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Energy Transition and its Impact on Indian Power Market

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Abstract

Indian electricity sector is undergoing a transition phase, where a massive quantum of 500GW of non-conventional energy is going to be integrated into the existing resources of conventional energy by 2030. However, these renewable sources like solar and wind are highly fluctuating in nature. Managing this renewable rich grid will be a challenge to the system operators. Also, as the predictability of the renewable energy is highly volatile in nature, existing energy pricing mechanism will need to be reviewed. Energy storage systems like batteries and pump storage are some promising technologies which will definitely help managing grid more efficiently. Presently maximum of energy need in our country is being sourced through conventional resources, majority from fossil fuels. Almost 89% of energy generated being transacted though long-term power purchase agreements between discoms/consumers and generators. Only about 11% of power is being transacted through energy exchanges. The trading volume through exchange is expected to be increased as Discoms are not showing less interest to go into long term PPA due to their financial burden. With the integration of highly variable renewable energy with grid in massive quantum, price volatility will be increased. A suitable change in energy pricing is required so that both the Discoms and generators can hedge their risk in renewable-rich volatile power market. Discoms/consumers with their power optimization tools can also participate in derivatives markets and hedge their risk. This will help Discoms to lower their power purchasing costs and prevent them from being saddled with the inflexibility of long-term PPAs as electricity demand profiles change. Discoms will have the flexibility to buy power based on demand. Under the proposed structure, long-term contracts in the physical (spot) market will be traded on power exchanges under the jurisdiction of the Central Electricity Regulatory Commission (CERC), while in the financial (derivatives) market contracts are set to be traded on commodity exchanges regulated by the Securities and Exchange Board of India (SEBI). CERC will help in designing electricity contracts and facilitate transactions of energy contracts. Physical and financial electricity markets will complement each other. This paper will analyse the possible impact of energy transition and introduction of electricity derivatives in India Power Market.

Keywords: *Energy transition, Renewable Energy, Energy Storage, Power market derivatives, Grid Management.*

1.0 Introduction

Indian power sector is in a phase of rapid growth and is undergoing a rapid change – change in a way they are operated now. Electricity grid of India operates one of the largest synchronous grids in the world. The grid spreads over more than 3 million sqkm and caters almost 210 GW of peak demand. The Indian power system is expected to grow 8-10% p.a. for next several decades. Also Government of India has ambitious plan to add 175 GW of renewable energy capacity addition by 2022 (100 GW solar, 60 GW wind, 5 GW small hydro and 10 GW from other sources) and 6 to 7 million

electric vehicles by 2022 [6]. This will pose a challenge of efficient integration of this massive renewable to existing grid. Discoms are struggling with huge financial losses and have become increasingly reluctant to enter long-term PPAs with renewable energy developers as renewable tariffs hit a record low. PXIL and IEX, two power exchanges in India, has started their journey long back in 2008. IEX facilitates effective price discovery and allows players by providing an automated trading platform for the physical delivery of electricity, trade in energy contracts, Renewable Energy Certificates (RECs), and ES Certs (Energy Saving Certificates). With the introduction of Power Market Regulation 2021 by CERC, energy trading volume through the exchange is expected to be enhanced drastically. Introduction of this regulation will help to ensure fair, neutral and efficient price discovery. In July 2020, the Ministry of Power (MoP) approved the introduction of financial instruments being electricity forward contracts and derivatives in India [1][2]. The reform was much awaited and came on the back of the resolution of the dispute between the Central Electricity Regulatory Commission (CERC) and the Securities and Exchange Board of India (SEBI). This is an important incremental step in expanding the overall structure of physical delivery market, besides adding electricity as a commodity in the financial market. The introduction of derivatives to India's short-term power market will make it easier for renewable project developers to enter into offtake arrangements with the state-owned distribution companies (Discoms). The launch of this new financial instruments will help every stakeholders to plan and hedge their offtaker risk without requiring the signing of long-term contracts with Discoms for the financial closure of projects. Participation by the stakeholders in the futures market will be a positive step that will help to hedge the offtaker risk and provide flexibility and certainty of supply to both Discoms and developers. This would also help develop the price signal needed to incentivize supply into peak demand periods, which is the key to enabling battery deployments and demand response management [3].

