Commodity Derivatives and Risk Management
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Week-10
Lecture 50
Spot & Derivatives Contracts on Electricity

Welcome to the 50th lecture on Commodity Derivatives and Risk Management. And today we are going to introduce the concept of spot and derivative treading's on electricity. Now before we proceed with understanding different aspects of the spot and derivatives market, it is very important to understand electricity as a commodity, who produces, who consumes, how the electricity gets generated and transmitted. And these concepts are of immense use to us so that we will be able to understand how exactly the spot and derivatives market on electricity functions. Now, let us understand how the electricity market is as a concept. So, the electricity market can be a spot market where the wholesale trading of electricity leading to physical delivery happens. In addition to the spot market, we have a derivative treading's market where wholesale trading of electricity leads to a physical delivery at a future date which is basically an example of a forward contract. Let me repeat in case of a derivatives trading of electricity wholesale trading of electricity leading to physical delivery at a future date happens. In addition to the actual delivery at a future date we can have derivative contracts which are cash or financially settled derivative contracts and these are basically futures and options where no physical delivery of electricity happens. And unlike most other commodities a significant amount of spot trading of electricity happens in organized exchanges. Please recall that when we were discussing about spot commodities at different point in time, we have said that commodities spot markets are very fragmented, it operates all over the India or all over the world. But unlike other commodities where the spot market does not function in an organized exchange, a significant amount of electricity happens through spot trading in organized exchanges. Now let us understand some of the important well-known spot trading exchanges of electricity. One of the well-known spots for electricity is known as the Nord pool. This is basically a Nordic power exchange for the wholesale buying and selling of electricity. About 300 companies from 16 different European countries participated in this particular exchange. In addition to the Nord pool, we also have an exchange called EPEX SPOT where the European power exchange this exchange offers electricity trading in countries such as United Kingdom, Denmark, Finland, Norway, and Sweden. In addition to the EPEX SPOT we also have an exchange which is known as EEX. This particular exchange offers Euro denominated cash settled futures contract on electricity. Similarly in USA we have two exchanges which are PJM Interconnections and California ISO these are wholesale market for spot transaction of

electricity in USA. In addition to the spot trading, Chicago Mercantile Exchange, CME offers financially settled derivative contracts on electricity. In addition to these international spot and derivative exchanges India has a thriving spot market on electricity. The prominent or well-known electricity exchanges are India Energy Exchange, Power Exchange India Limited and Hindustan Power Exchange and please note that all these three exchanges predominantly offer spot trading of electricity. Now let us understand a little bit of electricity as a commodity. Electricity can be generated from non-renewable energy sources as well as renewable energy sources. From the non-renewable energy sources coal natural gas and nuclear energy are the most prominent sources of non-renewable energy sources and coal is predominantly used for generating nonrenewable energy all over the world. China India and USA are the largest consumers of the coal, and they use coal for significant amount of electricity generation. And generation of electricity based on coal or thermal power as a percentage to the total electricity generation varies from as low as 20 percent to as high as 71 percent. As you can see in the USA about 19 percent of total electricity generated uses thermal coal. Traditionally in China 61 percent of the total electricity is generated from the coal and India has about 71 percent of the electricity been generated from the coal. In addition to the non-renewable energy sources, we have a significant amount of renewable energy sources being generated predominantly from the solar. In addition to that we also have electricity being generated from water and wind. Now let us understand the whole business cycle of electricity. Please note that the electricity business cycle can be categorized into four groups that is generation, transmission of electricity, distribution of electricity and retailing of electricity. So, generation is the companies which produce or generate electricity these are known as your GENCOs. Similarly, transmission of electricity is bulk transfer of electricity from generating powerplants to substations. Normally transmission lines transmit electricity at 440 kv or higher voltage. Now the third aspect of the electricity business is the distribution business. Distribution relates to supply of electricity using low voltage wires to actual consumers. When we are talking about actual consumers these are household or industries, municipalities, road and traffic light systems. Basically, anybody whoever is consuming electricity is part of the distribution system. And there are many companies which are in the business of distributing electricity and these companies are popularly known as DISCOMs. And finally, the fourth aspect of the electricity business is retailing. Retailing is an activity which will lead to meter reading, billing, collection of bills and onsite support system. Now this particular diagram very clearly explains the whole business of electricity generation, transmission and distribution. As you can see, this electricity can be generated from the conventional power plant using coal or natural gas or any other form of non-renewable energy. And in addition to that you have renewable energy sources which are basically your solar power plants and wind energy and hydro energy. So, these companies will be generating electricity, they will be pumping this electricity to high

