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

"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)

Imbalances

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

Laws of Physics

Congestion Management

This commodity Travels as per laws of physics which are unique to itself. We cant 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.

Interdependencies

Ancillary Services

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

Speed of Light

Scheduling & Dispatch

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

Consolidated Overview…

	Nord Pool	PJM	AEMO	IEX
Participation	Voluntary for DAM	Compulsory for Real Time	Compulsory for DAM	Voluntary
Market Offerings	DA spot, hour-ahead, forward, futures, options	DA spot, real-time balancing, capacity credit markets	DA spot, Short term forwards	DAM, TAM
Bidding Type	Double Sided	Double Sided	Double Sided	Double Sided Closed, Open Auction & Continuous
Adjustment Market	Elbas: Intra-day auction market	Bid quantity can be changed till gate closure	--	Not available
Real-time / Balancing market	Counter trade	Balancing Market	Purchase of ancillary services & reserve capacity	UI charge for deviations
Pricing Rule	Zonal Pricing	Nodal Pricing	Zonal Pricing	Zonal Pricing
Pricing Type	Ex-ante	Ex-post	Ex-post	Ex-ante
Risk Management	Forwards, futures, options	FTRs, Bilateral OTC, Multi-settlement, virtual bidding	Bilateral OTC, Derivatives on Sydney Exchange	Bilateral OTC
Congestion Management	Area splitting	Security constrained economic dispatch	Locational signals for transmission	Area splitting
Transmission Losses	Included in zonal price	Included in LMP	To be purchased by generators	To be purchased by participants

iii. Indian Electricity Markets

Introducing Competition

Electricity Market

Production Function	Transportation Function	Merchant Function
• Generation	• Transmission • Distribution	• 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

Pre requisites for a competitive market

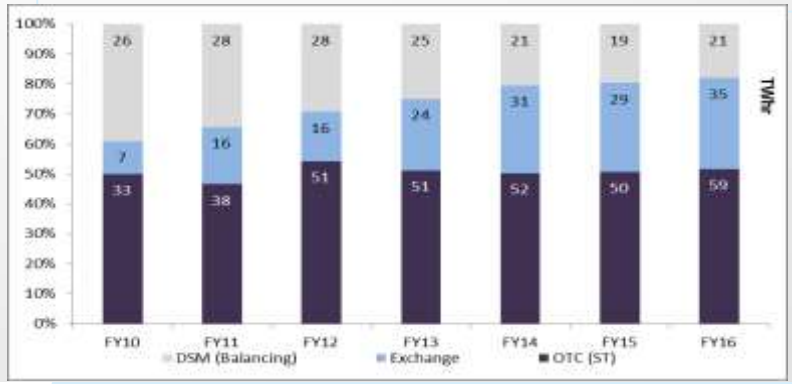
Unbundling of Utilities	• Separation of Vertically integrated utilities, transmission should be separated from generation & supply
Multi Buyer Model	• Choice to consumers to buy from any generator or third party • Choice to generator to sell to any buyer
System operator	• Independent System Operator: To maintain grid security and reliability, transmission allocation
Open Access	• Open Access in Transmission & Distribution Network
Imbalance Settlement Mechanism	• Deviation or Imbalance settlement mechanism to ensure discipline • Balance Responsible Party (Control Areas)
Trading	• Recognizing trading as a distinct activity
Autonomous Regulator	• To overlook the working of the Market

Present Market Overview

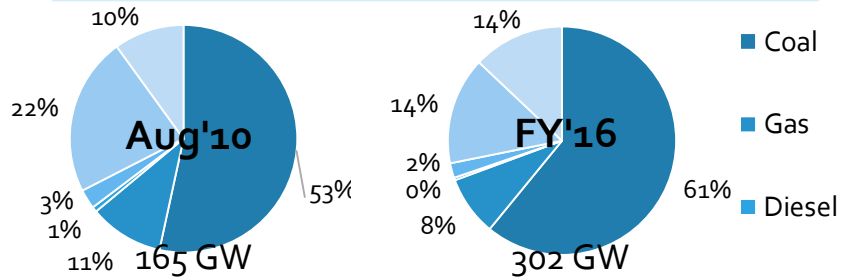
Long Term – **Exceeding 7 Years**	OTC PPAs	91%
Medium Term – **3 months – 5 years**	OTC Bilateral	<1%
Short Term – **Intraday - 3 months**	OTC Bilateral + EXCHANGE Collective-DAM Bilateral-TAM Weekly Daily Day Ahead Intraday	4% 3%
Balancing Market – **Real Time**	DSM Frequency linked	2%

Short Term Market Remained Stable

Exchange Transactions Registered Growth in Short Term Mkt.



