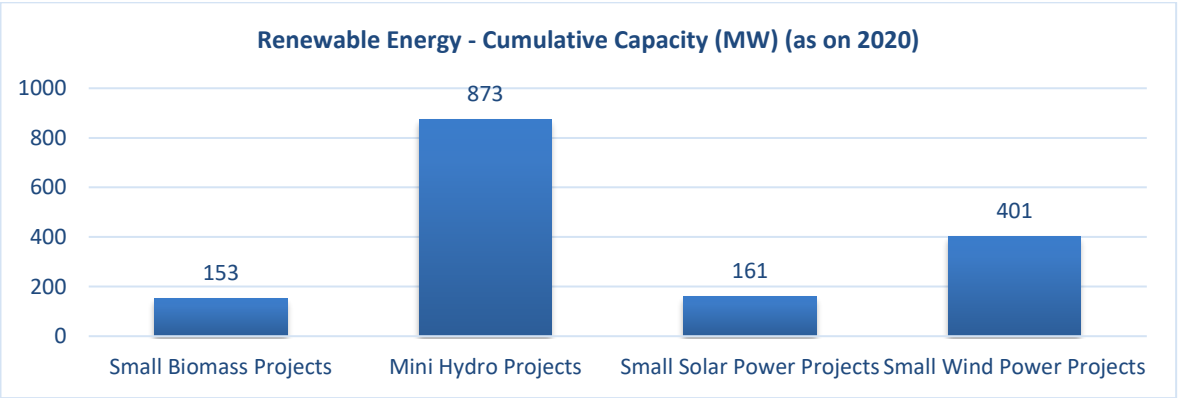


Illustration 40: Cumulative capacity of Renewable Energy (as on 2019)

3.8.2 Structure of Power Sector

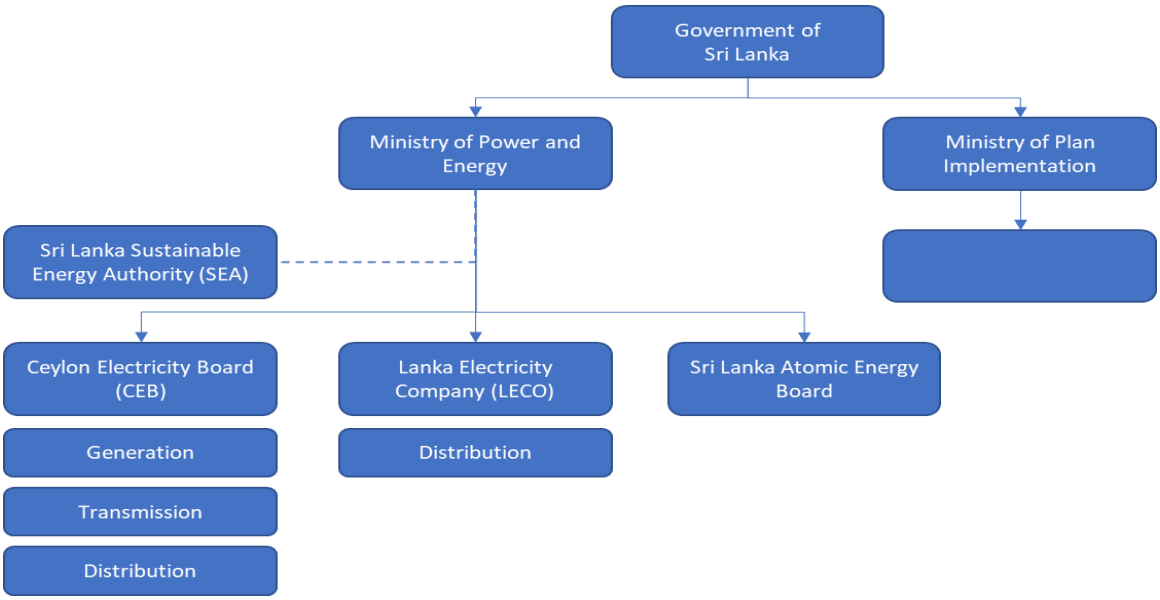


Illustration 41: Structure of Power sector in Sri Lanka[12]

3.8.3 Institutional, Legal, Regulatory Framework and Operational Structure

Table 18: Policy, Legal and Regulatory Framework available in Sri Lanka

Sno.	Particulars	Yes/No
1	Policy Framework	
A	Promotion of Competition in Generation	Yes
B	Promotion of Competition in Distribution	No
C	Promotion of Competition in Transmission	No
D	Multi-Buyer Model – unbundling of utilities	No
e	Promotion of merchant/IPP Generation Capacity Govt. Utilities	Yes
f	Promote Trading of Electricity	No
g	Promotion of Open Access	No
h	Reasonable tariff for Open Access	No
i	Promote competitive power procurement by utilities	No
j	Adequacy of transmission and distribution system	Yes
k	Development of support infrastructure	No
	Robust banking network with online payment facility	Yes
	Robust Telcom network with good internet connectivity	Yes
2	**Legal Framework**	
a	Recognizing Trading Activity	
b	Mandatory open access in transmission & Distribution	No

[12] (ADB, 2017)

Sno.	Particulars	Yes/No
c	Threshold for eligibility for open access to customers	No
d	Determination of charges and losses for open access	No
e	Licensing and functions of power exchange	No
f	Licensing for transmission, distribution & Trading	No
g	Establishment, function & Power of system operators	No
h	Establishment, function and power of electricity regulator	No
i	Adjudicatory power to regulatory and appeals	No
3	**Regulatory Framework**	
a	Grant of license / Authorization for setting up power exchange	No
b	Governance and market operation of power exchanges	No
c	Scheduling of transactions by power exchange	No
d	Market surveillance and reporting by power changes	No
f	Authorization of contracts on power exchanges	No
g	Electricity Gride Code – scheduling of electricity transactions	Yes
h	Procedure for open access and connectivity in transmission and distribution	No
i	Transmission and Wheeling tariff framework	No
j	Imbalance settlement Mechanism	No
k	Dispute Resolution	No

Table 19: Current State of Power Exchange and Available Features in Sri Lanka

	Competition	Openness of Market	Access to Infrastructure
High	Fully Competitive Market Determined by Market Forces	De-licensed Market	Open Access Implementation
Medium	**Semi-Competitive Market Regulated**	**Licensing Required, but independent Regulator**	Open Access provision available but not implemented
Low	No Competition/ Monopoly	Stringent Licensing Requirements	**No Provision for Open Access**

3.8.4 Current Framework and Gap Analysis

This sub-chapter attempts to summarize the sufficiency of the existing framework and determine the gaps in the framework for the establishment of power exchange in the country. Sri Lanka currently has a policy framework on Promotion of Competition in Generation and Promotion of merchant/IPP Generation Capacity and has not worked on the many parts of a conducive frameworks on Policy, Regulatory or Legal aspects.

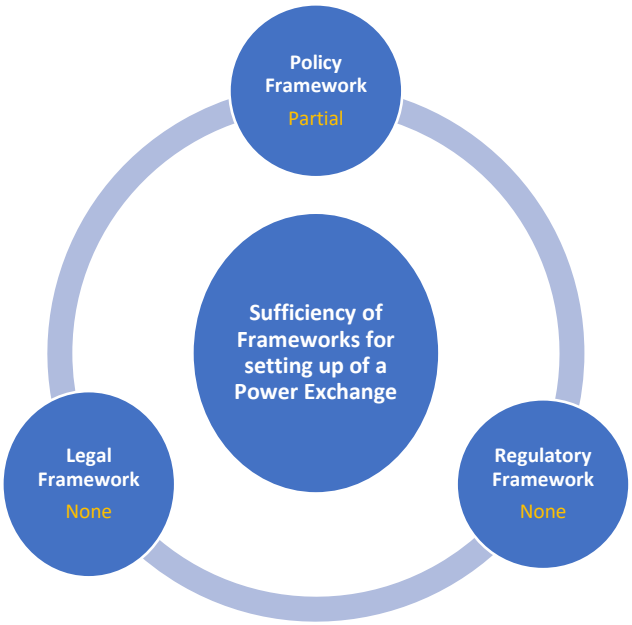


Illustration 42: Summary of sufficiency of frameworks for setting up Power Exchange in Sri Lanka

3.8.5 SWOT Analysis

SWOT Analysis on Sri Lanka Power Sector

Strengths	Weakness
•Energy sufficient •No Major load shredding •Abundant RE Potential	•High reliiance on high cost power •Low quantum of Demand •Poor Electricity demand growth •Low rediness for Power Trade and Open Access in terms of Institutional, Legal and Regulatory Framework
Opportunities	**Threats**
•Possible Interconnection with India •Cross Border Power Trade •Capacity Building from India	•Climate Change •Geopolitics around Oil supply and Pricing

Illustration 43: SWOT Analysis of Sri Lanka's Power Sector

3.9 Observations on Readiness to Set up National Power Exchanges in SAARC Member States

In the previous sections of this handbook, the readiness of each country in terms of policy, legal and regulatory framework and SWOT analysis is detailed. This chapter attempts to summarize the status of SMS in the setting up of NPEX.

In the SMS, India already has 2 fully functional power exchanges and the third power exchange is to become functional probably by next year. Apart from India, Pakistan's electricity sector is comparatively more organized with respect to other SMS.

Pakistan has most of the institutional structure operational or would be in operation in near terms, necessary for the setting up a national power exchange. Pakistan is equipped with unbundled power utilities, policy provisions to promote trading of electricity, legal provisions like the establishment of independent electricity regulator, establishment of a system operator, mandatory third-party access to transmission & distribution infrastructure, recognizing and licensing trading activity, licensing and functions of power exchange and Regulatory Provisions like transmission pricing and wheeling tariff framework and dispute resolution. However, it lags in policy, legal and regulatory provisions.

Enabling an environment with suitable policy provisions to promote non-discriminatory access to transmission and distribution networks through electricity policies will help Pakistan to establish power market/ power exchanges. The Government Policy may also provide enabling environment to facilitate licensing of the entities envisaged in the Electric Power Act 1997, it will increase buyers thereby increasing liquidity in the market.

To induce competition in the sector, the policy to implement the provisions of the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997 may be formulated. To promote merchant generation, the policy may permit the sale of power by Generators to licensees at competitive terms without requiring specific approval of tariff from NEPRA for each transaction. NEPRA may provide a ceiling tariff for such transactions and allow the purchase of power by DISCOMs within such limits.

The NEPRA may gradually adopt a power exchange model among the models discussed in this report. NEPRA may prescribe Open Access rules or regulations to further streamline Open Access. The open access regulations should provide a mechanism for short term Open Access/wheeling period, say for a period from one hour to one month etc. to facilitate market-based transactions. Grid Code may be amended to facilitate short term transactions say Day Ahead, Intra-Day etc. For smooth functioning of the energy market and Grid Discipline, a commercial mechanism for settlement of deviations/imbalance is necessary. Therefore, NEPRA may prescribe an imbalance settlement mechanism for deviations from the schedule by the Generators and Buyers.

Coming to Bangladesh, the country has a sufficient market with a sufficient size of electricity transactions to have viable power exchange. It is currently equipped only with an Independent System Operator and Dispute settlement regulations. However, the country lacks certain provisions and frameworks required to have NPEX. Provisions pertaining to the non-discriminatory open access to transmission and distribution need to be enabled. The policy to establish more

merchant capacity at a negotiated or discovered tariff through competitive bidding may be incorporated.

To check on prices, BERC may only specify a ceiling tariff for such procurement by utilities. Unbundling of utilities by separation of the generation, transmission and distribution functions ensures non-discriminatory access to a third party (open access), which is essential for the establishment of the market. It is suggested that unbundling should be incorporated in the Government policy.

The promotion of competition in all the segments of the electricity sector is essential. Therefore, it is suggested that a policy framework for multiple transmission licensees and distribution licensees may be established to induce competition in the transmission and distribution sectors. For the establishment of power exchange, it is essential that a policy framework for the promotion of trading in electricity should be established. To promote merchant power plants, the policy should be amended to provide flexibility to the utilities to procure power from the commercial power plants on a need basis i.e., time of the day or seasonal requirement and the tariff may be discovered through competitive bidding. To check on prices, BERC may impose a cap on prices at which such power may be procured by utilities.

The BERC Act, 2003 may provide for the development of the electricity market as one of the functions of BERC. It is suggested that open access in transmission and distribution should be provided by incorporating the provisions in this regard in the Electricity Act 2018 and the BERC Act 2003. It is suggested that the trading in electricity should be provided as licensed activity by incorporating the appropriate provisions in the Electricity Act 2018 and the BERC Act 2003.

In addition, to establish power exchange, it is desirable that the provisions for licensing and functions of power exchange should be incorporated in the Electricity Act 2018 and the BERC Act 2003. The BERC should frame regulations for the establishment of power exchange. The BERC should frame regulations for third party access and transparent allocation of capacity in the transmission and distribution network. The Regulator should frame regulations for imbalance settlement in case of deviations from the schedules which inter-alia should include the charging mechanism for deviations. BERC may also establish a framework for transmission and wheeling tariff, if not established already.

The other SMS are far from having a National Power Exchange in the next 5-6 years and are deliberated in relevant sections.

Chapter 04. Setting Up Power Exchanges in SAARC

4.1 Afghanistan

4.1.1 Existing Gaps and Recommendations

We have reviewed the following documents to analyse the regulatory and market space of Afghanistan.