2.0 Energy Transition in Indian Power Sector

At the Conference of the Parties (COP 26) in Glasgow in 2021, India announced a target of 500 GW of non-fossil fuel capacity by 2030. This is India's contribution to global efforts on climate mitigation. Presently all India installed capacity is more than 400 GW. India has already achieved addition of 113 GW RE capacity as on 31st May'22 (Figs.1 and 2).

India present evening peak demand touches 190 GW in April 2022 with monthly energy demand met 133 BU. Average daily demand 4.4 BU. Contribution from hydro was 12.3 BU, wind generation was 4.2 BU, solar generation was 7.8 BU.

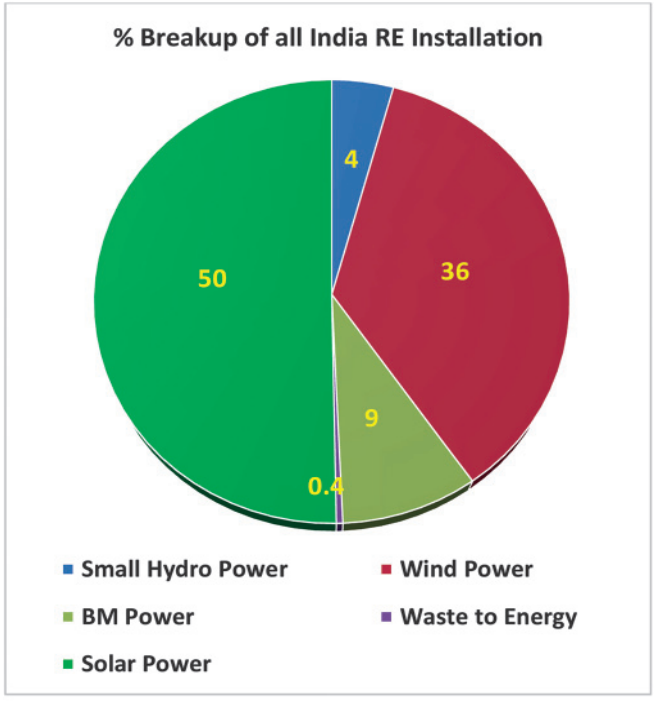

Figure 1: Break up of all India RE installation

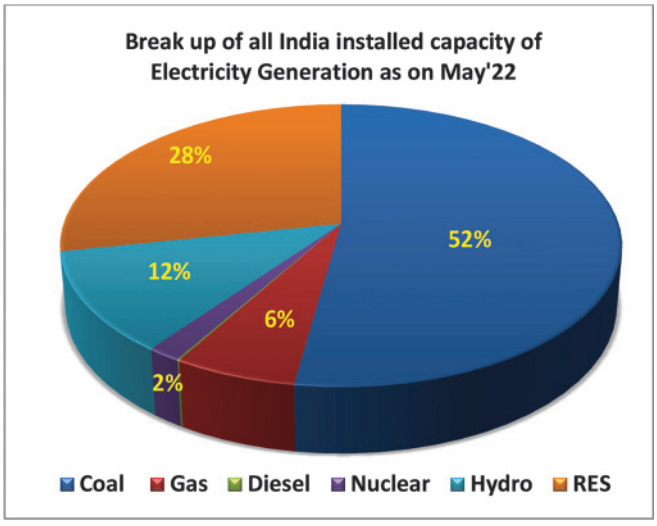

Figure 2: Break up of all India installed capacity

From the above generation and demand curve (Figs.3 and Fig.4), it is clear that energy storage is expected to play a critical role in India reaching the target of RE integration. Pump storage is one of the promising technology towards energy storage. The Central Electricity Authority of India has estimated a PHS potential of 96 GW, but only 3.3 GW is currently operational in India. Also battery storage is option for energy storage. India currently has only 20 MW of installed battery storage capacity, with 1.3 GW of storage capacity is under various stages of development [4].