Installed Capacity Tilted Towards Coal & Renewables



Indian Power Market Products…Missing Blocks

Medium Term 3 months- 5years	➢ OTC Licensed traders *(40)* ➢ Exchanges
Short-Term Intraday - 3 months	OTC Intraday- 3 months Exchanges 1. Intra-day 2. DAM 3. DAC 4. Daily 5. Weekly 6. Monthly 7. Derivatives
Balancing Market Real Time	Unscheduled Interchange/DSM Ancillary Services Demand Response
Transmission > 7 Years	➢ *Transmission Licensee* Exchanges ➢ Financial Transmission Rights ➢ Physical Transmission Rights

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

OTC

Physical or Financial

2) Futures

Exchange

Essentially Financial

3) Swaps

OTC

Financials

4) Options

OTC/Ex

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

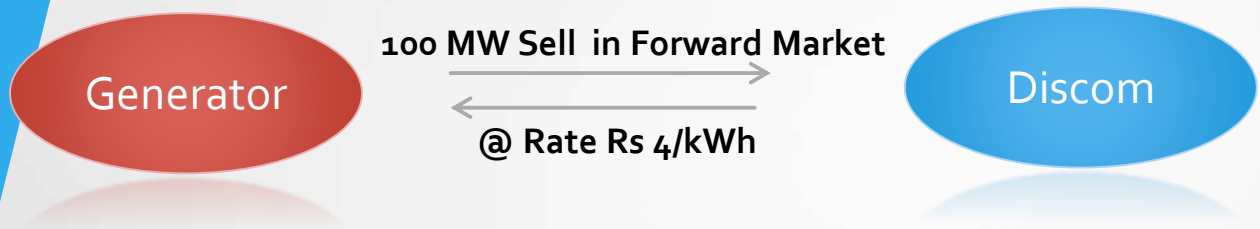
Electricity forward prices are:

- 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

Risks in Forward Market?

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.

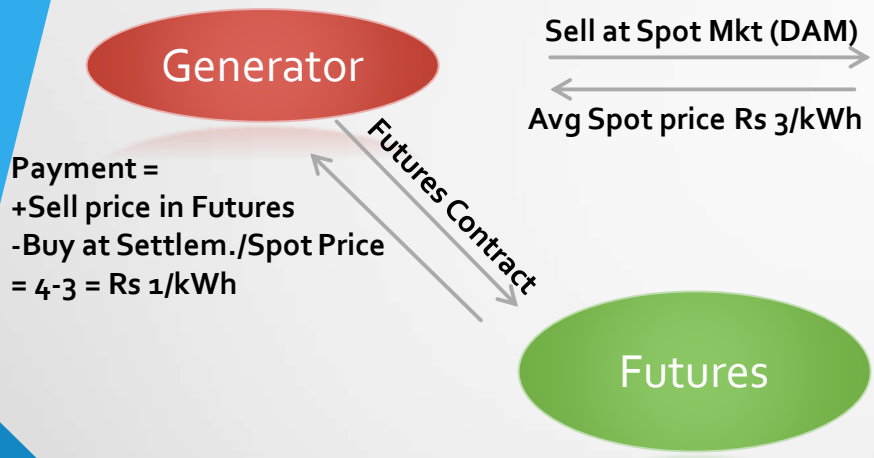
Main difference between Futures and Forwards is the quantity of power to be delivered.

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

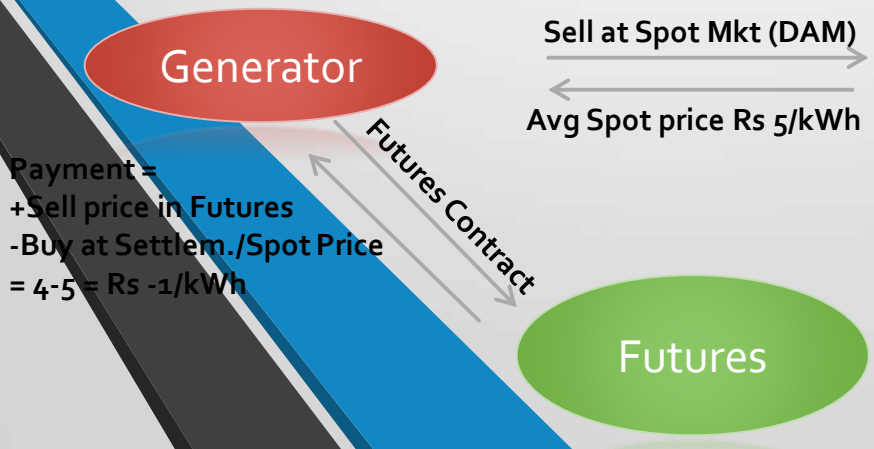
- Generator hedges 100 MW load in Futures Market
- Sells Futures Contract at a future price in Jan '17 @ Rs 4/kWh which settles at spot market price
- Scenario 1:- Avg. spot market price during delivery period say **Rs 3/kWh**