- National Priority Programs, 2017
- National Infrastructure Plan, 2017-2021
- Renewable Energy Policy, 2015 (Ministry of Energy & Water, 2015)
- Power Services Regulation Act, 2016
- Afghanistan Energy Sector Self-Sufficiency Development Plan,2016

Table 20: Gaps Analysis and Recommendations for Afghanistan

Particulars	Gap Analysis	Recommendations
Policy		
Promotion of non-discriminatory third party access (Open Access) to transmission and Distribution infrastructure	The Afghanistan National Infrastructure Plan 2017-2021 provides for an extensive plan for the development of transmission and distribution infrastructure. Further, the plan also envisages to position Afghanistan as a strategic partner in the regional energy market. However, the plan does not specifically cover the non-discriminatory access of transmission and distribution systems to the third party for establishing the market in electricity. The provision for third party sale is available in the Renewable Energy Policy 2015, however, it is restricted to renewable energy projects.	In addition to the development of infrastructure for ensuring supply, it is desirable that access to such infrastructure on a non- discriminatory basis in accordance with the objectives of the Power Services Regulation Act 2016 needs to be ensured in the future infrastructure plans of Afghanistan.
Multi-Buyer Multi Seller Model	The Renewable Energy Policy 2015 provides for the capacity addition through Independent Power Producers (IPP) route. However, the sale of electricity is restricted to the utility and the policy is restricted to RE sources. Further, Afghanistan Energy Sector Self-Sufficiency Development Plan 2016 also indicates a plan for private sector	To develop the electricity market, it is essential that there are multiple buyers and multiple sellers. Therefore, it is recommended that along with the private sector participation in generation and distribution, the consumers (say with large

Particulars	Gap Analysis	Recommendations
	entry in distribution sector which inter-alia suggests scope for a multi-buyer model.	load) may be permitted to purchase electricity from a third party.
Unbundling of Utilities	DABS had initiated the reforms of the energy sector in terms of unbundling a few years back. However, the policy provision could not be ascertained with the available data.	Unbundling of utilities by separation of the generation, transmission and distribution functions ensures non-discriminatory access to a third party (open access) which is essential for the establishment of the market. It is suggested that unbundling should be incorporated in the Government Policy.
Promotion of competition in Generation, Transmission & Distribution	The Power Services Regulation Act 2016 provides for multiple licenses for generation, transmission and distribution. However, a policy framework is not available to facilitate licensing.	A framework for competitive allocation of the licenses for generation, transmission and distribution should be established for transparent inducement of competition in the market.
Promote Trading of electricity	The Power Services Regulation Act 2016 provide for a license for the import and export of electricity which is a trading activity. It is also envisaged in the Afghanistan Energy Sector Self-Sufficiency Development Plan 2016 for the sale of power from IPPs to the consumers. However, the trading activity is not defined specifically within the above policy framework.	Recognizing trading activity at the national level is essential to establish a national market therefore a national level framework for trading in electricity should be established.
Promotion of merchant Generation capacity	The IPPs and private sector participation in generation have been incorporated in all the policies of the Government.	The government may establish a framework to mandate all generation capacity should have at least 25-30% of open capacity.
Legal		
Establishment of Independent Electricity Regulator	Article 5 of the Power Services Regulation Act 2016 provides that *"In order to achieve the objectives stated in this law and for effective*	To establish an independent Regulator, Article 5 of the Power Services Regulation Act 2016 may be modified as

Particulars	Gap Analysis	Recommendations
	and better electricity service delivery, the Energy Services Regulation Department shall function within the Ministry of Energy and Water." Therefore, though provision for the establishment of Regulator is provided however it is a department under the MEW. Hence, the Regulator is not independent from the Government.	*"In order to achieve the objectives stated in this law and for effective and better electricity service delivery, an independent Energy Services Regulation Authority shall be established.* Other Articles should be aligned with the above framework.
Establishment of a system operator	Article 3 (Terminologies), Clause 12 Power Services Regulation Act 2016 defines Electricity Dispatching Centre as *"the centre which functions to provide reliable and economic power, awareness, timing and to set and schedule production capacity, and the ability to import and transfer the power."* However, the functions and powers of such a Centre are not elaborated in the main body of the Act. Similarly, Article 3, Clause 23 defines - Transmission System Operator as *"a person responsible for the operation, maintenance and development of transmission in certain areas, and interconnections with other networks to strengthen the system in long-term to meet the requirements of the electric power transmission*." However, functions of such an entity are also not provided in the Act.	A separate Article on Electricity Dispatching Centre should be incorporated in the Power Services Regulation Act 2016 to provide functions and power of such centre for smooth functioning of the market. The functions may inter-alia include optimum scheduling and despatch of electricity, monitor grid operations, accounting of electricity transmitted through the grid, supervision and control over the transmission system, carrying out real-time operations, ensuring grid safety etc. It is also highlighted that the function of the development of transmission system lies with the transmission licensee and in general parlance Transmission System Operator is responsible for the functions as discussed above. Therefore, Article 3, Clause 23 need to be amended appropriately.

Particulars	Gap Analysis	Recommendations
Mandatory 3rd party access to transmission & distribution infrastructure	Article 32 of the Power Services Regulation Act 2016 casts obligation on the entity which has dominating force in the market to provide non-discriminatory access. Further Article 7 (3) provides for the regulation of such entity by the Regulator.	The power to frame regulations or framework for 3rd party access may be incorporated in Article 7 to smoothen 3rd party access.
Recognizing and licensing Trading Activity	The Power Services Regulation Act 2016 provide for a license for the import and export of electricity which is a trading activity. However, as such no recognition of the trading of electricity.	Recognizing trading activity in the Power Services Regulation Act 2016 will enable the trade of electricity within the country and thereby facilitate the establishment of power exchange.
Licensing and functions of Power Exchange	No provision is available in the Power Services Regulation Act 2016.	A provision should be incorporated in the Power Services Regulation Act 2016 for licensing and functions of power exchange.
Regulatory		
Power Exchange Regulations	Not available.	The Regulator should frame regulations for the establishment of power exchange having aspects covered in 2.2.3.a. of this report.
Procedure for 3rd party access (Open Access) and connectivity in transmission and distribution	Not available.	The Regulator should frame regulations for 3rd party access and transparent allocation of capacity in the T&D network.
Scheduling of electricity transactions	Not available.	The Regulator should frame regulations for scheduling and dispatch of electricity transactions and the role of the system operator.
Imbalance Settlement Mechanism	Not available.	The Regulator should frame regulations for imbalance settlement in case of deviations from the schedules which inter-alia

Particulars	Gap Analysis	Recommendations
		includes the charging mechanism for deviations.
Transmission pricing and wheeling tariff framework	The Power Services Regulation Act 2016 provides for determination of tariff by regulator however same is not available for our analysis.	The Regulator should frame regulations for transmission and wheeling tariffs to enable 3rd party access to the T&D System.
Dispute Resolution	Article 41 of The Power Services Regulation Act 2016 provides for the establishment of a Dispute resolution authority and a framework for dispute resolution.	No comments

4.1.2 Proposed Power Exchange Model

Afghanistan is a power deficit country to the tune of 80% of the total demand. It is important to build power generating capacity which is an important leg to create liquidity as a pre-requisite for power exchange which may be achieved by attracting private investments in this field. However, the current market condition and regulatory environment are not conducive for the same. The government of Afghanistan may bring in the regulatory and operational reforms in the country before bringing the separate power exchange in the country.

The power exchange model can be setup in Afghanistan when there are sufficient conditions available in the country as mentioned in section 2.1 of this document. A detailed step by step procedure is already mentioned in section 2.3 after addressing the gaps highlighted above.

4.2 Bangladesh

4.2.1 Feasibility Study: Existing Gaps and Recommendations

Following documents have been reviewed to analyse the regulatory and market space of Bangladesh:

a. BERC (Electricity Grid Code) Regulations, 2019
b. The Electricity Act, 2018
c. Power System Master Plan 2016
d. BERC Dispute Settlement (Amendment) Regulations, 2016
e. BERC Dispute Settlement Regulations, 2014
f. Sustainable and Renewable Energy Development Authority Act, 2012
g. Quick Enhancement of Electricity and Energy Supply (Special Provisions) Act, 2010
h. Policy Guidelines for Enhancement of Private Participation in Power Sector, 2008
i. Policy Guidelines for Power Purchase from Captive Power Plant, 2007, (Revised up to March 2019)
j. Bangladesh Energy Regulatory Commission (BERC) Act, 2003
k. Private Sector Power Generation Policy of Bangladesh, 2004

Table 21: Gaps Analysis and Recommendations for Bangladesh

Particulars	Gap Analysis	Recommendations
Policy		
Promotion of non-discriminatory 3rd party access (Open Access) to transmission and Distribution infrastructure	Clause 4(c) read with Clause 7(a) of the policy guidelines for enhancement of private participation in the power sector, 2008 provides that commercial power plants can sell electricity to large consumers at negotiated tariff. PGCB and all distribution licensees shall provide non-discriminatory open access to their transmission and/or distribution system for use by such generation licensee subject to payment of transmission/distribution wheeling charges determined by BERC.	For the establishment of power exchange, open access to transmission and distribution systems may be allowed to power exchanges on behalf of the generators and large consumers.
Multi-Buyer Multi Seller Model	The Government policy allows multiple sellers and multiple buyers by way of issuance of licenses for generation and distribution and also allowed large consumers to procure power through open access. However, the utilities are compelled to procure power through PPA mode and the tariff needs to be approved by BERC. Therefore, merchant generators or commercial power plants may not sell electricity to utilities on a short-term basis at negotiated/discovered tariffs.	The policy to establish more merchant capacity at a negotiated or discovered tariff through competitive bidding may be incorporated. To check on prices, BERC may only specify a cap on tariff for such procurement by utilities.
Unbundling of Utilities	Utilities are bundled as a single vertical entity	Unbundling of utilities by separation of the generation, transmission and distribution functions ensures non-discriminatory access to a third party (open access), which is essential for the establishment of the market. It is suggested that unbundling should be incorporated in the Government policy.

Particulars	Gap Analysis	Recommendations
Promotion of competition in Generation, Transmission & Distribution	The Power System Master Plan 2016 provides for competitive bidding in RE generation. Policy Guidelines for Enhancement of Private Participation in Power Sector, 2008 also provides for the procurement of power through competitive bidding.	The promotion of competition in all the segments of the electricity sector is essential. Therefore, it is suggested that a policy framework for multiple transmission licensees and distribution licensees may be established to induce competition in the transmission and distribution sectors.
Promote Trading of electricity	Policy to promote the trading of electricity is not present	For the purpose of establishment of power exchange, it is essential that a policy framework for the promotion of trading in electricity should be established.
Promotion of merchant Generation capacity	The policy guidelines for Enhancement of Private Participation in the Power Sector 2008 provides for the establishment of commercial power plants which have open capacity and they are free to sell their power to any large consumers. However, to sell power to utilities, the Tariff needs to be approved by the BERC. Therefore, these plants are not pure merchant plants as they enter into long term arrangements with the buyers.	To promote merchant power plants, the policy should be amended to provide flexibility to the utilities to procure power from the commercial power plants on a need basis i.e., time of the day or seasonal requirement and the tariff may be discovered through competitive bidding. To check on prices, BERC may impose a cap on prices at which such power may be procured by utilities.
Legal		
Establishment of Independent Electricity Regulator	Bangladesh Energy Regulatory Commission Act, 2003 provides for the establishment of an independent regulator.	The BERC Act, 2003 may provide for the development of the electricity market as one of the functions of BERC.
Establishment of a system operator	Section 5 of The Electricity Act, 2018 provides for the establishment of an Independent System Operator.	-

Particulars	Gap Analysis	Recommendations
Mandatory 3rd party access to transmission & distribution infrastructure	The policy guidelines for enhancement of private participation in the power sector 2008 provides for open access in transmission and distribution system, however, it could not be ascertained the provisions of any law which mandated open access in Transmission and Distribution.	It is suggested that open access in transmission and distribution should be provided by incorporating the provisions in this regard in the Electricity Act 2018 and the BERC Act 2003.
Recognizing and licensing Trading Activity	The trading is not a recognised activity in the law.	It is suggested that the trading in electricity should be provided as licensed activity by incorporating the appropriate provisions in the Electricity Act 2018 and the BERC Act 2003.
Licensing and functions of Power Exchange	Not Available.	To establish power exchange, it is desirable that the provisions for licensing and functions of power exchange should be incorporated in the Electricity Act 2018 and the BERC Act 2003.
Regulatory		
Power Exchange Regulations	Not Available.	The BERC should frame regulations for the establishment of power exchange having aspects covered in 2.2.3.a. of this report.
Procedure for third party access (Open Access) and connectivity in transmission and distribution	Regulations for third party access and transparence in allocation of capacity is not present	The BERC should frame regulations for third party access and transparent allocation of capacity in the transmission and distribution network.
Scheduling of electricity transactions	Regulation 7 - Schedule and Dispatch of BERC Grid Code 2019 provide for the scheduling of electricity transactions.	-
Imbalance Settlement Mechanism	The BERC Grid code 2019 imposes responsibility on the system operator to manage the variations in the frequency, however, as such	The Regulator should frame regulations for imbalance settlement in case of deviations from the schedules which inter-

Particulars	Gap Analysis	Recommendations
	no commercial mechanism is available to deal with these variations as the primary reason for frequency deviations from schedules.	alia should include the charging mechanism for deviations.
Transmission pricing and wheeling tariff framework	As per the provisions of the BERC Act 2003, BERC determined Tariffs for transmission and distribution. However, it could not be ascertained the framework notified by the BERC for the transmission and wheeling tariff.	BERC may establish a framework for transmission and wheeling tariff, if not established already.
Dispute Resolution	BERC dispute settlement regulation applies to settle disputes between the licensees or between licensees and the consumer.	-

4.2.2 Proposed Power Exchange Model

The power generation mix of Bangladesh is heavily reliant on natural gas with marginal costs of over $0.20/kWh. The electricity supply industry in Bangladesh is dominated by fossil fuels such as coal, gas and petroleum and has been increasing its contribution to generation capacity to meet the exponentially increasing demand and hence the environmental emissions. As a result, with the increasing cost of fossil fuels, it will be exposed to the rising cost of electricity and a significant risk of power outages due to their inability to cope up with the demand increase.