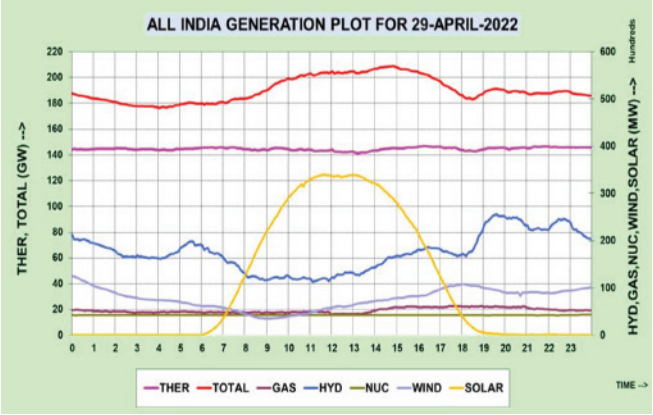

Figure 3: All India generation status for 29th April 2022

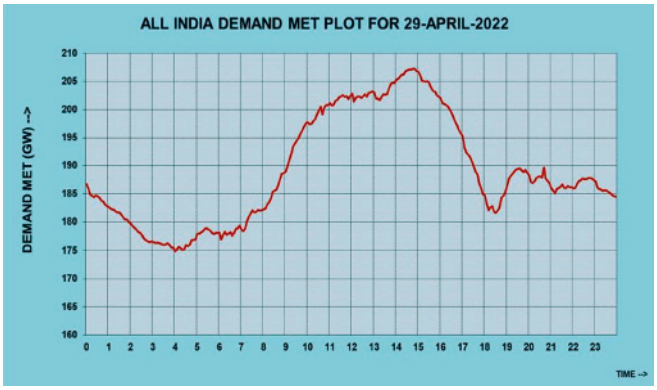

Figure 4: All India demand status for 29th April 2022

3.0 Present Scenario of Indian Power Market

The Electricity Act (2003) tries to promote competition by unbundling and treating generation, transmission and distribution as separate entities. In order to address the needs of the power sector, the last decade has seen the setting up of markets for bilateral trading of electricity followed by trading of power on power exchanges in 2008. The trading of bulk power from private generators was facilitated through Power Trading Corporation (PTC)

India to reduce the payment risk. The very idea of restructuring the power market in the country came up with the need of supplying the power deficit southern regions from the power surplus eastern regions of the nation.

Electricity Act 2003 has provisions for enabling competition in bulk power market, retail power market, enabling market development and mitigation of market power. Consequently, power exchanges like Indian Energy Exchange (IEX) and Power Exchange India (PXIL) were established in the year 2008. Today, India also does international power

Table 1: All India generation status

Category of Energy Sources	Generation (MU) in FY 2021-22	Generation (MU) in FY 2020-21
Thermal	1,114,704	1,032,130
Nuclear	47,019	42,893
Hydro	151,695	150,240
Bhutan IMP	7,484	8,819
Renewable Sources	169,375	147,745
Total	1,490,277	1,381,827