voltage power lines. This part is your transmission lines and from the high voltage power lines there will be substations which will be stepping down the electricity and that will be finally consumed by industrial consumers, commercial consumers or residential consumers. So, this particular image which I have taken from the web link, is also a very interesting document related to understanding electricity as a business. So, I would urge each of you to visit this particular web link to understand more about electricity as a business if some of you are not exactly aware of electricity as a commodity. Now coming to electricity market in India, electricity as a commodity is in concurrent list in India. So, the concurrent list is given in the constitution of India in which the central government as well as the state government both can make laws on the subjects which are mentioned on the concurrent list. So, electricity is in the concurrent list in India, hence the electricity generation, transmission, distribution, retailing etcetera are controlled both by the central government as well as different states of India. So, under central government we have certain a few public sector units such as NTPC and NHPC which are basically electricity generating companies. We have power grid corporation of India which is the interstate transmission and distribution of electricity. So, this is basically your body which maintains the transmission of electricity. And in addition to the central government organizations, we have also different states in India who have their own state electricity boards who are involved in the power generation, distribution and retailing. And there are many private companies such as Tata power, GVK, Reliance power etcetera which are also involved in generation, transmission, distribution and retailing as well as power trading. In India electricity act of 2000 governs all activity related to the electricity market and central electricity regulatory commission which is popularly known as CERC that is the sole regulator of all things related to electricity. Now let us understand a little more on the concept of natural monopoly and the PowerGrid corporation. See please note that the power grid corporation of India is in the business of developing the national electricity grid for India. I am sure when you may be travelling by road or by train you may be seeing these lines of electricity grids. So, these are developed by power grid corporation of India and this national electricity grid is nothing but the interstate and inter regional electricity power transmission system and these are basically known as the backbone of the whole electricity market in any country or region. Unless this infrastructure is developed no electricity can be transacted between the producers and the consumers. And this grid system ensures that the electricity generated anywhere in India can be transacted to anywhere else in India. And basically, power grid corporation of India is considered as a natural monopoly. So, a business will be natural monopoly such that when the most efficient number of firms in that industry is one. So, if that industry has more than one company operating in that line of business then that is not a natural monopoly and that is also not a very efficient system. So, as defined, a natural monopoly will typically have a very high fixed cost and it is neither required nor practical to have more than one company producing those goods and services. So, obviously, as you can

