Derivatives Market in Electricity

Akhilesh Awasthy
CEO (Power Markets)
Mercados EMI
In this presentation...

- Fundamentals of Markets
- Electricity Market
- Indian Electricity Market
- Derivative Market
i. Markets
“Market is a mechanism for matching supply and demand for a commodity through the discovery of an equilibrium price.”

**Requisites for Creation & Classification of Markets**

- Quality
- Quantity
- Price
- Date of Delivery
- Mode of Settlement
- Conditions to Contract
Commodity

“A basic good used in commerce that is interchangeable with other commodities of the same type”

Characteristics

• Product should be essentially uniform across producers
• Often used as inputs in production of other goods and services, i.e. large scale utility
• To be traded on an Exchange, a commodity must meet specified minimum standards, known as Basis Grade

Eg: Grains, Gold, Oil, Natural Gas, Foreign Currencies, Electricity etc.
ii. Electricity Markets
Electricity, a unique commodity

Flow (Non storable)

Laws of Physics

Interdependencies

Speed of Light

Imbalances

Congestion Management

Ancillary Services

Scheduling & Dispatch

Because of complications in Production & Delivery systems, mismatches will always exist in supply & consumption as against contracted Power. System Operator manages these imbalances.

This commodity travels as per laws of physics which are unique to itself. We can't tell electricity where to go or not to overload a route/line. One transaction of electricity can affect any or all other transactions for delivery.

Production & Consumption of electricity is dependent on ancillary services which make the transmission system work, such as Operating Reserves, Reactive Power, etc.

SO Schedules Contracts in advance and mingles energy in real-time by Dispatching Generation to meet demand.
Property rights of Electricity Commodity?

- Electricity is a flow, means that a property right cannot be assigned by title. No one owns electricity per se.
- Qualified wholesale market participants obtain ‘privileges’ to inject or withdraw power from the grid at specific locations.
- These Privileges encompass obligations to comply with technical rules and procedures for settling accounts based on metered injections and withdrawals.

All Rights are reciprocal and are derived from Contracts.
Electricity Market Design

Electricity markets are designed to match supply and demand, taking into consideration the technical limitations, elasticities and delivery requirements.

- Design is influenced by not only Economic, Engineering considerations but also by Historical, Political and Social Considerations. These factors make every country unique.

- If the spot electricity markets were complete and perfect then all forward markets could be organized around financial contracts pegged against spot prices.

- The efficiency of Spot Markets to facilitate intertemporal effects as startup costs and ramping constraints, and spatial effects such as constraints on transmission lines decides the level of dependence on Forward Markets.
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iii. Indian Electricity Markets
Introducing Competition

**Electricity Market**

- **Production Function**
  - Generation

- **Transportation Function**
  - Transmission
  - Distribution

- **Merchant Function**
  - Wholesaling (Supply)
  - Retailing (Demand)

**Natural Monopolies**

**Step-1:** Introduce competition in **Supply side** so as to decrease electricity prices. (Demand side competition doesn’t result in reduction of prices unless production is competitive)

**Step-2:** Introduce competition in **Demand Side** so as to pass the gains in supply side directly to consumers
<table>
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<td>Unbundling of Utilities</td>
<td>Separation of Vertically integrated utilities, transmission should be separated from generation &amp; supply</td>
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<td>Multi Buyer Model</td>
<td>Choice to consumers to buy from any generator or third party</td>
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<td>Choice to generator to sell to any buyer</td>
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<td>Balance Responsible Party (Control Areas)</td>
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<td>Trading</td>
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<td>Autonomous Regulator</td>
<td>To overlook the working of the Market</td>
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Present Market Overview

Long Term
Exceeding 7 Years
- OTC PPAs 91%

Medium Term
3 months – 5 years
- OTC Bilateral <1%

Short Term
Intraday - 3 months
- OTC Bilateral 4%
- EXCHANGE Collective-DAM 3%

Balancing Market
Real Time
- DSM Frequency linked 2%

Installed Capacity Tilted Towards Coal & Renewables
- Aug'10: 165 GW (Coal: 11%, Gas: 14%, Diesel: 22%, Renewables: 53%)
- FY'16: 302 GW (Coal: 3%, Gas: 11%, Diesel: 14%, Renewables: 61%)

Short Term Market Remained Stable
- Exchange Transactions Registered Growth in Short Term Mkt.