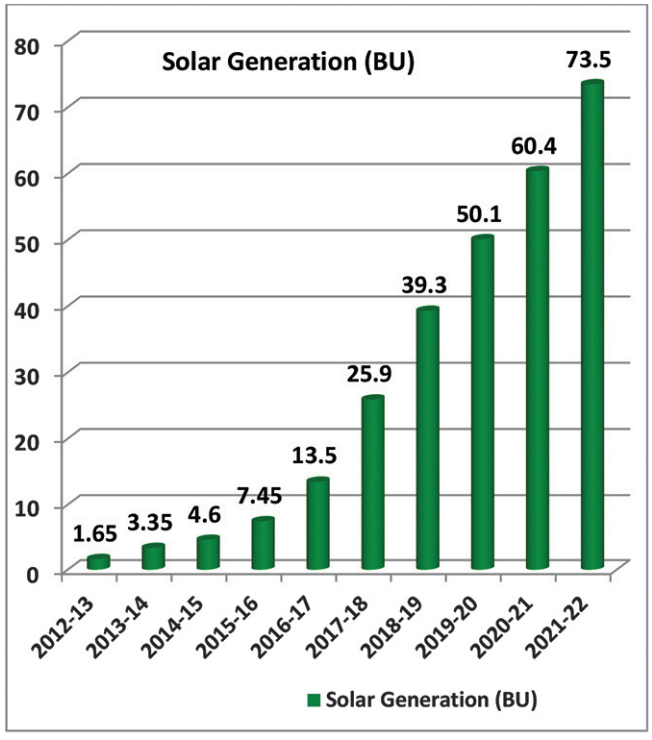

Figure 5: All India solar generation trend

trading with Bhutan, Nepal and Bangladesh [2]. The introduction of power exchange has slowly increased the volume of power traded and decreased their prices in the short term market.

Introducing derivatives: For Indian power market, the introduction of derivatives will be a game changer because today consumers have some reservation on participating in the spot market as they are prone to fluctuations in prices. Both industries and utilities look for some price certainty. Today, no option is available to them to hedge their position. Once we have the derivatives in place, the trade would become similar to what happens globally, where exchanges

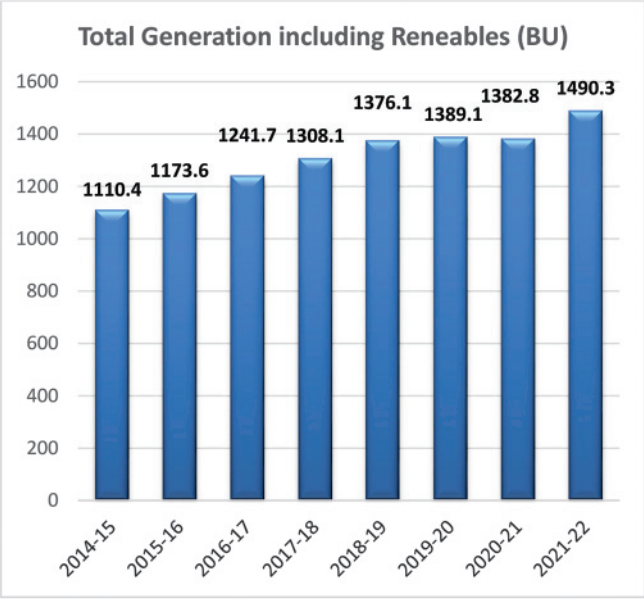

Figure 6: All India total generation trend

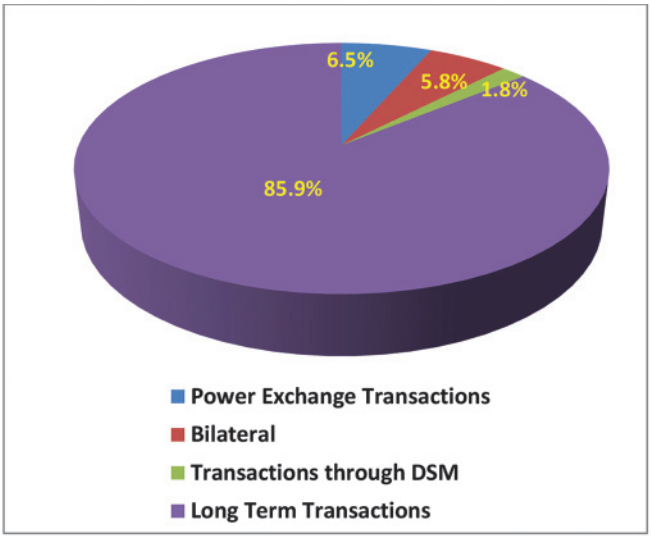

Figure 7: All India solar generation trend

are contributing more than 50 per cent of the total consumption. Once this happens the participants will also be able to realize the real potential of the exchange route.

Most of the generation capacities are tied up in long term power purchase agreements (of 25 years) with the distribution companies (Discoms) and the rest in medium term contracts (up to 5 years) and short term contracts (up to 1 year).

On account of many difficulties of these long term/medium term PPAs, many Discoms have started to purchase power from energy exchanges to meet their short-term needs.