In the bundled electricity market, it is very difficult to isolate costs related to generation, transmission, and distribution. Hence, an aggregated cost tariff is imposed on customers. In Bangladesh, BERC enacts the regulated aggregated tariff on consumers considering government rules and guidelines. Due to this monopolistic approach consumers have no options left.

If the electricity market is open for all, more IPPs, SIPPs, PPPs, and other private sector will compete to enter the market. A more level playing field will be created for retailers. The retailers will not only bargain on offered price but also on the other facilities to the customers. As a result, better plans, quality, and reliability of power will be assured, price of electricity will reduce and there will be huge scope for additional generation. Customers will have more choices for retailers and retailers will give better service than what the monopolies do. India has a deregulated market with two power exchanges and a third exchange is also expected soon. The opening of Bangladesh's power market would enable trading of electricity through the pool or bilateral contract with neighbouring countries like India. Please refer to below representation for the same.

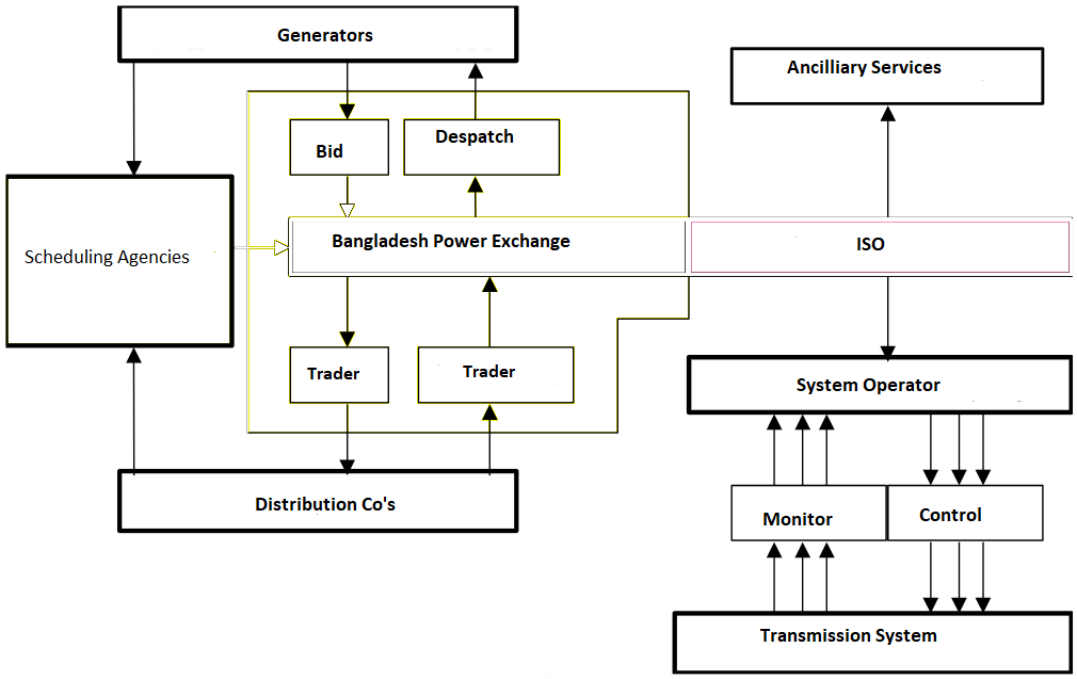


Illustration 44: Power Exchange model for Bangladesh

Power exchange model can be setup in Bangladesh by enabling the required regulatory and policy changes such as unbundling generation, transmission, and distribution, facilitating open access for sale of power, enacting regulations for imbalance settlement mechanism, promoting policies to encourage merchant generating stations etc. These reforms along with measures to create multi-buyer and sellers could help to build the market participants and thereby developing power exchange.

4.3 Bhutan

4.3.1 Feasibility Study: Existing Gaps and Recommendations

Following documents have been reviewed to analyse the regulatory and market space of Bhutan

a. Bhutan Sustainable Hydropower Development Policy, 2021
b. Domestic Electricity Tariff Policy of Bhutan, 2016
c. BEA Tariff Determination Regulation, 2016
d. Alternative Renewable Energy Policy, 2013
e. Framework for Private Participation in Infrastructure, 2010
f. BEA Dispute Resolution Procedure, 2009
g. Bhutan Sustainable hydro development policy, 2008
h. BEA Grid Code Regulation, 2008
i. Electricity Act of Bhutan, 2001

Table 22: Gaps Analysis and Recommendations for Bhutan

Particulars	Gap Analysis	Recommendations
Policy		
Promotion of non-discriminatory 3rd party access (Open Access) to transmission and distribution infrastructure	Clause 23.9 & 23.10 of The Alternative Renewable Energy Policy 2013 provides for 3rd party sale by a RE project and switching between 3rd parties. However, such sale is subject to 1st right of utility to buy such power. As such no provision in policies could be ascertained for open access in a non-discriminatory manner.	The provisions with respect to the promotion of non-discriminatory access to transmission and distribution networks should be incorporated in all electricity policies to enable the establishment of the market in electricity.
Multi-Buyer Multi Seller Model	Clause 23.9 of The Alternative Renewable Energy Policy 2013 provides for sell of power by a RE project to any consumer. However, other than RE, the provisions with respect to the promotion of multiple sellers and buyers could not be ascertained.	Unbundling of utilities by separation of the generation, transmission and distribution functions ensures non-discriminatory access to a third party (open access) which is essential for the establishment of the market. It is suggested that unbundling should be incorporated in the Government Policy.
Unbundling of Utilities	Utilities are bundled as a single vertical entity	Unbundling of utilities by separation of the generation, transmission and distribution functions ensures non-discriminatory access to a third party (open access) which is essential for the establishment of the market. It is suggested that unbundling should be incorporated in the Government Policy.
Promotion of competition in Generation, Transmission & Distribution	The framework for private participation in infrastructure 2010 provides for a competitive bidding framework forward of the projects. The Alternative Renewable Energy Policy 2013 also envisaged the setting up of IPPs. However, the	The promotion of competition in all the segments of the electricity sector is essential therefore it is suggested that a policy framework for multiple transmission licensee and

Particulars	Gap Analysis	Recommendations
	competition in the transmission and distribution segment could not be ascertained.	distribution licensee may be established to induce competition in the transmission and distribution sector.
Promote Trading of electricity	Clause 12 of the Bhutan Sustainable Hydropower Development Policy 2021 provides for the promotion of cross border trading and the electricity market. However, as such policy for the promotion of trading within the country could not be ascertained.	For the purpose of establishment of national power exchange, it is essential that a policy framework for the promotion of trading in electricity within the country should be established.
Promotion of merchant Generation capacity	The Alternative Renewable Energy Policy 2013 also envisaged the setting up of IPPs. However, policies for the promotion of conventional merchant capacity could not be ascertained.	To promote merchant power plants, the policy should be amended to provide a framework for setting up of merchant power plants and also flexibility to the utilities to procure power from such power plants on a need basis i.e. time of the day or seasonal requirement and the tariff may be discovered through competitive bidding. To check on prices, BEA may impose a cap on prices at which such power may be procured by utilities.
Legal		
Establishment of Independent Electricity Regulator	Section 7 of the Electricity Act 2001 provides for the Establishment of the Bhutan Electricity Authority as an independent regulator.	NA
Establishment of a system operator	Section 39 of the Electricity Act 2001 provides for the establishment of a System operator.	NA
Mandatory 3rd party access to transmission & distribution infrastructure	Section 11.2(iii) of the Electricity Act 2001 provides for the responsibility of the BEA to ensure non-discriminatory access to the transmission and distribution system.	NA

Particulars	Gap Analysis	Recommendations
Recognizing and licensing Trading Activity	Section 22.1 of the Electricity Act 2001 provides for the issuance of a trading license by BEA.	NA
Licensing and functions of Power Exchange	Not provided.	To establish power exchange, it is desirable that the provisions for licensing and functions of power exchange should be incorporated in the Electricity Act 2001.
Regulatory		
Power Exchange Regulations	Not Available	The BEA should frame regulations for the establishment of power exchange having aspects covered in 2.2.3.a. of this report.
Procedure for 3rd party access (Open Access) and connectivity in transmission and distribution	Regulations are not framed for third party open access for supply of power and transaction for T&D	The BEA should frame regulations for 3rd party access.
Scheduling of electricity transactions	Chapter 7 of the Grid Code Regulation, 2008 of BEA provides for SCHEDULING AND DISPATCH CODE.	NA
Imbalance Settlement Mechanism	Chapter 7 of the Grid Code Regulation, 2008 of the BEA provides for the responsibility of the System Operator to manage deviations from schedules.	The BEA should frame regulations for imbalance settlement in case of deviations from the schedules which inter-alia includes the charging mechanism for deviations.
Transmission pricing and wheeling tariff framework	The transmission and wheeling charges are being periodically determined by the BEA.	NA
Dispute Resolution	The Dispute Resolution Procedure, 2009 of BEA provides for dispute resolution between licensees and licensees and customers.	NA

4.3.2 Proposed Power Exchange Model

In Bhutan, the concepts of electricity deregulation, multi-buyer and multi-seller model, imbalance or deviation settlement open access etc. are still evolving. Due to demand-side and supply-side constraints, the power sector in Bhutan currently does not have provisions in their respective electricity acts for open access and related aspects.

The power exchange model can be setup in Bhutan when there are sufficient conditions available in the country as mentioned in section 2.2 of this document. A detailed step by step procedure is already mentioned in section 2.3 after addressing the gaps highlighted above.

4.4 India

4.4.1 Feasibility Study: Existing Gaps and Recommendations

Following documents have been reviewed to analyse the regulatory and market space of India

a. CERC (Sharing of Inter-State Transmission Charges and Losses) Regulations, 2020
b. CERC (Procedure, Terms and Conditions for grant of trading licence and other related matters) Regulations, 2020
c. CERC (Cross Border Trade of Electricity) Regulations, 2019
d. CERC (Terms and Conditions of Tariff) Regulations, 2019
e. Tariff Policy, 2016
f. CERC (DSM and related matters) Regulations, 2014
g. CERC (Power Market) Regulations, 2010
h. CERC (IEGC) Regulations, 2010
i. CERC (Open Access in inter-State Transmission), 2008
j. National Electricity Policy (NEP), 2005
k. Indian Electricity Act, 2003

Table 23: Gaps Analysis and Recommendations for India

Particular	Gap Analysis	Recommendations
Policy		
Promotion of non-discriminatory 3rd party access (Open Access) to T&D infrastructure	The National Electricity Policy 2005 and Tariff Policy 2006 and 2016 promoted open access in transmission and distribution system.	To further enhance choice to consumers, retail supply competition may be introduced through policy directives.
Multi-Buyer Multi Seller Model	The Competitive Bidding Guidelines of Government provides for the procurement of power by distribution utilities through competitive bidding. Further Policy also promotes merchant capacity. The open access in distribution system and unbundling of State	The policy may further provide for reducing the threshold of 1MW for eligibility for open access in distribution which will increase buyers thereby increase liquidity in the market.