Coal Gas Diesel Renewables
## Indian Power Market Products...Missing Blocks

<table>
<thead>
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<th>Medium Term</th>
<th>OTC Licensed traders (40)</th>
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<td>3 months - 5 years</td>
<td>Exchanges</td>
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<th>Short-Term</th>
<th>OTC Intraday - 3 months</th>
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<td>Intraday - 3 months</td>
<td>Exchanges</td>
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<td>1. Intra-day</td>
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<td>2. DAM</td>
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<td>3. DAC</td>
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<td>4. Daily</td>
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<td>5. Weekly</td>
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<td>6. Monthly</td>
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<td>7. Derivatives</td>
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<th>Balancing Market</th>
<th>Unscheduled Interchange/DSM</th>
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<td>Real Time</td>
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<td>Demand Response</td>
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<th>Transmission</th>
<th>Transmission Licensee</th>
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<td>&gt; 7 Years</td>
<td>Exchanges</td>
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<td></td>
<td>Financial Transmission Rights</td>
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<td>Physical Transmission Rights</td>
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Development of Power Market

Advantages of an Organized Power Market

• Market Participants can efficiently manage their portfolios by choosing different products available under long term, medium term and short term duration.

• Provides an exit route for PPAs.

• Efficient Market provides transparency and which may lead to easy financing.

• Markets are driven by the force of economies i.e. demand and supply and hence the prices are derived.

• Market Participants e.g. DISCOMS may reap benefits of real time balancing.

• Typically lower unit pricing compared to standard electricity supply contracts.

Derivative products may provide an avenue to hedge against spot-price volatility
iv. Derivative Markets
Complete Market Products

Physical Markets + Financial Markets

**Spot**
Immediate Delivery

**Forward**
Delivery at some point in future

**Derivatives**
Risk Mgmt. tools for product/time/place

- Futures
- Options
- CfD

Commodity Exchanges first evolved to facilitate agri-markets or ‘mandi’ through electronic platforms.
Derivative Markets

- A contract which derives its value from price of an underlying commodity
- All financial contracts are derivative contracts
- Performs economic functions like Transferring risks, Discovery of Future prices, Increasing saving and investments in long run
- Participants in Derivative Market- Hedgers, Speculators, Arbitrageurs
- Could be a combination of spot and/or published forward/ contract prices
- Difficult to “value”
  - as published forward curves do not really represent the types of prices covered by contracts
Common Derivatives

1) Forwards
   - Physical or Financial

2) Futures
   - Essentially Financial

3) Swaps
   - Financials

4) Options
   - Physical or Financial
1) Forwards (OTC Contracts)

Obligation to buy or sell a fixed amount of electricity at a pre-specified contract price (the forward price), at certain time in the future (called maturity or expiration time).

Electricity forwards are custom tailored supply contracts between a buyer and a seller,

Buyer is obligated to take power and Seller is obligated to supply.

Electricity forward prices are:

Based on forward (long-term) expectations

Stable behavior

Long-term forwards have low volatility, short-term forwards may have high volatility

Correlation with fuels

In India, long term Forwards called ‘PPA’ with >7 year offtake & levelised tariff are in vogue.
Example

- Forward Contract Entered in Jan’17 for Delivery in June 17

Two types of Credit Risk

i) **Replacement Risk:** Before Start of Delivery if any counterparty defaults. For ex. If Buyer B defaults on March 17 to take power from Seller S, then Seller has to enter in a new contract at current market price, which will be generally at low price say @Rs. 3/u with a new counterparty. So Replacement Risk=(4-3)*Contract Volume

ii) **Settlement Risk:** If the electricity is delivered but buyer defaults to make payment, this creates settlement risk which has generally several times higher risk than replacement risk=4*Contract Volume. In addition to this delay in payment also comes in settlement risk