Upon enactment of the electricity Act 2003, power trading has been recognized as a distinct activity in the Indian electricity industry.

Power Exchanges - Indian Energy Exchange Ltd (IEX) and Power Exchange India Ltd (PXIL), have started their journey in 2008 with the intent of creating a comprehensive market structure under the rules and regulations of CERC. CERC has issued power market regulations in 2021 with the objectives:

(1) To design electricity contracts and facilitate transactions of such contracts;
(2) To ensure fair, neutral, efficient and robust price discovery, till such time the responsibilities are transferred to the market coupling operator in respect of day ahead contracts or real-time contracts or any other contracts as notified by the commission;
(3) To facilitate extensive, quick and efficient price discovery and dissemination.

The power exchange aggregates the buy and sell bids separately and clears the market on the basis of supply-demand equilibrium. The intersection point of buy and sell curve determines the Market Clearing Price (MCP) and Market Clearing Volume (MCV). Such transactions are also known as collective transactions as buyers and sellers are anonymous to each other (Fig.8).

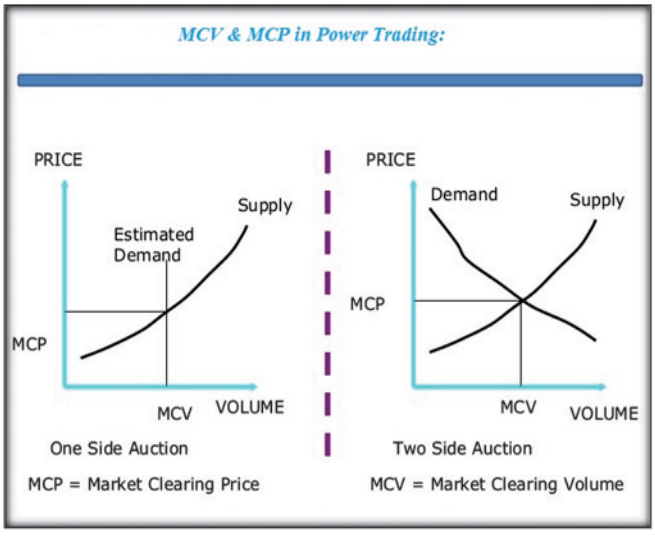

Figure 8: Electricity Price discovering mechanism

There are many power exchanges across the globe like:

Power Exchanges in World

- Australia: IMO (Independent Market Operation)
- Belgium: APX Group
- Czech Republic: PXE (Power Exchange Central Europe)
- France: EPEX SPOT
- Germany: EEX (European Energy Exchange) and EPEX SPOT
- Hungary: HUPX (Hungarian Power Exchange) and PXE.

- India: IEX (Indian Power Exchange and PXIL (Power Exchange India Ltd.)
- Japan: JEPX (Japan Electric Power Exchange)
- Korea: KPX (Korean Power Exchange)
- Philippines : Philippine Wholesale Electricity Spot Market
- Portugal: EEX
- Scandinavia: Nord Pool Spot
- Singapore: EMA (Energy Market Authority of Singapore) and EMC (Energy Market Company)
- USA: FERC (Federal Energy Regulatory Commission)

Power transacted through power exchanges in India is in three different types : real time contracts, day ahead contracts and term ahead contracts (up to 11 days in duration).

In order to bring more reforms in power sector, Ministry of Power took the initiative of resolving the jurisdictional issue between SEBI and CERC with regard to various forms of contracts in electricity for Efficient Regulation of Electricity Derivatives by constituting a committee on 26th October, 2018, under the Chairmanship of the Additional Secretary, Ministry of Power with representatives from Department of Economic Affairs (Ministry of Finance), Central Electricity Authority, Central Electricity Regulatory Commission (CERC), Power System Operation Corporation Limited (POSOCO), Security Exchange Board of India (SEBI), Indian Energy Exchange, Power Exchange of India Limited and Multi Commodity Exchange to examine the technical, operational and legal framework for electricity derivatives and to give recommendation in this regard. Committee submitted its report on 30.10.2019 with the following recommendations:

1. All Ready Delivery Contracts and Non-Transferable Specific Delivery (NTSD) Contracts as defined in the Securities Contracts (Regulation) Act, 1956 (SCRA) in electricity, entered into by members of the power exchanges, registered under CERC (Power Market) Regulations, 2010, shall be regulated by CERC subject certain conditions,
2. Commodity Derivatives in electricity other than Non Transferable Specific Delivery (NTSD) Contracts as defined in SCRA shall fall under the regulatory purview of SEBI.