Particular	Gap Analysis	Recommendations
	Boards promote multi-buyer -Seller model.	
Unbundling of Utilities	The National Electricity Policy 2005 provides for the restructuring of vertically integrated utilities to promote efficiency in the distribution system. It also provides for separation of transmission utility to ensure non-discriminatory open access.	NA
Promotion of competition in Generation, Transmission & Distribution	The National Electricity Policy and Tariff Policy provides for the promotion of competition in generation by mandating DISCOMs to procure power through competitive bidding. Competitive bidding in construction of transmission systems and provision of parallel distribution licensee in a supply area.	To further enhance choice to consumers, retail supply competition may be introduced through policy directives.
Promote Trading of electricity	The National Electricity Policy 2005 promotes trading in electricity and setting up of power exchange by framing appropriate regulations by Regulators.	NA
Promotion of merchant Generation capacity	The National Electricity Policy 2005 and Short term bidding guidelines provides scope for the Distribution Companies to purchase power from the merchant generators through DEEP or power exchange platforms.	To further promote merchant generation, the policy may provide for optimisation of power purchase by distribution licensees by replacement of costlier long term PPA with the cheap power available with the merchant generators/market.
Legal		
Establishment of Independent Electricity Regulator	Section 76 and 82 of the Electricity Act 2003 provides for the establishment of an independent Electricity Regulator at the Centre and State level respectively. While Section 79 provides for functions of the Central Regulator, Section 86 provides for the function of the State	NA

Particular	Gap Analysis	Recommendations
	Regulator. One of the mandates of the Regulators u/s 66 of the Act is to promote the development of the market including trading in electricity.	
Establishment of a system operator	Section 26, 27 and 31 of The Electricity Act, 2003 provides for the establishment of an Independent System Operator at the National, Regional and State levels respectively.	NA
Mandatory 3rd party access to transmission & distribution infrastructure	Section 38(2)(d) and 39(2)(d) of the Electricity Act 2003 provides for mandatory Open Access in Transmission System and Section 42(2) provides mandatory Open Access in Distribution System to eligible consumers.	NA
Recognizing and licensing Trading Activity	The trading activity is recognised as licensed activity in The Electricity Act 2003. The Act provide powers to Regulations to issue Trading License.	NA
Licensing and functions of Power Exchange	Licensing and functions of Power Exchange is deliberated in the legislation pertaining to the Electricity	NA
Regulatory		
Power Exchange Regulations	CERC Power Market Regulations 2010 provides for norms for the registration and governance of power exchanges.	NA
Procedure for 3rd party access (Open Access) and connectivity in transmission and distribution	CERC (Inter-State Open Access) Regulations 2008 provides for detailed provisions for grant of Open Access to the eligible entities.	NA
Scheduling of electricity transactions	Part 6 of the CERC Indian Electricity Grid Code Regulation 2010 provides Scheduling and Despatch Code for scheduling of electricity transactions including power exchange transactions.	NA

Particular	Gap Analysis	Recommendations
Imbalance Settlement Mechanism	The CERC (DSM and related matters) Regulations 2014 provides for a detailed commercial mechanism for settlement of deviations/imbalances in the System.	NA
Transmission pricing and wheeling tariff framework	As per the provisions of the Electricity Act 2003, The Central & State Regulators are empowered to determine Transmission Tariff and State Regulators are empowered to determine wheeling tariff for Distribution system.	NA
Dispute Resolution	The Electricity Act 2003 delegates adjudicatory powers to the Electricity Regulators and also constituted an Appellate Tribunal for Electricity (APTEL) for hearing appeals against orders of Electricity Regulators.	NA

4.4.2 Way forward on Existing Power Market

4.4.2.1 Status of Power Market in India

Electricity Act 2003, brought about the establishment of the Power Market, paving way for setting up the first power exchange in the country in 2008. The government and the regulators have been actively discussing strengthening India's exchange markets based on the successful development of power markets in other developed economies across the globe like the Nordic countries, Germany and the UK, Netherlands, and Switzerland. Going forward, the technology-led energy marketplace will play a pivotal role in ushering India's energy shift and building an energy order which is underpinned by competitiveness, efficiency, and sustainability.

The short-term power market enables efficient discovery of prices with increased liquidity, which is one of the key enablers. Having a variety of products is another key enabler for the effective functioning of the power exchange. India has already introduced a bouquet of products in short term power markets and exploring further opportunities to strengthen it.

The country is pushing to increase the RE share in the country's power portfolio. India's introduction of RTM in 2020 is a step towards supporting power generators to participate in Short Term power markets and it allows the trading of contingent surpluses.

Further, as a step towards improvement in short term power markets, the Green Term-Ahead Market (GTAM) in launched in Aug 2020. It enabled a certain level of confidence among RE generators to trade their power in power exchanges to increase the viability of products and to optimize the portfolio.

4.4.3 Next Steps for Power Market Development in India

Power exchanges in India need to diversify their products and should launch financial products like electricity derivatives like futures and forwards. Energy derivatives are a type of financial contract in which the underlying asset is an energy product, such as electricity. The derivatives market can provide vibrancy by increasing trade volumes and encouraging participation by separating the physical delivery of electricity from the financial settlement. This will allow hedgers, speculators, and a host of other participants to trade in the electricity market.

A spot market and the derivatives market facilitated by power exchanges will complement each other. It will result in the metamorphosis of conventional players with long term PPAs to shift to exchanges by establishing forward prices with derivatives. This process will increase the liquidity in derivatives and subsequently in the spot market and vice versa. The futures and options market shall be lucrative for power sector stakeholders like investors and traders.

Ancillary services are an indispensable part of power system operation which are required for maintaining load generation balance on real time basis and enhancing the reliability of the power system. Broadly, there are two types of ancillary services: Frequency services and non-frequency services.

Frequency Ancillary services: Three levels of Frequency Control are generally used to maintain load-generation balance i.e., Primary Frequency Control, Secondary Frequency Control and Tertiary Frequency Control.

Non-Frequency Ancillary service: This includes Network control Ancillary services & System restart Ancillary services. Network control Ancillary services includes Voltage support and reactive power support. System restart Ancillary services is used to restore the system after partial or full blackout.

In India, the System Operator is responsible for deployment of Ancillary services. Recently, Central regulator has issued new regulation for Ancillary services i.e. Ancillary Service Regulations 2022 which aims to deploy range of technologies and mechanism such as Storage, demand response etc. Also, the regulation provides for market-based procurement of Tertiary Ancillary services.

4.4.3.1 Types of Ancillary Services and Their Mechanism of Procurement

Primary control generally refers to local automatic control available in all conventional generators, which delivers reserve power negatively in proportion to change in system frequency. The Primary reserves have been ensured through suitable amendments in the Indian Electricity Grid Code which require the generating stations to keep such reserves for system security by not scheduling beyond the installed capacity. The Primary reserves are delivered automatically through turbine governors, in which the generating units respond quickly to the frequency deviation as per droop characteristic of the units. Primary reserve responds to frequency signals typically within 5-10 seconds and sustain up to 5 mins. Thus, Primary control works by deploying Primary reserves instantaneously to restore the system frequency to tightened nominal frequency band of 49.95-50.05 Hz. The procurement of Primary reserves is through administrative mechanism and is linked to the Variable charge of the thermal stations.

To relieve the Primary reserves, Secondary Control responds in 30 seconds and can ramp up to their full output within 15 mins and can sustain up to at least 30 mins. Secondary Control is deployed by the System Operator through control signals like Automatic Generation Control which delivers the reserve to restore the system frequency. For Secondary reserves, Central regulator (CERC) has made it mandatory for all ISGS to be Automated Generation Control enabled which allows the System Operator to activate, deploy and control the secondary reserves. Currently, Secondary reserves are also mainly procured through administrative mechanism based on the Variable charges (Energy Charges) of the thermal stations. The regulation also has a provision to incentivise the stations based on the ramping rate. The Ancillary services regulation has also extended the eligibility to provide secondary ancillary services to Energy storage and demand response to create fast response and manage grid reliability more efficiently. It has been proposed that in due course of time, Secondary Ancillary services procurement shall also be done through Market.

Tertiary reserves are deployed to relieve Secondary reserves and it is generally activated within 15 minutes from the dispatch instructions and can sustain up to 60 mins. Tertiary reserves are activated in case the Secondary reserves have been continuously deployed in one direction for 15 min for more than 100 MW. Through the new Ancillary services Regulations 2022, the Central regulator has provided for market-based mechanism for procurement of Tertiary Ancillary services. The new regulation allows all generating stations, Energy storage technologies and demand response mechanisms to participate in the tertiary ancillary market. As per the new regulation, the System Operator shall procure the tertiary ancillary services through Day Ahead market and Real time market at Power Exchanges. The System shall make an assessment of the requirement of the tertiary services on Day Ahead basis and shall bid (as a buyer) in the Day Ahead Market at Power Exchanges. Any changes in the requirement of the tertiary Ancillary services is corrected through Real Time market.

4.5 Maldives

4.5.1 Feasibility Study: Existing Gaps and Recommendations

Maldives currently has a policy framework on the promotion of merchant/IPP Generation Capacity by way of allowing captive power plants for consumers, where SLETCO is not providing services. Other provisions required for setting up power exchanges haven't been formulated in terms of frameworks on Policy, Regulatory or Legal aspects. The gap analysis has been done based on the literature available with the multi-lateral agencies. Only two documents could be accessed and referred from Maldives government portals, viz. Utility Regulatory Authority Act, 2021, Generation, Distribution and Supply Licensing Regulation, 2015.

4.5.2 Proposed Power Exchange Model

Preliminary analysis shows that the Maldives as a group of Islands, has complete dependence on diesel fuel for power generation and there is no availability of transmission interconnection among the islands within the Maldives. In such a scenario, considering setting up a national power exchange would not be feasible.

Considering the geography and the resource potential of Maldives, a conventional power exchange model may not be viable. Alternatively, Maldives needs to focus on identifying the least cost power generation and distribution options. The same can be achieved by way of solar/ tidal based de-centralized distributed generation. The Maldives also needs to carefully adopt this model with detailed diligence with respect to the ecological sensitivity of the islands.

The decision by Ministry of Environment, Energy and Sustainability of Maldives to develop and adopt floating solar on the lagoons is a step in the right direction.

4.6 Nepal

4.6.1 Feasibility Study: Existing Gaps and Recommendations

Following documents have been reviewed to analyse the regulatory and market space of Nepal

a. Electricity Regulatory Commission Rules, 2018
b. Electricity Regulation Commission Act, 2017
c. Electricity Act 2049 (1992)
d. Hydropower Development Policy 2058 (2001)
e. Electricity Tariff Fixation Rules 2050 (1994)

Table 24: Gaps Analysis and Recommendations for Nepal

Particulars	Gap Analysis	Recommendations
Policy		
Promotion of non-discriminatory 3rd party access (Open Access) to transmission and distribution infrastructure	Nepal Power Sector currently house Single buyer model and it is important to have a multi buyer model. In the recent past, Nepal is selling excess power to Indian power exchange in day ahead market.	The provisions with respect to the promotion of non-discriminatory access to transmission and distribution networks should be incorporated in all electricity policies to enable the establishment of the market in electricity.
Multi-Buyer Multi Seller Model	The Hydropower Development Policy 2058 (2001) provides for the promotion of hydro capacity by various routes. The policy also provides for the installation of hydro plants for self-consumption. However, other than hydro, the provisions with respect to the promotion of multiple sellers and buyers could not be ascertained.	Policy may be formulated to promote the competition in the generation thereby establishing multiple generators in the country. Further, presently NEA is acting as a single DISCOM for the supply of power in the entire country. To enable multiple buyers, it is essential that different distribution areas may be bifurcated and each area should have at least one DISCOM. To further increase the participation by the consumers, the industries may be facilitated to buy electricity from generators directly or market.

Particulars	Gap Analysis	Recommendations
Unbundling of Utilities	Partially unbundled	Unbundling of utilities by separation of the generation, transmission and distribution functions ensures non-discriminatory access to a third party (open access) which is essential for the establishment of the market. It is suggested that unbundling should be incorporated in the Government Policy.
Promotion of competition in Generation, Transmission & Distribution	The Hydropower Development Policy 2058-2001 provides for the promotion of Hydro capacity and a competitive bidding framework for the award of the projects. However, the competition in the Transmission and Distribution segment could not be ascertained.	The promotion of competition in all the segments of the electricity sector is essential therefore it is suggested that a policy framework for multiple transmission licensee and distribution licensee may be established to induce competition in the transmission and distribution sector.
Promote Trading of electricity	The Hydropower Development Policy, 2001 provides for the promotion of cross border trading and the electricity market. However, as such policy for the promotion of trading within the country could not be ascertained.	For the purpose of establishment of national power exchange, it is essential that a policy framework for the promotion of trading in electricity within the country should be established.
Promotion of merchant Generation capacity	The Hydropower Development Policy, 2001 provides for private entrepreneurs to use the electric system of NEA to transmit electricity generated by them. However, policy for other than Hydro power could not be ascertained.	To promote merchant power plants, the policy should be amended to provide framework for setting up of merchant power plants and also flexibility to the utilities to procure power from such power plants on need basis i.e. time of the day or seasonal requirement and

Particulars	Gap Analysis	Recommendations
		the tariff may be discovered through competitive bidding.
Legal		
Establishment of Independent Electricity Regulator	New Electricity Act is pending in parliament for ratification for a long. Section 3 of the Electricity Regulation Commission Act 2017 provides for the Establishment of the Electricity Regulation Commission as an independent regulator.	The regulator has been recently established. The regulator should come up with full-fledged intervention in the regulation
Establishment of a system operator	Section 12D of the Electricity Regulation Commission Act 2017 provides for regulating operator of the system by the Regulator, however as such functions and duties of system operator could not be ascertained.	A separate Section on System operator may be incorporated in the Electricity Regulation Commission Act 2017 to provide functions and power of such operator for smooth functioning of the market. The functions may inter-alia include optimum scheduling and despatch of electricity, monitor grid operations, accounting of electricity transmitted through the grid, supervision and control over the transmission system, carrying out real-time operations and ensuring grid safety etc.
Mandatory 3rd party access to transmission & distribution infrastructure	Specific provision for 3rd party access to transmission and distribution system is not available, however, Section 14C of the Electricity Regulation Commission Act 2017 empowers Commission to implement necessary resolutions for competition among licensees.	The Regulator may exercise its powers under Section 14C of the Electricity Regulation Commission Act 2017 to provide non-discriminatory 3rd party access to transmission and distribution system.
Recognizing and licensing Trading Activity	As per Section 2(B) of the Electricity Regulation Commission Act 2017, the definition of 'Licensed Person' includes the activity of 'trade'. Further Section 14(H) requires Commission to monitor trading activity. Also Rule 16	NA

Particulars	Gap Analysis	Recommendations
	of the Electricity Regulatory Commission Rules, 2018 provides for Regulating Trading Margin by the Commission. Therefore, Trading Activity is recognised.	
Licensing and functions of Power Exchange	Section 13B & 14 of the Electricity Regulation Commission Act 2017 envisages the establishment of the wholesale market and promotion of competition.	To establish power exchange, it is desirable that the provisions for Licensing and Functions of power exchange should be incorporated in the Electricity Regulation Commission Act 2017.
Regulatory		
Power Exchange Regulations	Partially regulations are present. Strong framework and Standards are needed	The ERC should frame regulations for the establishment of power exchange having aspects covered in 2.2.3.a. of this report.
Procedure for 3rd party access (Open Access) and connectivity in transmission and distribution	Regulations are not framed for third party open access for supply of power and transaction for T&D network	The ERC should frame regulations for 3rd party access and transparent allocation of capacity in the T&D network.
Scheduling of electricity transactions	The Electricity Regulation Commission Act 2017 provides for framing of Grid Code and Distribution Code, however the same is yet to be notified.	ERC should notify the scheduling code under the Grid Code and Distribution code.
Imbalance Settlement Mechanism	Currently, there is no imbalance settlement mechanism in the country	The ERC should frame regulations for imbalance settlement in case of deviations from the schedules which inter-alia includes the charging mechanism for deviations.
Transmission pricing and wheeling tariff framework	The Transmission and Wheeling charges are being periodically determined by the ERC.	NA
Dispute Resolution	As per the ERC website, the Grievances Handling/Dispute Handling Mechanism is under preparation.	NA

4.6.2 Proposed Power Exchange Model

There are existing power trading arrangements between Nepal and India through bilateral contracts. Nepal Electricity Authority (NEA) has recently become a member of the Indian Energy Exchange (IEX) and does transactions in the Indian power market using the IEX platform.