*Credit risk exposure is defined as the sum of the settlement and the replacement risk.*
2) Futures

Traded on organized 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
- Sells Futures Contract at a future price in Jan ‘17 @ Rs 4/kWh which settles at spot market price
- Scenario 1: Avg. spot market price during delivery period say Rs 3/kWh

\[
\text{Payment} = +\text{Sell price in Futures} - \text{Buy at Settlement/Spot Price} = 4 - 3 = \text{Rs 1/kWh}
\]

\[
\text{Earnings of Genco: Spot Mkt} = 3 \\
\text{Futures} = 1 \\
\text{Overall} = 4
\]

- Scenario 2: Avg. spot market price during delivery period say Rs 5/kWh

\[
\text{Payment} = +\text{Sell price in Futures} - \text{Buy at Settlement/Spot Price} = 4 - 5 = \text{Rs -1/kWh}
\]

\[
\text{Earnings of Genco: Spot Mkt} = 5 \\
\text{Futures} = -1 \\
\text{Overall} = 4
\]
Situation of Seller at various Spot Price

When Spot Price is low, Futures seems profitable since it hedges price risk, but at higher spot price the seller is getting same price. There is no prospect for greater profit. Solution is Option Contracts!!

The Seller through a put option—is provided a way to have higher profits at high spot prices while still being protected against low prices by paying an insurance premium.
Options

Not new!
Optionality needed to react to fluctuations in consumption, transmission interruption or plant outages
Power plants or gas storage provided flexibility to balance system
Now; optimise profit against market prices
Many options on daily or hourly basis can be seen as type of power plant

Virtual power plant
Option works like Insurance contract

Buyer of Option is the insured
Risk is removed from the portfolio
Pays premium

Seller of Option is the insurer
Risk is added to the portfolio
Collects premium
Options

Buyer has the **right** but not the obligation to buy or sell the asset at the previously agreed price.

Seller has the **obligation** to deliver or take.

Similar to insurance

- buyer pays premium every year
- insurance pays any damages

Call: gives the option holder the right to **buy** at a predetermined price

Put: gives the holder the right to **sell** at a predetermined price

**Strike price** - Price for which underlying commodity can be bought or sold

**Value option contract** is relative to strike price
Hedging with Options

- Generator hedges 100 MW load in Options Market
- Buy a put contract in Jan ‘17 at a strike price of Rs 4/kWh by paying a premium @ Rs. 0.5/kWh
- Scenario 1: Avg. spot market price during delivery period Rs 3/kWh. Hence Exercise Option
  
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<th>Spot</th>
<th>Option</th>
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<tr>
<td>3</td>
<td>0.5</td>
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  Earnings of Genco: 3.5

- Scenario 2: Avg. spot market price during delivery period Rs 6/kWh, Option not exercised

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<tr>
<th>Spot</th>
<th>Futures</th>
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<tr>
<td>6</td>
<td>-0.5</td>
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  Earnings of Genco: 5.5
Situation of Seller at various Spot Price

When Spot Price is low then Options are profitable since it hedges price risk and even at higher spot price the seller is getting spot price-premium. There is prospect for greater profit but at cost of premium.
Swaps

Financial contracts

Holders pays fixed price for electricity, regardless of floating electricity price, or vice versa, over the contracted time period.

Established for fixed quantity of power referenced to a variable spot price at either a generator’s or a consumer’s location.

For short- to medium-term price certainty up to a couple of years.

Strip of electricity forwards with multiple settlement dates and identical forward price for each settlement.
Example: Electricity Swap

Imagine it is November 2009 and a generator enters into a contract to sell 50 MW of electricity for the period of December 2009 at a daily floating price. The power can be generated at Rs 3000/MWh.

What is the market risk?
Supply Unhedged

Basis: PX baseload
Volume: 50 MW
Period: 01/12/09 - 31/12/09 (31 days)
Fixed Price: None
Floating Price: ???
Prod. costs: 3000 Rs
Example Electricity Swap

• Bank agrees to pay Generator Rs 3500/MWh for 50 MW of power during December 2009.