Based on the recommendations of the Committee both SEBI and CERC have come to an agreement that CERC will regulate all the physical delivery based forward contracts whereas the financial derivatives will be regulated by SEBI.

Now let us discuss about derivatives focusing electricity being the under lying assets.

Electricity is traded through:

1. Physical markets:
   (a) SPOT for immediate delivery
   (b) FORWARD for future delivery
2. Financial Markets i.e. Derivatives:
   (a) Futures
   (b) Options
   (c) Swaps

Presently SPOT for immediate delivery is available in India.

Electricity Derivatives: An Introduction [8][9][10]

What are derivatives?

Derivatives are financial instruments whose value is based upon the value of an underlying asset like equities, currency or other financial assets or commodities. Most common types of derivative instruments are forwards, futures, options, and swaps.

And specifically, electricity derivatives are financial instruments whose underlying asset is based on electricity.

Economic functions imparted by a derivatives market

The derivatives market performs a number of economic functions. A brief summary follows.

- First, the derivatives market helps to transfer risks through hedging.
- Second, derivatives, due to their inherent nature, are linked to the underlying spot markets. With the introduction of derivatives, the underlying market witnesses.
- Third, prices in an organised derivatives market reflect the collective perception of market participants about the future. Hence they provide important price signals which in the absence of derivatives markets are largely not available.

4.0 Forwards, Futures and Options

Forwards: A forward contract can be defined as an agreement to buy or sell an asset on a specified date for a specified price. Details of the contract like delivery date, price and quantity are negotiated bilaterally by the parties to the contract.

Futures: Futures markets are standardized contracts that trade on exchanges and are settled on a daily basis. These arrangements come with fixed maturity dates and uniform terms.

Options: Options are contracts that give the purchaser the right, but not the obligation, to buy or sell a security or commodity traded on an exchange, at a fixed price within a specific period of time.

Participants in the market

Participants in a derivatives market can be risk givers or hedgers and risk takers. Risk givers or hedgers are those who have a risk due to physical exposure to the commodity.

Here electricity, being the underlying asset, is the relevant

commodity.

Generators, Discoms, end users participate in this market and are basic players.

Risk takers can be those who do not have physical exposure to this commodity but want to make gains from inequalities in the market. Financial investors and arbitrageurs can be these players.

Objectives of participations in the market

Increased competition in electricity markets will help in reducing electricity prices, but will also result in greater price volatility as the industry moves away from administratively determined, cost-based rates and encourages market-driven prices. Price volatility introduces new risks or threats for GENCOs, DISCOMS, End users etc.

Electricity derivatives can help these market participants to manage, or hedge price risks in a competitive electricity market. Futures contracts are legally binding and negotiable contracts that call for the future delivery of electricity. In most cases, physical delivery does not take place in derivative market and the futures contract is closed by buying or selling a futures contract on or near the delivery date. Other electricity derivatives include options, price swaps, basis swaps, and forward contracts.

Electricity derivatives examples

Derivatives market in India for electricity has not yet sailed through and is in preparation and implementation phase.

Across the globe, electricity futures and option contracts are being traded on different exchanges. One example of contract specifications of NYMEX electricity futures and option contract is given below:

Italian power base load (GME) calendar month futures - contract SPECS

Hedging

It is a risk management strategy. Its basic purpose is to protect potential threats or risk. Instruments for hedging purpose involves derivatives, such as options and futures contracts. Derivatives instruments can be used to hedge or to speculate.