Earnings of Genco:

Spot Mkt	3
Futures	1
	4

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



Earnings of Genco:

Spot Mkt	5
Futures	-1
	4

Situation of Seller at various Spot Price

High Profit Zone

When Spot Price is low then 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

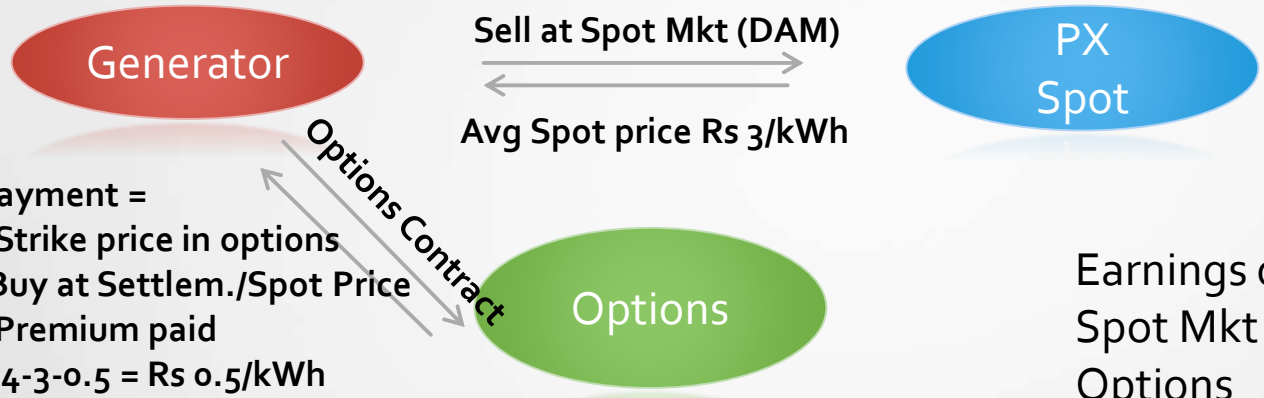
Put: gives the holder the right to *sell* at a predetermined price

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

Value option contract is relative to strike price

Hedging with Options

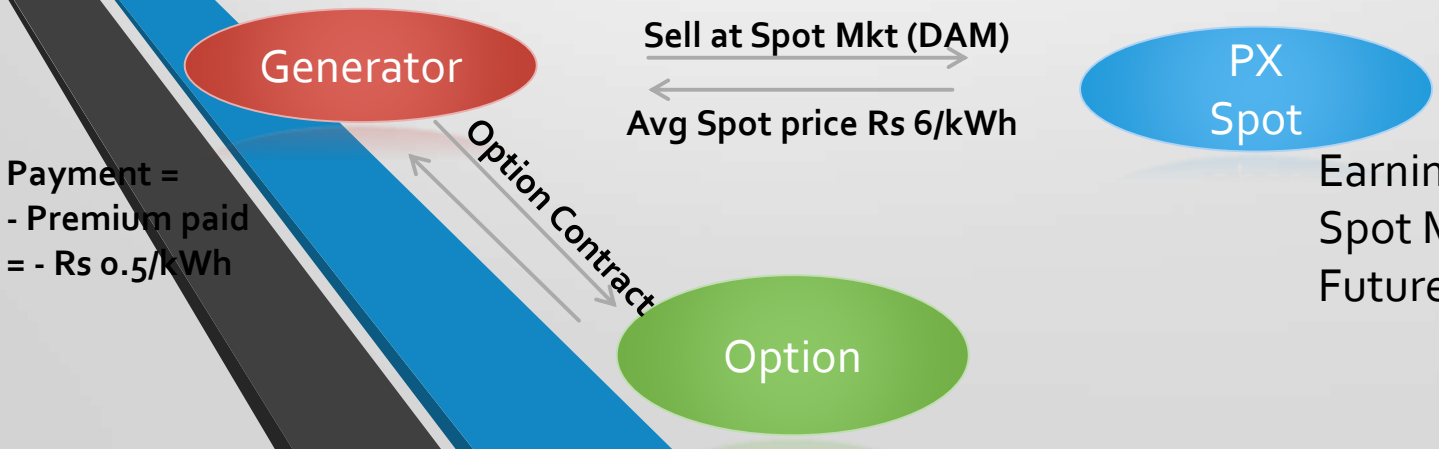
- Generator hedges 100 MW load in Options Market
- Buy a put contract in Jan '17 at a strike price of Rs 4/kWh by paying a premium @ Rs. 0.5/kWhr
- Scenario 1:- Avg. spot market price during delivery period **Rs 3/kWh. Hence Exercise Option.**