The power sector in Nepal currently does not have regulatory provisions as well as market and support infrastructure for setting up a national power exchange. However, cross border trading arrangements can provide a learning opportunity and hands-on experience of the function of power exchange to Nepalese power sector stakeholders. Nepal Government may consider bringing associated reforms, institutional and regulatory provisions to facilitate the setting up a national power exchange in Nepal after gaining confidence and technical know-how from the Indian power market.

4.7 Pakistan

4.7.1 Feasibility Study: Existing Gaps and Recommendations

The following documents have been reviewed to analyse the regulatory and market space of Pakistan:

a. NEPRA Import of Power Regulations, 2017
b. Tariff Approval Procedure Regulation, 2017
c. National Electric Power Regulatory Authority Wheeling of Electric Power Regulations, 2016
d. NEPRA Supply of Electric Power Regulations, 2015
e. Market operator Registration, Standards and Procedure Rules, 2015
f. Power Generation Policy, 2015
g. Tariff Standard Procedure Rules, 2014
h. Notification NEPRA Procedure for Filing of Appeal Regulations, 2012
i. Performance Standards (Generation) Rules, 2009
j. NEPRA Competitive Bidding Tariff Regulations, 2008
k. NEPRA National Transmission and distribution company Grid Code, 2005
l. NEPRA's Complaint Handling and Dispute Resolution (Procedure) Rules, 2005
m. Performance Standards (Transmission) Rules, 2005
n. NEPRA Power Safety Code for Transmission and Distribution Licensees
o. Licensing (Generation) Rules, 2000
p. NEPRA Licensing (Application Modification)
q. NEPRA (Tariff Standards and Procedure) Rules, 1998
r. Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997
s. NEPRA Renewable Generation with Amendments
t. NEPRA Interim Power Procurement

Table 25: Gap Analysis and Recommendations for Pakistan

Particulars	Gap Analysis	Recommendations
Policy		
Promotion of non-discriminatory 3rd party access (Open Access) to transmission and distribution infrastructure	The promotion of 3rd party access to the Transmission and Distribution system could not be ascertained.	The provisions with respect to the promotion of non-discriminatory access to the Transmission and Distribution network should be incorporated in all electricity policies to enable the establishment of the market in electricity.
Multi-Buyer Multi Seller Model	The Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997 amended in 2018 provides for licensing of multiple entities viz., Generators, CPP, DISCOMs, Bulk Consumers,	The Government Policy may provide enabling environment to facilitate licensing of the entities envisaged in the Act, it will increase buyers thereby

Particulars	Gap Analysis	Recommendations
	Retail Supplier, Traders etc. which is essential for the establishment of multi-buyer and multi-seller model for the establishment of the market. However, policies of the government yet to be formulated for the promotion of these entities.	increasing liquidity in the market.
Unbundling of Utilities	As per the Government plan of restructuring, the un-bundling of WAPDA was completed in 2000 and the criteria are met.	NA
Promotion of competition in Generation, Transmission & Distribution	The National Power Generation Policy from time to time promoted competition in the Generation Sector. With the 2018 amendment in the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997, competition is to be proposed to be introduced in the Transmission and Distribution System also by way of introduction of competitive bidding and retail supply licenses. However, policy on the same could not be ascertained with the available information.	To induce competition in the sector, the policy to implement the provisions of the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997 may be formulated.
Promote Trading of electricity	Paragraph 9 of the ECC Summary establishes the mandate and timeline for CPPA-G to prepare (by 2018) the plan with the design, transition and implementation of the competitive wholesale electricity market — the Competitive Trading Bilateral Contract Market (CTBCM) — to start by 2020. Further, the Act also provides recognises trading as licensed activity.	NA
Promotion of merchant Generation capacity	The National Power Generation Policy from time to time promoted the private sector participation in the Generation Sector. However, provisions of merchant capacity as such could not be ascertained with the available information.	To promote merchant generation, the policy may permit the sale of power by Generators to licensees at competitive without requiring specific approval of tariff from NEPRA for each transaction.

Particulars	Gap Analysis	Recommendations
		NEPRA may provide a ceiling tariff for such transactions and allow the purchase of power by DISCOMs within such limits.
Legal		
Establishment of Independent Electricity Regulator	Section 3 of the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997 provides for the establishment of the National Electric Power Regulatory Authority (NEPRA). Section 7 provides for Powers and functions of the Authority. One of the mandates of the Regulator u/s 7(2)(ia) is to promote the development of a market, including trading, in accordance with the national electricity policy and the national electricity plan.	NA
Establishment of a system operator	Section 23G of the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997 provides for the establishment of a System Operator. The function of the System operator is (a) Generation scheduling, commitment and dispatch; (b) Transmission scheduling and generation outage coordination; (c) Transmission congestion management; (d) Cross border transmission coordination; (e) Procurement and scheduling of ancillary services and system planning for long term capacity.	NA
Mandatory 3rd party access to transmission & distribution infrastructure	Section 14C of the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997 provides for the right to Open Access in Transmission System for captive power generation. Further, proviso to Section 21(2)(a) and 22 enables bull consumers to directly	NA

Particulars	Gap Analysis	Recommendations
	purchase electricity from Generators, if allowed by NEPRA.	
Recognizing and licensing Trading Activity	The trading activity is recognised as licensed activity u/s 23C of the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997.	NA
Licensing and functions of Power Exchange	Section 23A of the Regulation of Generation, Transmission and Distribution of Electric Power Act, 1997 provides for Market Operator as Licensed Activity. The Market Operator is defined as *"a person responsible for the organization and administration of trade in electricity and payment settlements among generators, licensees and consumers"*;	NA
Regulatory		
Power Exchange Regulations	The NEPRA (Market Operator Registration, Standards and Procedure) Rules, 2015 provides for registration of Market operators. Presently, the Market operator acts as a single buyer for the DISCOMs and manages the long term PPA of the DISCOMs. The NEPRA is also in process of establishing of Competitive Trading Bilateral Contract Market (CTBCM) which is a capacity market. The energy is proposed to be dispatched based on the economic despatch principle. The prevailing power exchange model provides for the energy market and also counter-party risk is assumed by such power exchange.	The NEPRA may gradually adopt a power exchange model among the models discussed in this report.
Procedure for 3rd party access (Open Access) and connectivity in transmission and distribution	The Grid Code and Distribution Grid Code notified by NEPRA provide for Open Access and connectivity in Transmission and Distribution System respectively under connection code. Further, NEPRA (Wheeling of Electric	NEPRA may prescribe Open Access rules or regulations to further streamline Open Access. These Open Access regulations should provide a mechanism for short term

Particulars	Gap Analysis	Recommendations
	Power) Regulations, 2016 provides for the procedure to avail open access/ wheeling in the Transmission and distribution system.	Open Access/wheeling period, say for a period from one hour to one month etc. to facilitate market based transactions.
Scheduling of electricity transactions	Scheduling and Dispatch Code has been provided in the NEPRA Grid Code for scheduling of Generators. However, the code does not facilitate short term transactions.	Grid Code may be amended to facilitate short term transactions say Day Ahead, Intra-Day etc.
Imbalance Settlement Mechanism	The imbalance mechanism could not be ascertained with the available information.	For smooth functioning of the energy market and Grid Discipline, a commercial mechanism for settlement of deviations/imbalance is necessary. Therefore, NEPRA may prescribe an imbalance settlement mechanism for deviations from the schedule by the Generators and Buyers.
Transmission pricing and wheeling tariff framework	The Transmission and wheeling tariff is prescribed under NEPRA (Wheeling of Electric Power) Regulations, 2016.	NA
Dispute Resolution	The NEPRA Complaint Handling and Dispute Resolution (Procedure) Rules, 2015 and NEPRA (Resolution of Disputes between Independent Power Producers and other Licensees) Regulations, 2003 provides for dispute resolution framework.	-

4.7.2 Proposed Power Exchange Model

The electricity sector in Pakistan is comparatively more organized with respect to other SAARC member countries after India. Pakistan has most of the institutional structure operational or would be in operation in near terms, necessary for the setting up an NPEX. In Pakistan most of the provisions and desired institutional structure is operational.

NEPRA is the power sector regulator entrusted with bringing transparency and judicious economic reforms, with a prime focus on adopting sound commercial principles, to the sector. It is also accountable for ensuring efficient tariff structures and market design for sufficient liquidity in the power markets. The NEPRA (Amendment) Act, 2018 has provisions for the development of an electric power market and reducing regulatory oversight. Structural changes for the support of bringing wholesale and retail markets have been introduced. The power supply has been unbundled from the

distribution. But it is not a separately licenced activity that can create a retail market. Provisions of granting power trading licence have been introduced for the wholesale trade of electricity. Provinces are now also eligible to develop their own transmission system within the province.

Central Power Purchasing Agency (CPPA-G) is another central agency responsible for procuring power on behalf of State-owned DISCOs. In addition to this, CPPA-G is also a market operator and is responsible for facilitating the power market transition from the current single buyer to a competitive market. It has the overall strategy to bring in efficiency through introducing competition in power generation and retail distribution. Considering the above, CPPA-G has brought the concept of Competitive Trading Bilateral Contract Market Model (CTBCM) and currently, this model is under stakeholder discussion phase. CTBCM is a bilateral contract market, in which sellers (Generators and Traders) will sell directly to the buyers (Distributors, as detailed Suppliers, other Retail Suppliers, Bulk Supply Customers) through bilateral contracts. Settlement and payment of bilateral transactions will be done bilaterally between sellers and buyers and Balancing Mechanisms will be done by and through the Market Operator.

As this would be a capacity market, only long-term contracts would be traded and there would be no short-term power trading. However, newer contracts may not be having obligation to produce and purchase unlike PPA contracts, and therefore would, in the long run, facilitate energy markets also. CPPA-G has adopted this mechanism due to the presence of longer duration PPAs with DISCOMs and the absence of short and medium duration power procurement options.

However, it is also recommended to bring products such as Day-Ahead Market (DAM) and Term Ahead Market (TAM) for the surplus, untied and Un-Requisitioned Surplus (URS) power for the short-term market. CTBCM can also consider providing the platform for settling Contract for Difference (CfD) contracts. Under this mechanism, Generators with a CfD will sell their electricity into the market as a normal business and the CfD will then pay, for each MWh of output, the difference between a PPA tariff rate i.e. Market Reference Price (MRP) for electricity and a contract 'strike price' established through the CfD allocation process. This difference payment may be positive or negative depending upon the settlement conditions. The generator will receive a difference in payment from the Contract for Difference if the Market Reference Price is lower than the strike price, but they may have to pay back the difference if the Market Reference Price is higher than the strike price. Although, there would be very limited participation initially, but this would also facilitate to develop the market in the longer run. This would also create a market and therefore, investors would also be interested to invest in Pakistan's electricity market and provide a much-needed boost to the domestic power economy. Also, market participants will also be remained informed about the technicalities attach to shirt term duration contracts.

The case of the development of Indian Power exchanges and becoming part of the mainstream is relevant to quote here. There were very limited participation and liquidity in Indian power exchanges during its initial days which have grown now to cater to nearly 8% of the total power demand of the country. Indian power exchanges have now become an important part of the power procurement optimization strategy and stakeholders are now reaping the benefits of having a short-term wholesale market in Indian power exchanges.

Pakistan may explore developing intra-regional power markets with neighbouring countries which would enable the country to expand the market and optimise the resources.

