Electricity futures

Electricity generators, grid operators and distributors use futures contracts to mitigate price risk. Besides regular players in the electricity market, speculators and arbitrageurs do trade in electricity futures. Re-visit the Indian Energy Exchange (IEX) for contract details.

Exchanges offer *futures contracts* on base load and *peak load* ranging from daily, weekly, monthly, seasonal (summer and winter) and yearly contracts. Futures contracts on system prices as well as for different areas/regions are also offered. Normally, futures contracts on system prices are more prevalent in all power exchanges as it has more liquidity.

Buyers and sellers pay/receive a locational/regional marginal price for buying/selling electricity in the spot market. However, when these entities mitigate the locational/regional marginal price risk with futures contracts based on system price, *locational basis risk* arises. Locational basis risk is managed through *Contract for Differences (CFDs).* CFDs are also known as basis contracts.

Electricity generators, grid operators, distributors, end users use futures contracts to mitigate price risk as outlined below.

As generators are naturally long on electricity, they take short positions to mitigate the price risk. Similarly, end-users take long futures positions as they are short on spot electricity. Transmission system operators/distributors/power trading companies buy electricity from generators and sell these to other distributors or end-users. Hence, transmission operators can take either long or short position in futures contracts depending on whether they have net short or long position in spot electricity.

Suppose a power trader has agreed to buy 100 MWh (per hour) electricity from an independent power producer during the next 3 months for 24 hours a day. The power trader has agreed to supply electricity to an industrial consumer for 50 MWh (per hour) for next 3 months, but only during 9 a.m. – 6 p.m. in the morning. After netting off, the power trader is net long in electricity for 50 MWh for 24 hours for 3 months and 50 MWh for 6 p.m. – 9 a.m.

The power trader takes short futures position to the tune of the exposed position.

To summarize, to hedge the price risk:

- Generators take short positions

- Transmission system operators/distributors may take long (short) futures depending on whether these entities are net short (long) on spot electricity.
- End users take long futures positions.

Generators/transmission system operators/distributors/ end users can also take strip futures contracts to mitigate the price risk.

Contract for differences (CFDs)

CFDs contracts were first introduced by Nord Pool in the year 2000. Forwards and futures contracts help in mitigating the price to be paid or received at a future date. But we know that a buyer/seller may actually pay or receive the area/region price, which may differ substantially to system price if there is congestion in the transmission grid. Hence, an entity which buys a derivatives contract based system prices.

An area price may differ substantially to system price if there is congestion in the transmission grid. Hence, an entity which buys a derivatives contract based on system price may not benefit from such contracts. CFDs are used to mitigate this risk – risk that a buyer pays higher price than the system price or a seller receives a price lesser than the system price. CFDs derive their values from the difference between area price and system price.

CFDs = Area price (P) – System price (SP)

CFDs can trade in positive, negative or zero value depending on whether AP > SP, AP < SP or AP = SP. AP is higher than SP when an area is a net deficit region. That is, when demand from that area is higher than the supply to that area. If the buyer of electricity is anticipating higher area prices, the buyer takes a *long positon* in CFDs.

If AP > SP an anticipated, CFD has a positive value. In this case, the buyer pays higher price for electricity consumption in the spot market, but receives the differential from the CFD market. Higher cash outflows in the spot market is compensated with the gain from the CFD market.

If AP < SP, they buyer pays less for electricity consumption, but pays the price differential to the CFD counterparty.

Similarly, if AP is expected to be less than SP, then the area is a surplus area. Power supply companies/generators earn less revenue by supplying to this area. To mitigate this risk, power supply utilities /generators take short position in CFDs. If AP < SP, utilities receive less from selling electricity to spot market, but are compensated by the earnings from CFDs. Below table shows the traded prices of CFDs indicate the market's prediction of the price difference between the area price and system price during the delivery period.

Table 1

Product Series	Closing value (Rs in per MWh)	Hours
1. System region1 – Jan 2019	-12.75	743
2. System region2 – Feb. 2019	-14.05	720
3. System region 3 – March 2019	1.9	2184

In the above table, the product series System region 1 – Jan. 2019 indicates the price difference between and region 1 area price (AP) and system price (SP) for the month January 2019. This contract closes at Rs. 12.75 per MWh indicating that system price (SP) is expected to be higher than the area price for the January 2019. Similarly, for other contacts 2 and 3.

Example: Suppose an independent power producer (IPP) (injects electricity into the grid in region 1 area) took a short position on CFD of region 1 at a price of – Rs. 14.05 per MWh. On 20th January 2019, the system price and region 1 area price were either (a) Rs. 43 per MWh and Rs. 26.65 per MWh (b) Rs. 43 per MWh and Rs. 32 per MWh, respectively.

Calculate the profit and loss due to CFD if the independent power produce (IPP) squares up short CFD on 20th January. Also find out the price it would receive per MWh of electricity it supplies including profit/loss from CFD.

Solution:

Region area price = 26. 65 per MWh

On 20th February 2019, the IPP would receive Rs. 26.65 per MWh from spot delivery of electricity.

System price = Rs. 43 per MWh

Value of CFD = (26.65 – 43) per MWh = -16.35 per MWh all expressed in rupees.

The IPP took a short position in CFD on 20th February 2019, the value of CFDs is -16.36 per MWh. The IPP squares up the short CFD position at a lesser value Rs. 16.35 per MWh, thus making a profit of Rs. 2.30.