Earnings of Genco:

Spot Mkt	3
Options	0.5
	3.5

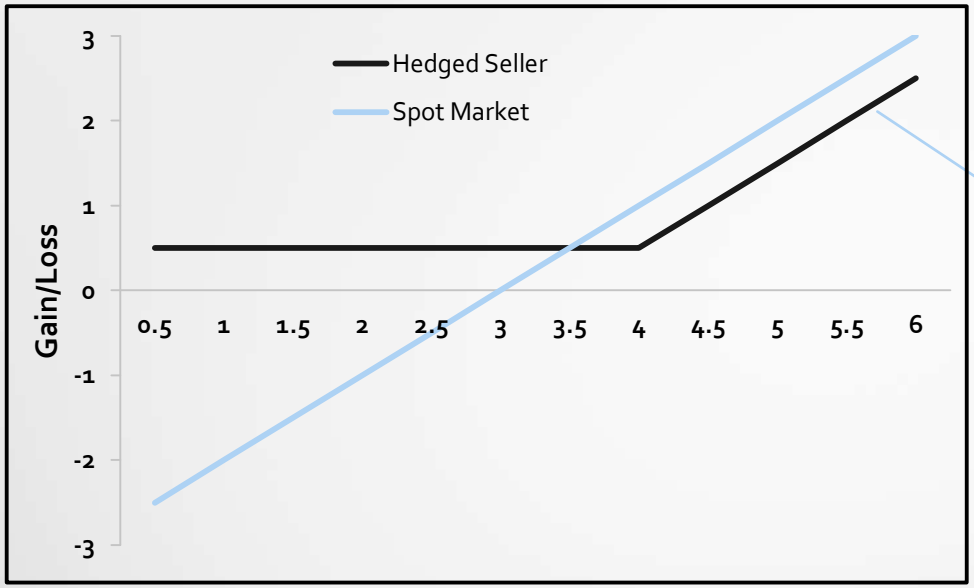
- Scenario 2:- Avg. spot market price during delivery period **Rs 6/kWh, Option not exercised**



Earnings of Genco:

Spot Mkt	6
Futures	-0.5
	5.5

Situation of Seller at various Spot Price



High Profit Zone

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.

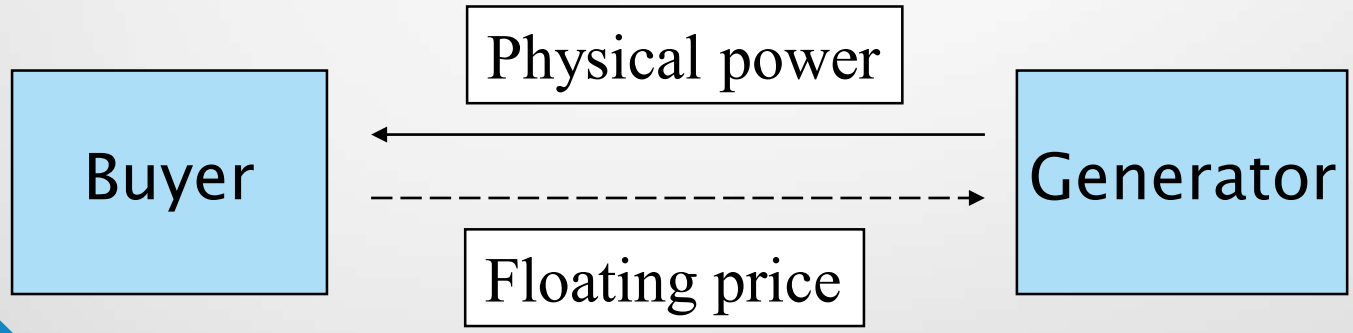
For short- to medium-term price certainty up to a couple of years.

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)