4.8 Sri Lanka

4.8.1 Feasibility Study: Existing Gaps and Recommendations

The following documents have been reviewed to analyse the regulatory and market space of Sri Lanka:

a. Electricity (Procedure for Review and Adjustment of Tariffs) Rules No. 03 of 2016
b. Electricity Procurement Rules, 2016
c. Tariff Methodology, 2015
d. Regulatory Manual, 2014
e. Electricity (Applications for Licenses & Exemptions) Regulation, 2009
f. Sri Lanka Electricity Act, 2009
g. National Energy Policy and Strategies of Sri Lanka, 2008
h. Grid Code, 2014
i. Sri Lanka Public Utilities Commission Act, 2002
j. The Electricity Dispute Resolution Procedure Rules
k. Technical Standards
l. Electricity Transmission Performance Standards Regulations

Table 26: Gaps Analysis and Recommendations for Sri Lanka

Particulars	Gap Analysis	Recommendations
Policy		
Promotion of non-discriminatory 3rd party access (Open Access) to transmission and distribution infrastructure	The provisions with respect to the promotion of non-discriminatory access to Transmission and Distribution networks are not available	The provisions with respect to the promotion of non-discriminatory access to Transmission and Distribution networks should be incorporated in all electricity policies to enable the establishment of the market in electricity.
Multi-Buyer Multi Seller Model	Policy to promote the competition in the Generation is missing	Policy may be formulated to promote the competition in the Generation thereby establishing multiple generators in the country. Further, presently CEB is responsible for over 90% of total electricity distribution/ retail sales while Lanka Electricity Company Ltd. (LECO) handles the remaining 10%. Though CEB is divided into multiple Distribution divisions, however, due to single ownership, is acting as a single Discom for the supply of power in the entire country. To enable multiple buyers, it is essential that CEB need to be restructured and DISCOMs allow purchase directly

Particulars	Gap Analysis	Recommendations
		from the Generator. To further increase the participation from the consumers, the industries may be facilitated to buy electricity from Generators directly or market.
Unbundling of Utilities	Utilities are bundled as a single vertical entity	Unbundling of Utilities by separation of the Generation, Transmission and Distribution Companies ensures non-discriminatory access to a third party (open access) which is essential for the establishment of the market. It is suggested that unbundling should be incorporated in the Government Policy.
Promotion of competition in Generation, Transmission & Distribution	Provisions related to the Promotion of competition are not present	The promotion of competition in all the segments of the electricity sector is essential therefore it is suggested that a policy framework for multiple transmission licensee and Distribution licensee may be established to induce competition in the transmission and distribution sector.
Promote Trading of electricity	Policy to promote the trading of electricity is not present	For the purpose of establishment of national power exchange, it is essential that a policy framework for promotion of trading in electricity within the country should be established.
Promotion of merchant Generation capacity	Policy to promote merchant power is not present	To promote merchant power plants, the policy should be formulated to provide framework for setting up of merchant power plants and also flexibility to the utilities to procure power from such power plants on need basis i.e., time of the day or seasonal requirement and the tariff may be discovered through competitive bidding.
Legal		
Establishment of Independent Electricity Regulator	Section 2 of the Sri Lanka Electricity Act, 2009 delegates powers of	The development of the market is an essential element for the establishment of the liquid market in

Particulars	Gap Analysis	Recommendations
	Regulator to Public Utilities Commission. One of the principles, the Commission is required to follow in the discharge of its functions is to promote competition, where appropriate.	electricity therefore such function of the Commission may be incorporated in the Sri Lanka Electricity Act, 2009.
Establishment of a system operator	Provision of establishment of system operator is not present in Sri Lanka Electricity Act, 2009	A separate Section on System operator may be incorporated in the Sri Lanka Electricity Act, 2009 to provide functions and power of such operator for smooth functioning of the market. The functions may inter-alia include optimum scheduling and despatch of electricity, monitor grid operations, accounting of electricity transmitted through the grid, supervision and control over the transmission system, carrying out real-time operations, ensuring grid safety etc.
Mandatory 3rd party access to transmission & distribution infrastructure	Provisions for Mandatory Third-Party access to transmission and distribution is not present in Sri Lanka Electricity Act, 2009	The 3rd party access to transmission and distribution systems is essential for the establishment of national power exchange. Therefore, the Sri Lanka Electricity Act, 2009 may provide for non-discriminatory access to the Transmission and Distribution system.
Recognizing and licensing Trading Activity	Well functioning market multi survey and multi seller model is required and required regulatory enablers need to be put in place	It is suggested that the trading in electricity may be provided as licensed activity by incorporating the appropriate provisions in the Sri Lanka Electricity Act 2009.
Licensing and functions of Power Exchange	Not available	To establish power exchange, it is desirable that the provisions for Licensing and Functions of power exchange may be incorporated in the Electricity Regulation Commission Act 2017.
Regulatory		

Particulars	Gap Analysis	Recommendations
Power Exchange Regulations	Not Available	The PUC may frame regulations for the establishment of power exchange having aspects covered in 2.2.3.a. of this report.
Procedure for 3rd party access (Open Access) and connectivity in transmission and distribution	Regulatory enables to facilitates the open access transaction to be put in place for liquidity	The PUC may frame regulations for 3rd party access and transparent allocation of capacity in the T&D network.
Scheduling of electricity transactions	Under Generation Dispatch Code of the GRID CODE of Sri Lanka provides for System Operator to follow economic dispatch and schedule generation, either the day ahead or in a real-time basis.	PUC/CEB may notify the scheduling code under the Grid Code to demarcate schedules of third-party transactions.
Imbalance Settlement Mechanism	Regulations for imbalance settlement are not present for inter-alia and charging mechanism for deviation	The PUC may frame regulations for imbalance settlement in case of deviations from the schedules which inter-alia includes the charging mechanism for deviations.
Transmission pricing and wheeling tariff framework	Transmission pricing and wheeling tariff frame work is not present for the use of T&D system	In addition to access to the Transmission and Distribution system, it is essential to put in place Transmission and wheeling charges applicable for use of the Transmission and Distribution system.
Dispute Resolution	The Electricity (Dispute Resolution Procedure) Rules, 2016 provides for a dispute resolution mechanism.	NA

4.8.2 Proposed Power Exchange Model

The Sri Lanka Electricity Act, 2009 (subsequent amendment in 2013) mandates the commission to promote competition and determine transmission pricing such that it provides efficient service possible to the consumers. In the absence of a legal and policy framework for cross border electricity trade, the regulatory framework specific to cross border electricity trade is also not available. Open access is also not available as Ceylon Electricity Board (CEB) continued to be the single buyer of electricity.

In the absence of enabling frameworks, market, and liquidity it would not be viable to setup and operate a power exchange in Sri Lanka. However, Sri Lankan stakeholders can take advantage of the Indian Power market by engaging in Cross Border Energy Trading (CBET) in near future, if feasible. As per the study conducted by AD, the Indian Government is committed to trade electricity with Sri Lanka by undersea transmission cables with an expected project outlay of around USD 339 Million. (2006 estimate).

4.9 Facilitation of Cross Border Electricity Trade through National Power Exchanges

SAARC Inter-Governmental Framework Agreement (IGFA) for Energy Cooperation, has been signed by the Foreign Ministers of the eight Member States on November 27, 2014. This agreement strives for adopting measures to enhance power trade in the region.

Indian Government has recently approved the participation of Bangladesh, Bhutan, and Nepal to participate in the Indian power market and facilitate Cross Border Electricity Exchange (CBET) through power exchanges in India. Central Electricity Regulatory Commission (CERC) of India has issued the guidelines for CBET for participation in the DAM, TAM market of India. As of date, Nepal is participating in the IEX DAM market through NTPC Vidyut Vyapar Nigam Limited (NVVNL). Bangladesh and Bhutan are yet to participate in the Indian power market.

CBET among the SMS requires a coordinated and integrated approach towards harmonization of the regulatory, legal, and operational framework. Following key parameters have been identified to ensure consistency in approaches to implement CBET in the SAARC region.

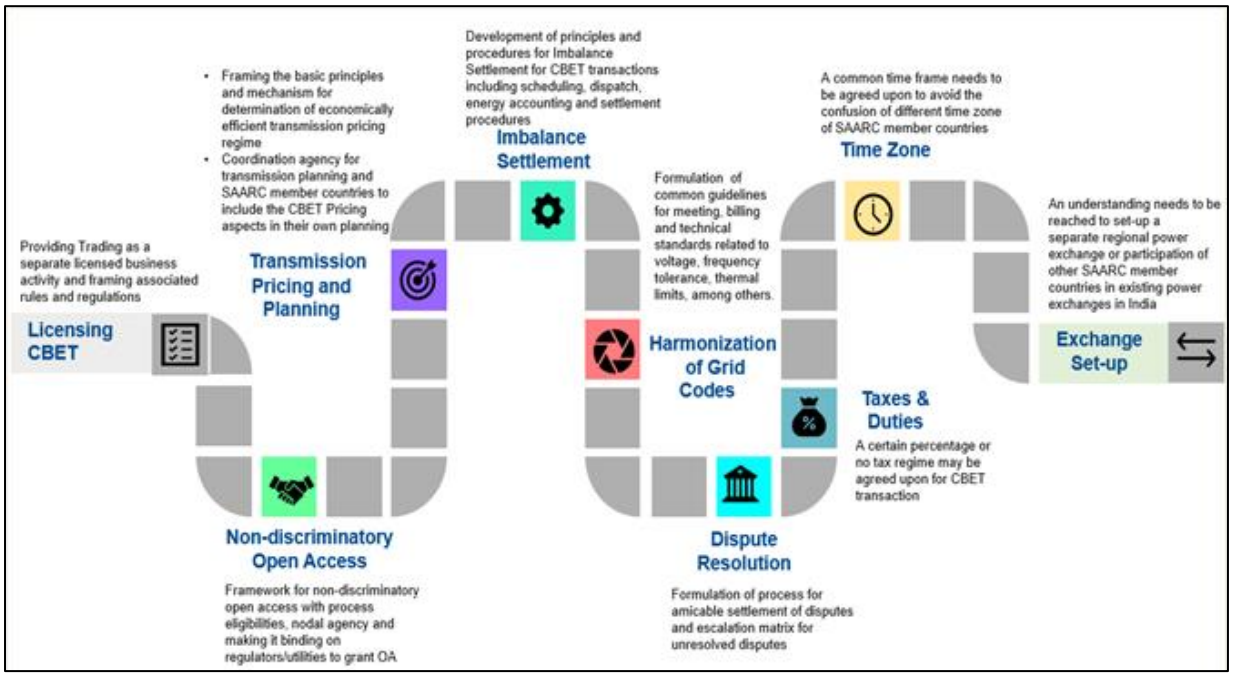


Illustration 45: Requisites for CBET

There is a compelling case for the integration of the short-term power market of SMS. The sporadic demand-supply mismatch on an hourly, daily, and seasonal basis provides an excellent opportunity for a marketplace where surpluses and deficits can be managed synergically at the regional level on a real-time basis.

Also, the SMS have constraints in terms of natural resources like oil, gas, coal, etc., imports from the resource rich countries, making them prone to geo-politics to ensure energy security. In addition to energy security, the region is also facing challenges of climate change. This mandates the region to become resilient to energy security and climate change. The International Solar Alliance's initiative to

target effective utilization of solar resources, OSOWOG intends to connect the entire world for the purpose.

With these prospects, CBET will prove a synergetic arrangement for optimum utilization of the resources and ensuring energy security. This might also act as a first step towards a mature and developed market in the region.

CBET among the SMS requires a coordinated and integrated approach towards harmonization of the regulatory, legal, and operational framework. The key parameters have been identified and deliberated in the handbook to ensure consistency in approaches to implement CBET in the SAARC region. Gaps and requirements to facilitate CBET has been listed in the preceding sections. SMS need to form a forum to discuss the modalities and implementation aspects related to CBET in the region.

4.10 Benefits of Developing National Power Exchanges

Member States can avail following benefits from the development of national power exchanges:

Technical and Operational Benefits

a. Optimal use of regional resources and system operation
b. Improved energy security and reliability of respective power systems
c. Optimized transmission network
d. Reduce fossil fuel imports
e. Reduce environmental impact

Economic and Financial Benefits

a. Improvement in industrial productivity and competitiveness
b. Cost-effective power system
c. Less exposure to volatile international energy prices
d. Better return to investors in generation assets

Environmental Benefits

a. Less impact on local and global environment
b. Renewable energy development
c. Improvement in social indicators

4.11 Summary of Recommendations

The preparation of this handbook summarizes the requirements for having national power exchanges and the need for the same. Based on the understanding of global practices and hands-on experience of the consortium of setting up and managing a power exchange in India, the steps have been identified for setting up of power exchange and are broad-lined as the part of summary of recommendations.

Preparing SMS with policy, legal, regulatory and operational frameworks: To start with, the SMS needs to prepare policy, legal, regulatory and operational frameworks. In the region, apart from India, Pakistan has a more functional institutional structure and would be in operation in the near term, necessary for setting up a national power exchange.

Pakistan currently has a policy framework on Promotion of merchant/ IPP Generation Capacity and promotes trading of electricity. The Electric Power Act 1997, facilitates licensing of the entities to ensure an increase in liquidity in the market and promote merchant power generation. Policy provisions with respect to the promotion of non-discriminatory access to transmission and distribution networks needs to be provisioned. Thus, Pakistan may ensure introducing of true competition in the sector. It may also prescribe open access rules or regulations to further streamline open access. Grid Code may be amended to facilitate short term transactions and may prescribe an imbalance settlement mechanism.

In addition to Pakistan, Bangladesh is currently equipped with provisions related to having an independent system operator and dispute settlement. However, the country lacks certain provisions and frameworks required to have NPEX. Provisions pertaining to the non-discriminatory open access to transmission and distribution, policy to establish more merchant capacity, unbundling of utilities by separation of the generation, transmission and distribution functions are to be incorporated. It is suggested that unbundling should be encouraged as the government policy. Bangladesh also needs to establish the provisions for licensing and functions of Power Exchange, regulations for the establishment of power exchange, regulations for imbalance settlement in case of deviations from the schedules and the framework for transmission & wheeling tariff.