Hence, the IPP receives Rs. 28.95 per MWh of electricity from both spot market and profit from CFD.

Case (b) Region 1 area price = Rs. 32 per MWh

On 20th February 2019, the IPP would receive Rs. 32 per MWh from spot delivery of electricity.

System price = Rs. 43 per MWh

Value of CFD = (Rs 32 – Rs. 43) per MWh = - Rs 11 per MWh

The IPP took a short position in CFD on 20th Feb. 2019 at Rs. -14.05 per MWh. On 20th February 2019, the value of CFD is -11 per MWh. The IPP squares up the short CFD position at a higher value – Rs. 11 per MWh, thus making a loss of Rs. 3.05. Hence, the IPP receives Rs. 28.95 per MWh of electricity from both spot market and adjustment of loss from CFD.

Spark spread futures

Spark spread futures are typical cross-commodity spread contracts applicable to the electrical sector. Spark spread is defined as the difference between the price of electricity sold by a produce and the price of the fuel used to generate electricity. When natural gas is used to generate electricity, the spread is known as spark spread and when coal is used to generate electricity, the spread is known as dark spread. A fuel constitutes a significant portion of total costs incurred by power producers, these spread contracts help power producers mitigate price risk of both input and output.

The spread is calculated based on the difference between price of electricity (in MWh) and the fuel cost associated with generating this power. Power plants convert fuel into heat and then to electricity. Heat rate measures the amount of fuel required to generate 1 unit of electricity. It is measured as mmbtu per MWh, i.e. number of units of natural gas (in mmbtu) is required to generate 1 MWh of electricity.

Heat rate = $\frac{\text{Quantity of fuel consumed}}{\text{Quantity of electricity produced}}$

Lesser the heat rate, higher is the efficiency of the power generation unit. If a unit requires 8 mmbtu to generate 1 MWh of electricity, the heat rate for this plant is 8 mmbtu/MWh.

The futures price of electricity and the natural gas/coal also helps in determining *market implied heat rate* (MIHR)

MIHR = $\frac{P_{e\text{ (Futures/forward price of electricty)}}}{P_{g\text{ (Futures price of natural gas/coal)}}}$

A power producer is considered efficient, when its own heat rate is lower than the market implied heat rate.

Example:

An electricity producer heat rate is 10 mmbtu (MMBTU / MBTU, means One Million British Thermal Units (BTU)) / MWh . The 1 month futures price for electricity and natural gas are USD 27 per MWh and USD 2.8 per mmbtu, respectively. Find out the MIHR and comments on whether the electricity producer is efficient or not compared to other player's in the market.

Solution:

MIHR = $\frac{P_{e\text{ (Futures/forward price of electricty)}}}{P_{g\text{ (Futures price of natural gas/coal)}}} = \frac{USD\ 27}{USD\ 2.8} = 9.64$

The MIHR is 9.64

As the producer's heat rate is 10, it is inefficient. This indicates that the producer will earn lesser margin in the coming month as compared to other players.

Spark spread calculation:

As electricity producer's margin is governed by spark spread

Spark spread = price of electricity (per MWh) – (Heat rate * Natural gas price per mmbtu).

Example: A generator is currently selling electricity (per MWh) at USD 26.05. It is buying the natural gas for USD 2.50 per mmbtu. Calculate the spark spread, if the heat rate is 9.027 mmbtu.

Solution: USD 26.05 – (9.05*USD 2.50) = USD 3.48.

Long and Short Positions for a Spark Spread Futures Contract

Electricity producers are exposed to both input and output price risk associated with both electricity and natural gas/coal price. These spread futures help power producers to mitigate both input and output price risk in one single contract. Futures contract on spark spread (short position) helps the electricity utility companies to fix their gross margin.

As the underlying units for electricity and natural gas are different, electricity producers have to take different number of units for electricity and natural gas contracts as part of the spread contract.

Long and short spark spread positions

Long position (buyer) of the spark spread futures	Buys the output (electricity) futures contract sells the input (natural gas) futures contract
Short position (seller) of the spark spread futures	Sells the output (electricity) futures contract Buys the input (natural gas) futures contract

Example:

In February 2019, the futures price in electricity and natural gas in the month of March 2019 is USD 27 per MWh and USD 2.8 per mmbtu, respectively. An electricity utility company requires 8 mmbtu of natural gas to produce 1 MWh of electricity. It wants to take short futures position on 7 electricity contracts at Chicago Mercantile Exchange (CME) as it intends to generate 5000 MW of electricity in the coming month. At CME, each electricity futures (day-ahead monthly) futures contract has 736 MWh of electricity as underlying. Find out how many long futures contracts on natural gas, it should take as part of the short spark spread position. Each natural gas contract has 10,000 mmbtu as the underlying unit.

Solution:

Spread spread = USD 27 – (8*USD 2.8) = USD 4.6

Underlying electricity (in MWh) for 7 contracts = 7*736 MWh = 5152 MWh

Amount of natural gas required to generate 5152 MWh of electricity

= 5152 * 8 = 42216 mmbtu of natural has

Each natural gas contract at CME is for 10,000 mmbtu

Number of natural gas contracts to be bought = 42216/10000 = 4.22.

In other words, the generator can buy 4 or 5 futures contract on natural gas.

Hence during February 2019, the utility company needs to take short position in 7 – 4 spark spread futures contract for the month of March 2019 and fix USD 4.6 per MWh as the margin.