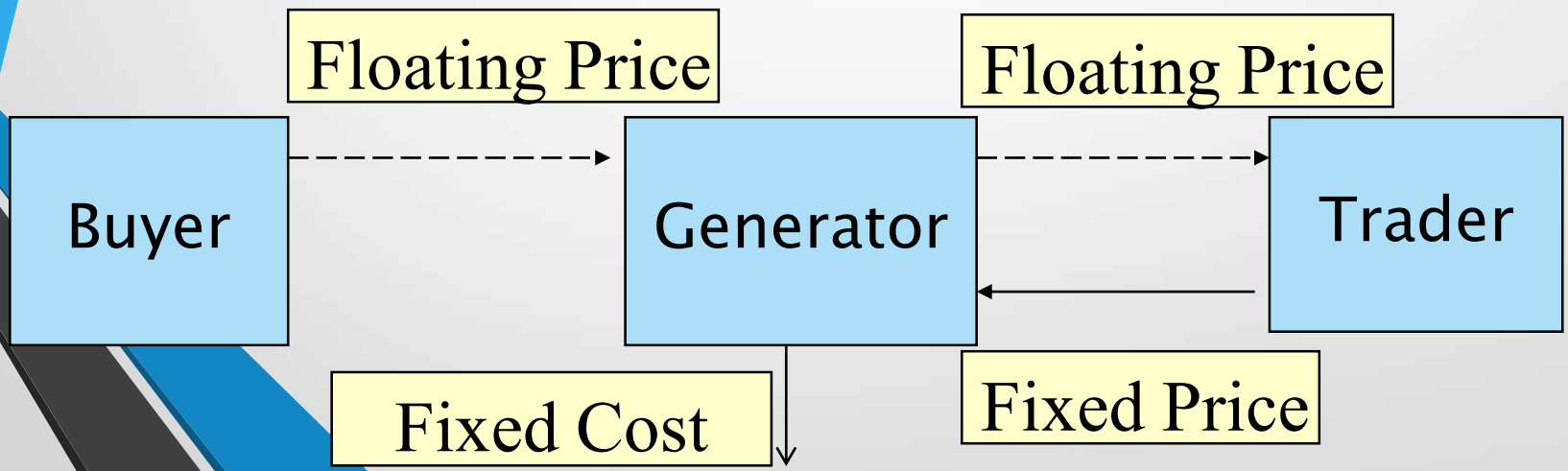
Fixed Price: None

Floating Price: ???

Prod. costs: 3000 Rs

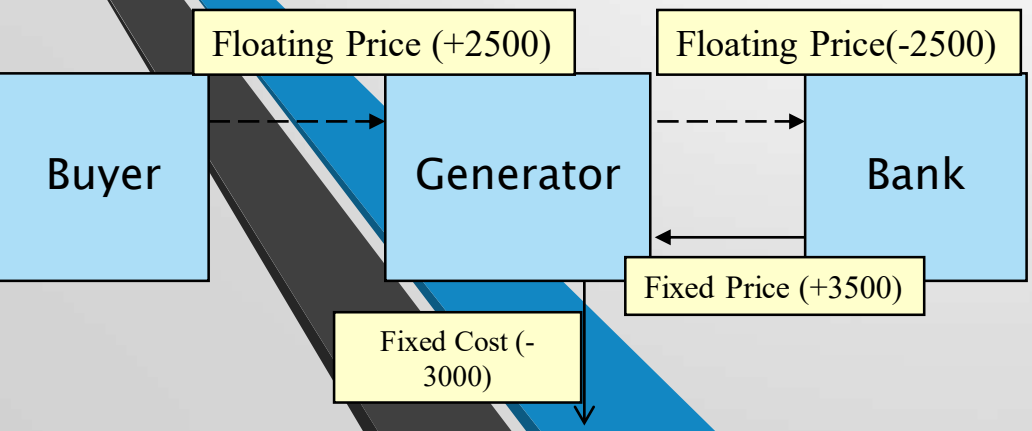
Example Electricity Swap

- 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)