The other countries need to develop the framework in majority of the aspects to be ready for establishing NPEX.

Develop and nurture domestic power markets: In addition to preparing the required frameworks, the SMS need to develop and nurture domestic power markets parallelly. Developing and nurturing domestic power markets ensures the transactions to be recorded in fair manner. It also gives a clear picture on the market size and market dynamics. Even though SMS choose not to corporatize/ unbundle the utilities, the process needs the utilities to sub-categorize or create separate business units based on the activity. This may be followed by opening up the sector for private participation. This will aid the utilities to record every transaction and understand the market size and opportunities. India already has a matured power market. Pakistan, Bangladesh, Nepal and Sri Lanka have unbundled the utilities and gradually opening private participation in the sector. They have to work on encouraging competition in order to fully develop the power markets. The others countries like Bhutan, Afghanistan and Maldives need to initiate the development of domestic power markets.

Participate in CBET: The process may be annexed with participating in power markets of neighbouring countries to address the energy needs of the country during surplus and deficit scenarios. Participating in neighbouring country markets will open up the sector to address the challenges along with attracting new investments and knowledge transfer which will aid the country in strengthening the efforts to build NPEX.

Establishing NPEX: With the above prescribed steps, the SMS would be placed better in establishing NPEX and can achieve maturity in terms of trade volumes in domestic power markets. This would enable the countries to increase the cross-border electricity trade and result in better resource utilization. The countries rich in solar and wind energy resources could trade and schedule electricity with countries rich in hydro and gas power potential. There is a compelling case for the integration of the short-term power market of SAARC member countries. The sporadic demand-supply mismatch on an hourly, daily, and seasonal basis provides an excellent opportunity for a marketplace where surpluses and deficits can be managed synergically at the regional level on a real-time basis.

Formation of Intergovernmental Forum on CBET: With increasing cross border electricity trade and established NPEX, the need to form an intergovernmental forum or a committee for resource optimization and institutionalization of cross border electricity trade becomes inevitable and the forum may be mandated to create framework for CBET in terms of CO_2 emission reduction in lines of resource optimization in addition to regular electricity trade. The forum may also be tasked with coordination between the countries, standardization and interoperability of grid codes among others. Gaps and requirements to facilitate CBET has been listed in the preceding sections. With the suggested intergovernmental forum, SMS may arrive with effective modalities and implementation aspects related to CBET in the region.

Creating a fund within SAARC to facilitate CBET: To facilitate CBET and evolve CBET, a support mechanism may be created within SAARC by allotting certain funds against each country to initiate the process of developing framework on power exchange.

To conclude, Pakistan and Bangladesh may gradually adopt a Power Exchange model among the models discussed. Though, the other SMS like Afghanistan, Bhutan, Maldives, Nepal and Sri Lanka are not equipped with the required framework to have an NPEX in near future, with the above suggested steps, can initiate the process of developing framework to establish efficient NPEX and participate in CBET.

Glossary

Aggregate Demand Curve

An aggregate demand curve (AD) shows the relationship between the total quantity of output demanded (measured as real GDP) and the price level (measured as the implicit price deflator). At each price level, the total quantity of goods and services demanded is the sum of the components of real GDP.

Appellate Tribunal for Electricity

The Appellate Tribunal was established at an appropriate time when the liberalisation of electricity industry under the Electricity Act was being implemented. Previously, the electricity activities were generally controlled by an integrated State Electricity Board. The State Electricity Boards have since been re-organised with generation, transmission and distribution of electricity being undertaken by different entities. There are also other significant developments in pursuance of the Electricity Act, 2003 such as de-regulation of generation, encouragement of captive generation, implementation of the concept of Open Access, involvement of substantial number of private generators and private players in other areas, electricity trading being allowed, involvement of Power Exchange, integration of the national grid etc. There has also been establishment of large power generating stations in pursuance of a Competitive Bid Process under Section 63 of the Electricity Act,2003. There has been, therefore, a natural growth of substantial litigations involving complex issues of unprecedented nature. These could not be adjudicated even under the bilateral arbitration because of the overall interest of the consumers, which is to be protected.

https://www.aptel.gov.in/about-us

Amsterdam Power Exchange (APX)

APX provides innovative technology and service solutions for the energy and environmental markets. Our business experience spans transaction management, registries, scheduling, settlements, demand-side management, asset control, analytics, operations, exchanges, clearing, and brokerage. With deep domain and technological expertise, the APX team is uniquely qualified to provide leading-edge market solutions on a foundation of trust, integrity, and experience.

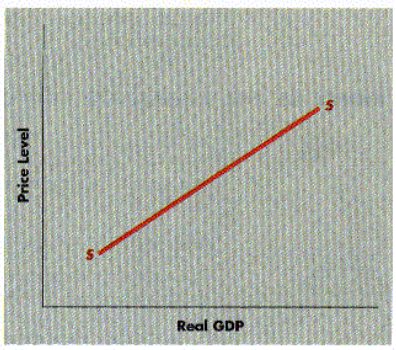
https://apx.com/about-our-company-apx/

Aggregate Supply Curve

The concept of aggregate supply does not refer to a fixed number, but rather to a schedule (a supply curve). The volume of goods and services that profit-seeking enterprises will provide depends on the prices they obtain for their outputs, on wages and other production costs, on the state of technology, and on other things. The relationship between the price level and the quantity of real GDP supplied, holding all other determinants of quantity supplied constant, is called the economy's aggregate supply curve.

AN AGGREGATE SUPPLY CURVE

This graph shows a typical aggregate supply curve. It has a positive slope (that is, it rises as we move to the right), meaning that the quantity of output supplied rises as the price level rises.



https://pzacad.pitzer.edu/~lyamane/bandb.html

Australian Securities Exchange

ASX is an integrated exchange offering listings, trading, clearing, settlement, technical and information services, technology, data and other post-trade services.

It acts as a market operator, clearing house and payments system facilitator. It oversees compliance with its operating rules, promotes standards of corporate governance among Australia's listed companies and helps to educate retail investors.

ASX operates markets for a wide range of asset classes including equities, fixed income, commodities and energy. As an integrated exchange, ASX's activities span primary and secondary market services, including the raising, allocation and hedging of capital flows; trading and price discovery; central counterparty risk transfer; and securities settlement for both the equities and fixed income markets.

https://www2.asx.com.au/about

Cross Boarder Energy Trade (CBET)

CBET can promote coordinated use of energy resources and potentially reduce the need for investments in new infrastructure to meet anticipated strong growth in electricity demand in both countries.
https://www.nrel.gov/docs/fy19osti/72066.pdf

The economic policies and re-structural developments have introduced possibilities of strong regional integration. Bilateral energy trade between India and its neighbours is a key building block of the integrated regional energy market.
https://www.ptcindia.com/cross-border-power-trade/

Its objective is to identify market factors and institutional issues that are most likely to affect the usefulness of infrastructure investments aimed at maximizing the benefits of CBET. The analysis assesses supply and demand characteristics by examining hourly load data, pricing data, generation capacity, tariffs, and historical CBET flows.
https://kathmandupost.com/opinion/2017/04/26/cross-border-energy-trade

Climate Vulnerability Forum

The Climate Vulnerable Forum (CVF) is an international partnership of countries highly vulnerable to a warming planet. The Forum serves as a South-South cooperation platform for participating governments to act together to deal with global climate change.

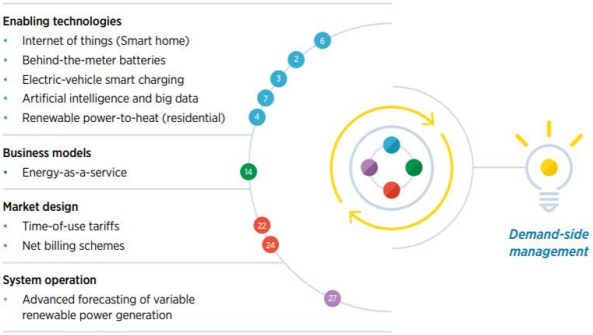
Day Ahead Market (DAM)

This type of market is based on auctioning electricity by an exchange or a pool technique. This market structure is designed to be either centralized or bilateral with two-way power flow. Bids are determined for maximizing total surplus. In the case of injecting free power at numerous locations, the locational energy price is set equivalent to the marginal change in total surplus. Three sets of conditions—guidelines to bid, directions for acceptance of bid, and settlement condition—are implanted before every auction. The multipart bid mechanism has been used by power pooling. An efficient auction is predominantly executed using a single-price day-ahead auction
https://www.sciencedirect.com/topics/engineering/day-ahead-market

Distribution Companies (DISCOMs)

Electricity distributors are different from electric suppliers. Distributors are those that deliver your actual energy, while suppliers are those that sell you your electricity.

Demand Side Management (DMS)



Demand Side Management (DSM) has been traditionally recognized as one of the major interventions to achieve reduction in energy demands while ensuring continuous development. In recent past, DSM has gained unprecedented importance and has become an integral part of almost all the central and state missions on promotion of Energy Efficiency. DSM interventions have helped utilities not only to reduce the peak electricity demands and but also to defer high investments in generation, transmission and distribution networks.
https://beeindia.gov.in/content/dsm

Energy Efficiency Certificate (EEC)

EECs also known as Energy Savings Certificates or White Tags are documents certifying that a certain reduction of energy consumption has been attained. EEC's represent the environmental benefit of eliminating Greenhouse Gas Emissions (GHGE). RECs assist in the creation of renewable power while EECs assist in the creation of energy efficiency projects, arguably a preferred method of reducing GHGE.
https://www.dps.ny.gov/07M0548/workgroups/WG1_NYS_EEC_Comments.pdf

Generation Companies

The companies which are generating electricity with the usage of conventional and non-conventional energy resources with different technologies

Green Term Ahead Market

The green term-ahead market (GTAM), a power trading platform, was launched to enable bulk electricity buyers (DISCOMs; corporates with a contracted load of 1 MW or above) to procure renewable energy (RE) on a short-term basis from sellers (merchant RE projects or DISCOMs having surplus RE beyond their renewable purchase obligations or RPOs).

https://cef.ceew.in/masterclass/explains/d5ee2888-9978-42fc-b482-b2d9c19a6cff

Inter-Governmental Agreement

An intergovernmental agreement (IGA) is any agreement that involves or is made between two or more governments in cooperation to solve problems of mutual concern. Intergovernmental agreements can be made between or among a broad range of governmental or quasi-governmental entities. Governments use IGAs for cooperative planning, development review, resource sharing, joint planning commissions, building inspection services, and more.

https://cdola.colorado.gov/intergovernmental-agreements-igas

Independent Power Producers (IPPs)

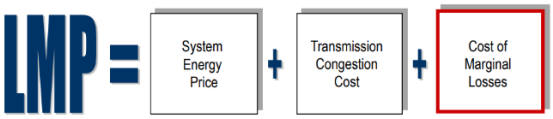
Independent power producers, or IPPs, are privately owned power plants. IPPs operate outside of the traditional utility grid owned, maintained and regulated by a public entity. This is why they are also known as non-utility generators.

All non-utility/nongovernment power producers are classified as IPPs. Independent power producers are fueled by a wide assortment of fossil fuels and, increasingly, renewables. The fuel an IPP relies on depends on a variety of factors, including the facility's age and location, start-up and operation costs, politics and fuel availability. This means that IPPs operate on a number of different fuels. Natural gas and nuclear power are popular due to the time period in which IPPs were first established. Renewable energy, such as that generated by solar and wind cooperatives, is produced and sold under the IPP model.

Some IPPs are developed with the sole purpose of providing power to the company that builds the power plant. Most are developed to profit from transforming energy and delivering it into the grid. This second category of IPPs sells their product via power purchase agreements (PPAs) with either utilities (wholesale) or individual businesses (retail).

https://www.americasgenerators.com/blog/post/2019/02/05/what-are-independent-power-producers.aspx

Locational Marginal Pricing

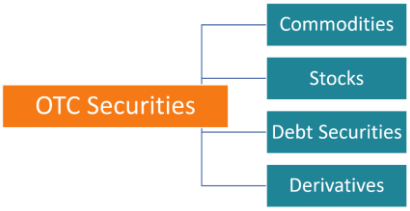


Locational Marginal Pricing (LMP) represents the cost to buy and sell power at different locations within wholesale electricity markets, usually called Independent System Operators (ISOs).

https://www.energyacuity.com/blog/what-is-locational-marginal-pricing-lmp/

Over the Counter Trading

Over-the-counter (OTC) is the trading of securities between two counterparties executed outside of formal exchanges and without the supervision of an exchange regulator. OTC trading is done in over-the-counter markets (a decentralized place with no physical location), through dealer networks.