• Generator agrees to pay Bank cash flows equal to a floating price on the same quantity of electricity for one year.

• By combining this swap with the indexed electricity supply contract, a Generator can lock in a fixed income and sell to PX.
Supply Hedged

Basis: PX baseload
Volume: 50MW
Period: 01/12/09 - 31/12/09
Fixed Price: 3500 Rs /MWh (As per Swap Aggr.)
Prod. Costs: 3000 Rs/MWh
Floating Price: 2500 (December-09 average)

Buyer | Generator | Bank

Floating Price (+2500)  | Floating Price(-2500)  | Floating Price (+3500)

IN | OUT
2500 (Recd. from Buyer from actual delivery)  | 2500 (Out to swap Banker)
3500 (Recd. from swap Banker)  | 3000 (Actual Delivery costs)

Net Gain from Hedging= 500/MWh
# Derivative Markets, examples

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<td>Germany, Austria, France, Italy, Spain,</td>
<td>Base load, Peak load, Off-peak load</td>
<td>Day ahead Spot Market of EPEx Spot</td>
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<td>Base load, Peak load</td>
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<td>Peak load, Off-peak load</td>
<td>Respective Spot prices</td>
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<tr>
<td>ICE Futures US</td>
<td>Futures</td>
<td>Respective ISO/RTOs of USA</td>
<td>Peak load, Off-peak load</td>
<td>Respective Spot prices</td>
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Intraday price volatility in IEX DAM

Prices at Indian Energy Exchange (IEX) on 13th Aug'17

- **NER+ER+NR+WR Price**
- **SR Price**
Area Prices @ IEX

Different Prices due to Congestion

- NR: Rs 3.38/KWh
- ROI: Rs 2.47/KWh
- MCP: Rs 2.49/KWh
- SR: Rs 3.51 KWh

Time Block: 08:45-09:00 for Delivery Date: 16 Mar 2017
Daily price volatility in IEX DAM – Sep 17 to Oct 17

Price at Indian Energy Exchange (IEX) from 1st Sep 17 to 30th Oct 17

Price (INR/MWhr)

MCP (Rs./MWhr)
Derivatives in Indian Power Market?

Long Term PPA (25 Yrs) = Two Part Tariff

Capacity (Fixed) + Energy (Variable) = Availability/PLF linked payment

As per energy Offtake by buyer

Forward Capacity Contract

Options Contract
Application: Example-1

- **Participant:** Open Access Consumer

- **Power portfolio:** 10 MW load, with Discom charging industrial tariff @ Rs 8000/MWh. PX spot market (DAM) prices are in the range of Rs 2000/MWh to Rs 3500/MWh, with landed cost in the range Rs 7000/MWh to Rs 8500/MWh. Contingency power is charged @ Rs 12000/MWh by Discom.

**Derivative Trading Strategy:**

- Purchase Futures contract say @ Rs 2500/MWh and lock the price of electricity w.r.t spot market (Alternatively, Swap contract would fulfill the requirement). Bidding in DAM could be placed with upper threshold of Rs 12000/MWh
Application: Example-2

- **Participant:** Generator

- **Power portfolio:** 1000 MW capacity, with technical minimum of 500 MW. FC is Rs 1500/MWh @ Technical Minimum (50% PLF) and VC is Rs 1800/MWh (Rs 4500/MWh below technical minimum).

**Derivative Trading Strategy:**

- Sell Futures contract for 1000 MW say @ Rs 3300/MWh (if available, based on Forward Curve) and lock the price of electricity w.r.t spot market (Alternatively, Swap contract would fulfill the requirement)
- Trade the entire 1000 MW power on PX DAM and receive the market determined price from PX. To ensure schedule for technical minimum quantum, the generator places bid at ‘0’ price for 500MW to ensure selection and receives the cleared PX price and price difference with the futures contract is settled separately.
- Alternatively, Options could be procured at a relevant strike price, in place of Futures
Thank You