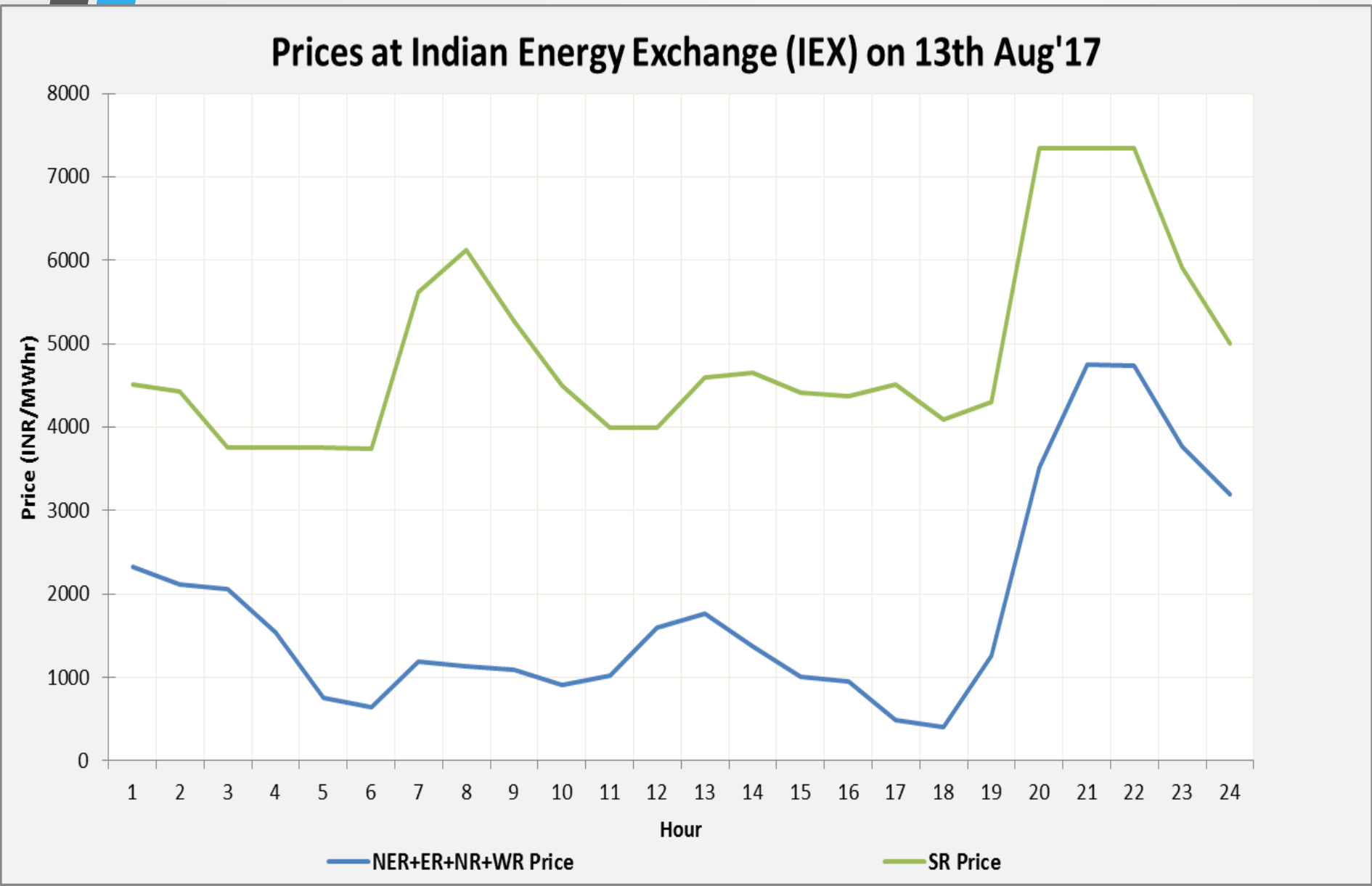
IN	OUT
2500 (Recd.from Buyer from actual delivery)	2500 (Out to swap Banker)
3500 (Recd. from swap Banker)	3000 (Actual Delivery costs)