Electricity derivatives will offer power offtake certainty for renewable investors

The short-term market has yet to reach its full potential. So far participation has been limited. Short-term electricity transactions as a share of overall electricity generation have remained at around 10% for the past decade. And to date,

Table 2: Example of power future

Contract unit	1 MW (24 MWh)1 MW×24 hours=24 MWh Clears in multiples of calendar days in the contract month.
Price quotation	Euro per MWh
Trading hours	Sunday - Friday 6:00 pm - 5:00 pm (5:00 pm - 4:00 pm CT) with a 60-minute break each day beginning at 5:00 pm (4:00 pm CT)
Minimum price fluctuation or tick size	•0.01 × 1 MW × 24 hours × # calendar days/month
Product code	CME Globex: ITBCME ClearPort: ITBClearing: ITB
Listed contracts	Monthly contracts listed for the current year and the next 2 calendar years. Add monthly contracts for a new calendar year following the termination of trading in the December contract of the current year.
Settlement method	Financially settled
Floating price	The floating price for each contract month is based on the hourly PUN Index GME determined for each baseload day during the contract month, commencing at, and including, the 00:00-01:00 hours auction and ending with, and including, the 23:00-24:00 hours auction for each baseload day. The floating price shall be the arithmetic average of all such hourly prices in respect of each baseload day in the contract month.
Termination of trading	Trading terminates at 12:00 noon Italy local time on the U.S. business day prior to the last calendar day of the contract month.
Days or hours	Baseload refers to every hour of the day for every day of the contract month. Adjustments will be made to the number of MWhs for daylight savings time to reflect the total number of hours in each calendar month. The range is from 672 to 745 MWh.
Position limits	NYMEX position limits
Exchange rulebook	NYMEX 1072
Block minimum	Block minimum thresholds
Price limit or circuit	Price limits
Vendor codes	Quote vendor symbols listing

participation of renewable energy (RE) in the short-term market has been minimal (less than 1%). But the introduction to derivative instruments of new market mechanisms on the Indian Energy Exchange platform will boost the short-term trading of RE. Market is a mechanism which for matching supply and demand for a commodity through the discovery of an equilibrium price. Electricity is non-storable. Because of complications in production and delivery systems, mismatches will always exist in supply and consumption as against contracted Power. System operator manages these imbalances.

Forward Contract in Electricity Derivatives market: As already defined the forward contract, it is a bilateral contract for delivery on a future date at a specific price. Price is determined based on different aspect of industry like input (fuel) price movement, its availability, weather condition, rainfall predictions, economic development rising demands for electricity etc.

Example

Forward contracts entered in June 2022 for delivery in October 2022 for delivery of 100MW power at a price of Rs.5/kWh.

Risks involved

Two types of credit risk are there like:

i. Replacement Risk:- Before start of delivery if any counterparty defaults. For example, if buyer to the contract defaults on August 2022 to take power from the generator, then generator has to enter in a new contract at prevailing market price, which may be at low price say @Rs. 4.5/kWh with a new counterparty. So Replacement Risk = (5-4.5)*Contract Volume

ii. Settlement Risk: Post delivery of power, if buyer fails to make payment to the seller. This risk has very high impact.

Credit risk exposure is as the sum of the settlement and the replacement risk.

Futures

- The most important and practical applications of Futures is Hedging.
- This contract obliges the buyer to purchase the underlying asset being electricity (or the seller to sell that commodity) at a predetermined future price and date.
- It is traded on exchanges.
- Majority of electricity futures contracts are settled by financial payments (cash settlement) rather than physical delivery, which lower the transaction costs.
- Futures contracts are highly standardized: Contract specifications, trading locations, transaction requirements, settlement procedures.
- Main difference between futures and forwards is the quantity of power to be delivered.
- Delivery quantity specified in electricity futures contracts is often significantly smaller than that in forward contracts
- Pros market consensus: Price transparency trading liquidity; Reduced transaction and monitoring costs.
- Cons Only Standardized Contracts tradable, no customization possible.

Hedging with Futures

• Generator hedges 100 MW load in Futures Market • Generator Sells Futures Contract at a future price in June 2022 @ Rs 5/kWh having expiry at the end of September 2022.