Contrary to trading on formal exchanges, over-the-counter trading does not require the trading of only standardized items (e.g., clearly defined range of quantity and quality of products). Also, prices are not always published to the public. OTC contracts are bilateral, and each party could face credit risk concerns regarding its counterparty.

https://corporatefinanceinstitute.com/resources/knowledge/trading-investing/over-the-counter-otc/

Power Purchase Agreements (PPAs)

A Power Purchase Agreement (PPA) is an arrangement in which a third-party developer installs, owns, and operates an energy system on a customer's property. The customer then purchases the system's electric output for a predetermined period. A PPA allows the customer to receive stable and often low-cost electricity

with no upfront cost, while also enabling the owner of the system to take advantage of tax credits and receive income from the sale of electricity. Though most commonly used for renewable energy systems, PPAs can also be applied to other energy technologies such as combined heat and power (CHP).
https://betterbuildingssolutioncenter.energy.gov/financing-navigator/option/power-purchase-agreement

Renewable Energy
Non-Conventional energy resource like solar, wind, biomass and other alternative resources

Renewable Energy Certificate (REC)
A renewable energy certificate is a market-based instrument that represents and conveys the property rights to the environmental, social and other nonpower attributes of renewable electricity generation. RECs represent the environmental attributes of one megawatt-hour (MWh) of electricity generation. RECs are tradeable and serve to substantiate both compliance and voluntary market claims.
https://www.epa.gov/sites/default/files/2020-06/documents/3.0b-solar-claims-and-renewable-energy-certificates.pdf

Risk Management Committee
To identify and increase awareness of risk events, to ensure that risk prevention and mitigation plans are effective. ERM allows management to effectively deal with uncertainty and identify associated opportunities, enabling a utility to,

- Realize operational efficiencies;
- Reap financial gains;
- Achieve lasting competitive advantages;

https://rmgfinancial.com/core/files/rmgfinancial/uploads/files/CRA%20for%20NAPCO%20ERM%20-%20Power%20Companies%201%2017%202013(1).pdf

Renewable Purchase Obligation (RPO)
Renewable Purchase Obligation (RPO) is the requirement mandated by Central/State Regulatory Commission and is relevant to Distribution Licensee: power distribution companies (DISCOMs); Open Access Consumer: ones acquiring power from power exchanges (IEX/PXIL), from traders, via bilateral agreements and so on

Real Time Market (RTM)
a key regulator of power sector of a country, proposed several amendments to create the necessary framework for the implementation of the real-time market (RTM), for electricity. This virtual discussion deliberates discussions around the implementation framework of RTM. The expert panel addresses the concerns of all business operations from the perspective of Utilities, System Operators and Market Operators. In addition, the panel unpacks key areas such as day closures, price mechanism, NOAR, real-time transaction ratios, and system communications.
Key discussion points:

- Implementation process of the RTM framework;
- RTM's role in uplifting the current market situation;
- Communication between Exchange, NLDC, SLDCs, DISCOMs and Generators;
- Buyer/Seller Mechanism in real-time decision-making;
- RTM for renewable energy generators;
- DSM prices vs RTM prices;
- RTM bidding and auction windows;

https://www.smart-energy.com/industry-sectors/energy-grid-management/rtm-an-introduction-to-real-time-electricity-markets/

Single Day-Ahead Coupling
The aim of Single Day-ahead Coupling (SDAC) is to create a single pan European cross zonal day-ahead electricity market. An integrated day-ahead market will increase the overall efficiency of trading by promoting effective competition, increasing liquidity and enabling a more efficient utilisation of the generation resources across Europe.
SDAC allocates scarce cross-border transmission capacity in the most efficient way by coupling wholesale electricity markets from different regions through a common algorithm, simultaneously taking into account cross-border transmission constraints thereby maximising social welfare.

Settlement Guarantee Fund
The Relevant Authority may prescribe from time to time the norms, procedures, terms and conditions governing each Settlement Guarantee Fund which may, inter-alia, specify the amount of deposit or contribution to be made by each clearing member to the relevant Settlement Guarantee Fund, the terms, manner and mode of deposit or contributions, conditions of repayment of deposit or withdrawal of

contribution from the Settlement Guarantee Fund, charges for utilisation, penalties and disciplinary actions for non-performance thereof.
https://www.sebi.gov.in/sebi_data/commondocs/ch12_p.pdf

Single Intraday Coupling
Single Intraday Coupling (SIDC) creates a single EU cross-zonal intraday electricity market. In simple terms, buyers and sellers of energy (market participants) are able to work together across Europe to trade electricity continuously on the day the energy is needed. An integrated intraday market makes intraday trading more efficient across Europe by:

- promoting competition
- increasing liquidity
- making it easier to share energy generation resources
- making it easier for market participants to allow for unexpected changes in consumption and outages

As renewable intermittent production such as solar energy increases, market participants are becoming more interested in trading in the intraday markets. This is because it has become more challenging for market participants to be in balance (i.e. supplying the correct amount of energy) after the closing of the day-ahead market.
https://www.nemo-committee.eu/sidc

State Load Dispatch Centre
The State Load Despatch Centre is the apex body to ensure integrated operation of the power system

Term Ahead Market (TAM)
Term-Ahead-Market (TAM) provides a range of products allowing participants to buy/sell electricity on a term basis for a duration of up to 11 days ahead. The operations are carried out in accordance with the "Procedures for Scheduling of Bilateral Transactions" issued by the Central Transmission Utility (PGCIL), under "CERC (Open Access in inter-State Transmission) Regulations, 2008", as amended from time to time and the Bye-Laws, Rules and Business Rules of the Exchange. Currently, products in the Term Ahead Market include Intra-day, Day-ahead Contingency, Daily and Weekly contracts to help participants manage their electricity portfolio for different durations.
https://www.iexindia.com/Products.aspx?id=AxYp2%2fiBEmk%3d&mid=IT8b%2bZM5cBA%3d

Transmission System Operators
A Transmission System Operator is an entity entrusted with transporting energy in the form of natural gas or electrical power on a national or regional level, using fixed infrastructure.

Unscheduled Interchange
Unscheduled Interchange in a time block for a generating station/load means its total actual generation/demand minus its total scheduled generation/total scheduled drawal. All payments on account of Unscheduled Interchange charges levied under Grid regulations and these shall be utilized for serving of investment of transmission schemes or for providing ancillary services including but not only limited to load generation balancing during low grid frequency to ensure grid security and safety.
https://www.ijsr.net/archive/v4i8/SUB157660.pdf

Unserved (Electricity) Energy
The concept of unserved energy is applied to measure any supply interruptions consumers experience from generation and interconnection inadequacy only. Unserved energy measures the amount of customer demand that cannot be supplied within a region of the NEM due to a shortage of generation, demand-side participation, or interconnector capacity. In other words, it is the amount of wholesale unserved energy that is relevant for the purposes of reporting on the reliability standard.
https://www.aemc.gov.au/sites/default/files/2019-07/Final%20report%20-%20Definition%20of%20unserved%20energy.pdf

Viability Gap Funding (VGF)[13]
VGF is a government support in the form of contribution of some of the construction cost, given in cash to a PPP project that already economically viable but has not had a financial feasibility.
[or]

13
https://www.dea.gov.in/sites/default/files/Document%204(i)_Guidelines%20for%20financial%20support%20to%20Public%20Private%20Partnership%20Projects%20in%20Infrastructure%20under%20the%20Viability%20Gap%20Funding%20Scheme%25.pdf

The quantum of financial support (VGF) to be provided under this scheme shall be in the form of a capital grant at the stage of project construction. The amount of VGF shall be equivalent to the lowest bid for capital subsidy, but subject to a maximum of 20% of the total project cost. In case the sponsoring Ministry/ State Government/ statutory entity proposes to provide any assistance over and above the said VGF, it shall be restricted to a further 20% of the total project cost.

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Annexures

Annexure – A: Questionnaire for Stakeholder

This questionnaire is intended to capture and understand the readiness of the specific country for setting up a functional Power exchange to facilitate the effective working of Power Markets. Based on the understanding and learnings by way of secondary research and focused (Stakeholder) Group Discussion, we intend to propose recommendations for setting up a power exchange.

Category: 01

1. What is the most suitable reform model for your country's electricity market which will promote competition, security of supply, and sustainability while at the same time being compatible with the government objectives?
2. What is the status of the below aspects in terms of maturity and facilitation by competent authorities?
    a. Competitive bidding for public procurement in the electricity sector
    b. Flexibility in the PPA,
    c. PPA renewal and exit Mechanism.
    d. Tariff structure
3. Is generation a de-license activity, if not is there any plan to do so in future?
4. Is there any provision for providing trading licenses under the existing electricity/ energy legislation of the country?
5. Is there a frequency management system in place which can automatically ensure that there is no overdraw when the frequency is more than 50 Hz+-1%?
    a. Is there a power scheduling mechanism in place and if yes, what is scheduling time interval blocks? 5 Min/ 10 Min/ 15 Min/ 30 Min??
    b. Is there a power scheduling mechanism in place and if yes, if any sort of deviations is observed can they be captured and penalized? In addition, if deviating from schedules causes congestion, are they priced accordingly? Is there any congestion relieving mechanisms procedures that exist?
    c. Are the provisions in place for integration of RE power and are scheduling mandates in place for RE?
6. Does your electricity specific legislation, talks about setting up power market/exchanges in your country? If yes, who is the competent (Regulatory) authority and is the competent (Regulatory) authority independently empowered to create regulation on power market development? If No, are they any plans at the federal or provincial level to enact legislation in this regard?
7. What is the level of participation of the private sector in the generation, transmission, and distribution of electricity?
8. What set of reforms was proposed to facilitate private sector participation in the electricity sector?
9. What policy support is available for the promotion of setting up merchant power plants with no tied capacity
10. Does your country have any sort of electricity market through immature or with minimum/ limited participation?

Category: 02

1. What is the total share of long term PPAs in the country?
2. How many buyers and sellers are there in the country and what is the total volume of the transaction?
3. Is there any plan in the near future to move from a single buyer model (BBN) to a multi-buyer model to facilitate the power market?
4. What is demand Supply and deficit/surplus position in the country and expectation in the next 5 years?
5. What is the demand-supply constraints in the country and policy framework to address the same?
6. Power purchase, trading model and institutional mechanism?
7. What is the composition of short term, medium-term, and long-term power purchase portfolios in the country?
8. Open access regulation and associated proposed reforms in near future? Are there provisions for Non-discriminatory open access in the electricity act?
    a. If yes, please define features and eligibility criteria for connectivity and open access (types of open access, tenure, and priority of open access)
    b. Is there any provision related to the Fixation of Open access charges, Procedure for grant of connectivity of open access including details of nodal agencies, processing timelines, Establishing the operational and commercial mechanisms?
9. How do renewable support schemes need to be designed and implemented to avoid or minimize distortion in the market?
10. Is there any plan to create an independent system operator?
11. Is transmission infrastructure enough to facilitate short term energy trading at the exchange? Is there any transmission system planning framework under the electricity policy/Act/Grid Code of the country?

Category: 03

1. What is your power procurement strategy (short term, medium term, long-term basis) and how do you optimize your power procurement cost? Is there any other power procurement method in addition to having PPA?
2. What is the tariff setting procedure for the country? What are the components of the tariff for commercial and industrial consumers?
3. Is power procurement pricing or electricity tariff in the country competitive and supporting the development of industries? If not, what are the problems?
4. Since there is already provision for non -discriminatory open access to transmission and distribution infrastructure, is it implemented on the ground and can consumers procure power from the source of their choice?
5. Is there a multi-buyer and multi-seller model in the country? If not, is the government trying to promote this model in the country?
6. What is the level of participation of the private sector in the generation, transmission, and distribution of electricity? What set of reforms was proposed to facilitate private sector participation in the electricity sector?

7. Is electricity trading allowed in the country? Is there any framework for setting up a merchant power plant in the country?
8. Is the government taking steps to bring electricity exchange in the country? If yes, what reforms are being proposed by the Government?

Annexure – B: Typical bidding process for real-time at IEX

The trading process is divided into four key sessions:

Bid Session

Key features:

a. 48 bid sessions during the day;
b. Each bid session for 15 minutes;
c. The first bid session is to start at 2245 hrs.;
d. The 15-minute gap between two consecutive bid sessions.

Single and/or block including linked bids:

a. Single bids: 15-minute bids for different price and quantity pairs can be entered through this type of order. Partial execution of the bids entered is possible.
b. Block bids: Block Bid for any 15-min block or series of 15-min blocks during the same day can be entered. Although no partial execution is possible i.e., either the entire order will be selected or rejected.

The bids so entered are stored in the central order book. The bids entered can be revised or cancelled till gate closure.

Matching Session

- At the end of the bid session, bids for each 15-minute time block are aggregated and matched using double-sided closed auction methodology as also pursued in the day-ahead market.
- The Area Clearing Price (ACP) and Area Clearing Volume (ACV) are determined for each block of 15 minutes as a function of demand and supply, which is common for the selected buyers and sellers.
- Selected participants have intimated about their partially or fully executed bids and other trade-related information within a 1-time block after the closure of the auction period.
- Funds availability:
  - Exchange uses ACP and ACV used to calculate the obligation of the selected participants and their power flow.
  - The bid limit shall be in accordance with the funds available in the settlement accounts of the participants.

Financial Settlement

Pay In / Pay Out (PI/PO) is done on T/ T+1 date respectively subjected to banking hours and holidays.

Result Session

- IEX to intimate Area Clearing Price (ACP) and Area Clearing volume (ACV).
- Exchange to send final results for confirmation and application for scheduling of Collective transactions-RTM to National Load Dispatch Centre (NLDC).
- NLDC sends the details of the schedule to respective Regional/State Load Dispatch Centres (RLDCs/SLDCs).

- RLDCs /SLDCs incorporate Collective Transactions-RTM in the Daily schedule.
- A scheduled transaction is considered deemed delivered.
- Deviations from schedules are dealt under UI or Deviation Settlement Regulations or Imbalance Settlement Regulations. The Regional Entities connected at ISTS networks are governed by CERC Regulations and Embedded Entities and entities connected to state transmission or distribution networks are governed by respective State Electricity Regulatory Commission's Regulations.