Net Gain from Hedging= 500/MWh

Derivative Markets, examples

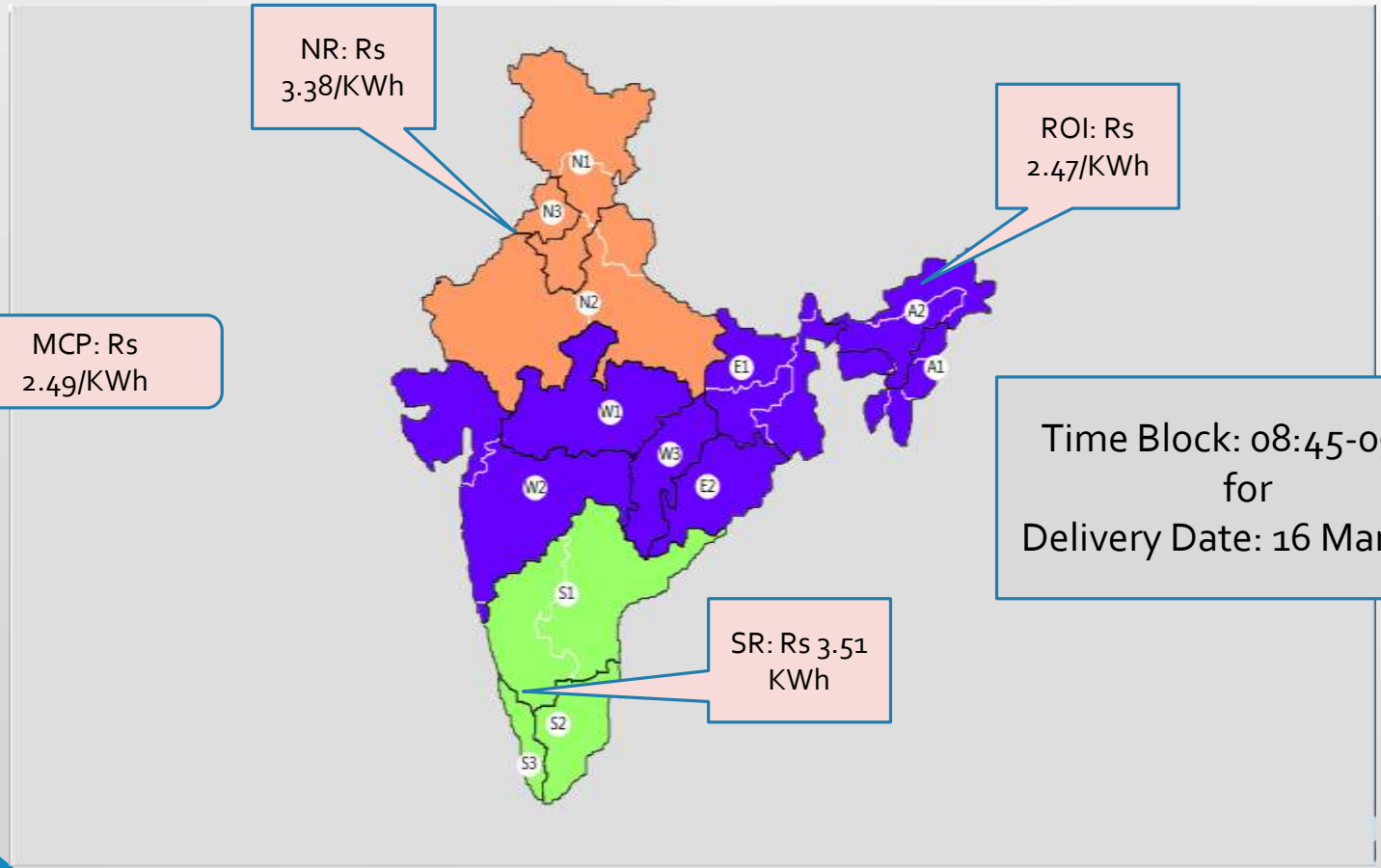
Exchange	Product	Country	Type	Settlement
EEX	Futures Options	Germany, Austria, France, Italy, Spain, Netherlands, Belgium	Base load Peak load Off-peak load	Day ahead Spot Market of EPEx Spot
NASDAQ OMX Commodities Exchange	Futures	UK, Scandinavia and Baltic countries	Base load Peak load	Day ahead Spot Market of Nordpool Spot
NYMEX	Futures	Respective ISO/RTOs of USA	Peak load Off-peak load	Respective Spot prices
ICE Futures US	Futures	Respective ISO/RTOs of USA	Peak load Off-peak load	Respective Spot prices