• Scenario 1: Avg. spot market price on 30.09.2022 is say

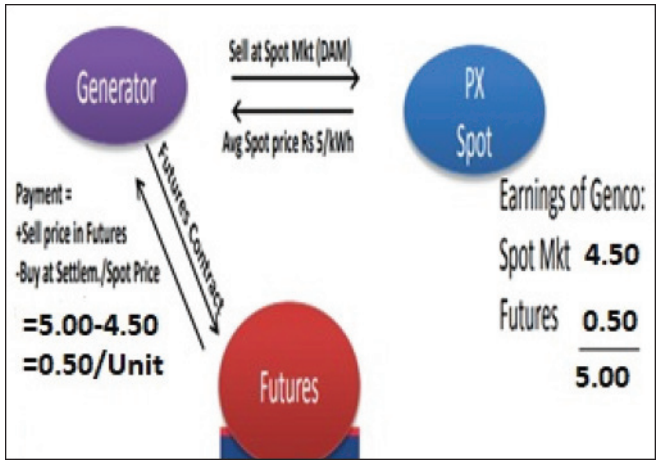

Figure 9: Pay-off table for scenario 1

Rs 4.5/kWh

Scenario 2: Avg. spot market price during delivery period

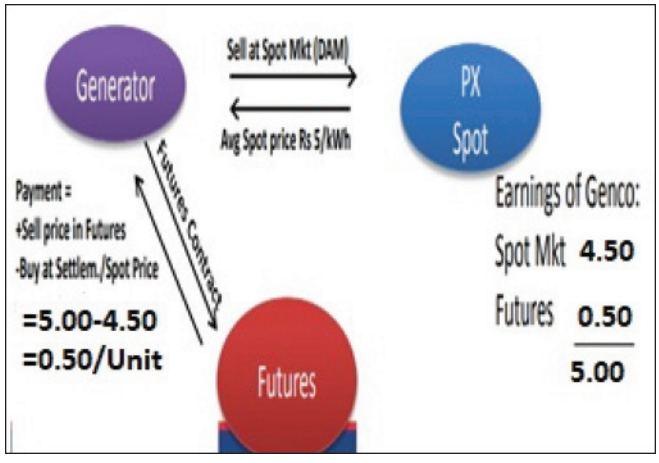

Figure 10: Pay-off Table for Scenario 2

say Rs 6/kWh

Situation of Seller at various Spot Price

When spot price is low then Futures seems profitable for seller since it hedges price risk but at higher spot price the seller is getting same price. There is no prospect for greater profit.

Under these circumstances, GENCOs may take position in option market.

Option

- Seller/GENCOs can buy PUT by paying a premium to the writer of PUT options.
- Say 10 MU will be delivered on 30.09.2022. Prevailing spot price is @ Rs.5 per unit and Genco is expecting price to fall below Rs.5/u.
- Premium payable per unit is, say, 10 paise per unit.
- Scenario 1: Avg. spot market price on 30.09.2022 is say Rs.4.7/kWh.
- Genco will protect the loss to the tune of (contracted price - spot price – premium paid) i.e. (5.00 - 4.70 - 0.10) × 10 MU = Rs.2 MU
- Scenario 2: Spot market price on 30.09.2022 is say Rs 5.3/kWh.
- Genco will lose the premium amount only.
- On the other hand, Discoms may hedge their positions by taking position through futures and options as applicable.

Conclusion

The Government of India along with different regulatory agencies is transforming the industry continuously. Power industry is moving from administratively tariff based pricing to market driven pricing. With the introduction of derivatives instruments, pricing is expected to be more fair, competitive. Stakeholders of the industry would be in a better position to manage risks. Transformation of this industry will attract more investment, ensure availability of power and do the betterment of the economy. In the recent past it has been seen power was being traded at Rs.20 per kWh on IEX and CERC capped it at maximum of Rs.12. This sort over pricing may pose a threat to economy's growth and development.

This industry plays a crucial role in the country's economy. That is why, transformation through market driven pricing, enhancement of liquidity, demand supply matching is a big welcome but regulatory control must coexist simultaneously.

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