Intraday price volatility in IEX DAM

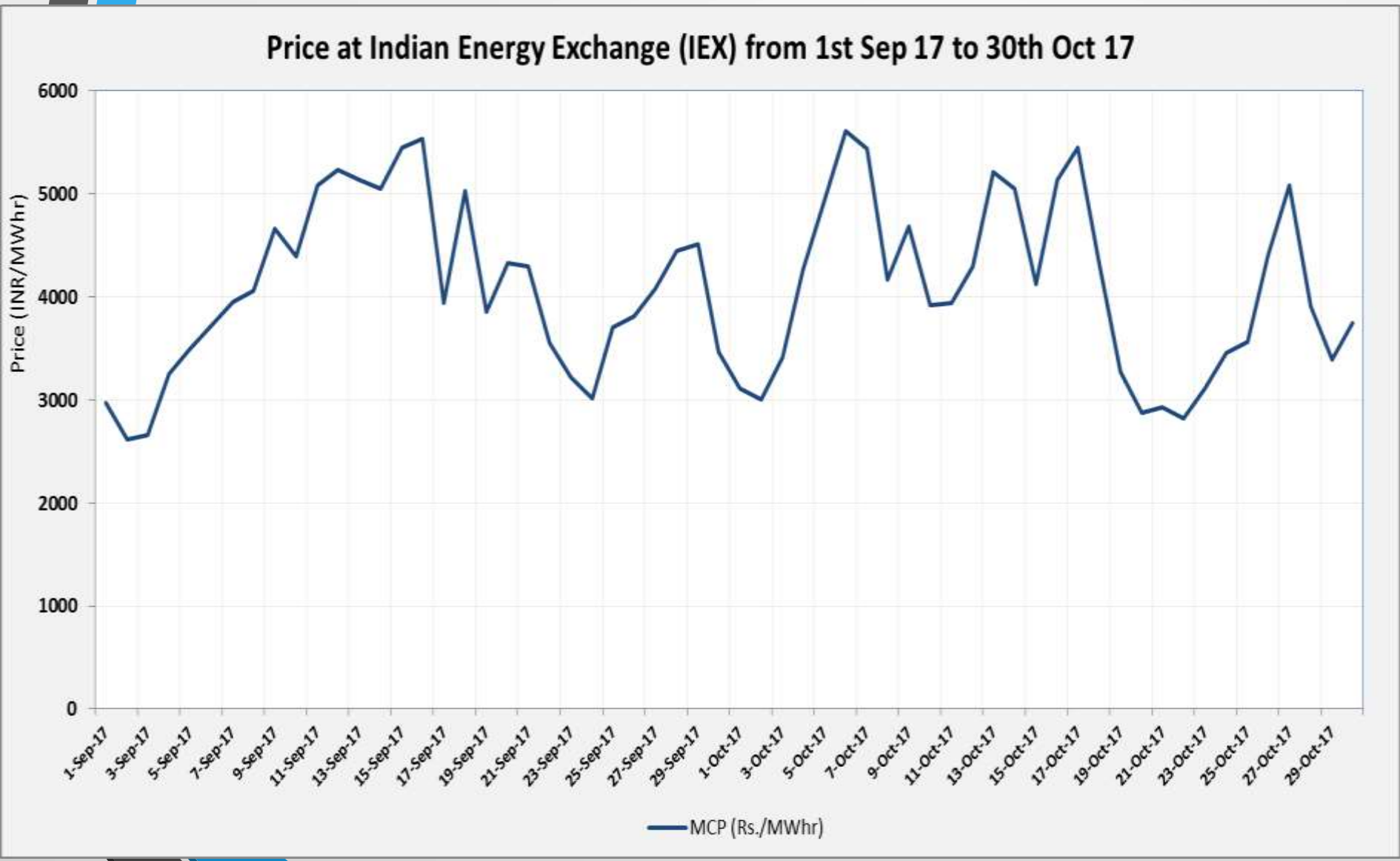


Area Prices @ IEX

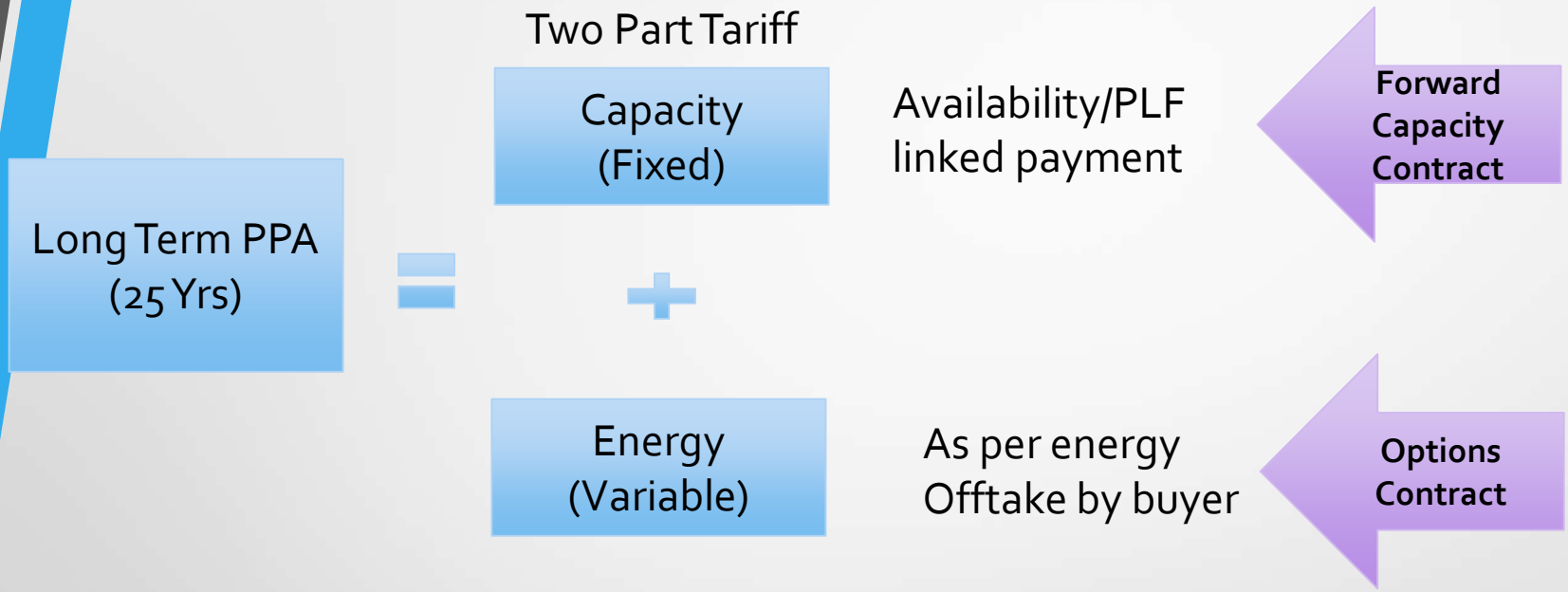
Different Prices due to Congestion



Daily price volatility in IEX DAM – Sep 17 to Oct 17



Derivatives in Indian Power Market?



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