understand we cannot have two companies creating parallel grid structure to transact or transmit electricity. So, in India we have only one company which is a natural monopoly and that is the PowerGrid corporation of India which is in the business of developing this grid system. Please note that I want all of you to understand the difference between a monopoly and a natural monopoly. Natural monopoly is a market where the most efficient number of firms which should operate in that line of business is one. Now coming to the electricity transmission structure in India in addition to the power grid corporation of India we have different load dispatch centers basically NLDCs, RLDC sand SLDCs and these load dispatch centers have been created for seamless transmission and distribution of electricity. And what is the objective or responsibility of these load dispatch centers? These load dispatch centers ensure that the highest level of load placed on the grid is made without surpassing the carrying limit of the transmission lines. And please note that CERC penalizes electricity producers and distributors and tries to bring discipline behavior for smooth functioning of the grid. I am sure all of you can remember or recollect that 31st July 2012 there was a major grid failure, and it is one of the largest power failures in India. Half of the Indian population was without power for 2 days and more than 300 trains were stranded, and the loss of this power grid failure was estimated into lakhs of crores of rupees. So, a very interesting explanation related to how there was grid stress and what led to the grid failure during these 2 days in July 2012 is available in this link given below. Again, I would urge each of you to read more on this particular event why the grid failure happened, what could be the cause and so that your understanding related to the importance of electricity transmission is clear. Now coming to another very interesting aspect please note that on 3rd April 2020 Prime Minister Mr. Narendra Modi appealed to Indian citizens to shut their lights at home at 9 p.m. on April 5 for 9 minutes and he called all citizens of India to do so to indicate or show solidarity with the workers who were maintaining India's essential services during COVID pandemic. And during that period of time power grid officials were predicting that if all 171.3 million households participated in switching of the lights, the total loss of the load could be 12,452-megawatt hour. However, the actual decline in the total demand when all people switched off their electricity and ACs and freeze and so on so forth, the actual demand drop happened during that period of time was 31,089-megawatt hour. So, why are we discussing this concept because such kind of a significant decline in demand or significant increase in supply creates grid stress and grid failure happens. In fact, in this context please read and very interesting analysis how the power grid officials what kind of initiatives they do they did during these two days April 3rd to April 5th so that the grid failure did not happen. So, very interesting article again I would urge each of you to read this particular article. In this context, please note that the Central Electricity Regulatory Commission, the Unscheduled Interchange Charges and Related Matter Regulation of 2009, governs the Unscheduled Interchange Market in India. So, what exactly is Unscheduled Interchange? As the Unscheduled Interchange can be defined as a concept

where electricity producer generates lower or higher volume of electricity than it has agreed for. Similarly, a buyer or a discom draws a higher or lower amount of electricity than it has demanded during a given period of time. So, to maintain the discipline in the grid CERC leaves different kinds of fines on buyers and consumers of electricity. And this fine is known as Unscheduled Interchange and CERC leaves fine for Unscheduled Interchange. As you can see the Unscheduled Interchange for a power generation company is actual generation minus the scheduled generation. Similarly, the Unscheduled Interchange for a buyer is going to be actual trial minus the scheduled trial. And this is just a snapshot which I have taken from the CERC website to show how the CERC charges different kinds of UI rates. So, depending on the certain threshold label, as you can see the UI rate paisa per kilowatt hour is mentioned. Again, this is not a full list of the Unscheduled Interchange. I have just taken a snapshot of the complete details about this Unscheduled Interchange charges and how and when CERC leaves this Unscheduled Interchange charges are mentioned in this particular weblink. Now coming to the exchange trading of electricity at the Indian exchanges. So, this is what is our focus. So, all that what we have discussed since the beginning of this session relates to understanding the different aspect of electricity generation production of electricity transmission and distribution of electricity and the role of CERC to maintain the stability in the PowerGrid. Now, coming to the exchange of trade exchange trading of electricity at Indian exchanges, let us understand three concepts that is your long-term power purchase agreement, short term contracts and day ahead market. So, this day ahead market is what gets exchanged or what gets traded in electricity exchanges. As I have mentioned India has three electricity exchange these are popularly known as IEX, HPEX and PXIL. So, when we are talking about spot trading of electricity, we are talking about the day ahead market and that is the agenda or that is the main focus of our discussion. But let us first understand what do we mean by long-term power purchase agreements and what are short term contracts. Please note that whenever a generation company or electricity producer starts a new power plant, they try to identify who is going to be the long-term buyers of electricity. So, as part of the long-term power purchase agreement that PPA stands for power purchase agreement, distribution companies and generation companies enter into long term power purchase agreement and that is done for fulfilling the regular based load requirement of the buyers. Please note that not only generation companies power generation companies want to identify a fixed buyer, but distribution companies also want to identify a fixed seller from whom they will be buying electricity over a long period of time. So, this long-term power purchase agreement is undertaken by both DISCOMs and generation companies as counterparties. Please note that this is nothing but a forward contract agreement and at times this contract can be beyond 25 years. So, both generation companies and distribution companies will enter into long term power purchase agreement which may go beyond 25 years. And the DISCOMs and the generation companies agreed to buy fixed volume of energy for every hour over the years

at a negotiated price. Please note that I am not using the word fixed price, the price is not fixed, price can be a variable price. For example, maybe both parties can agree that the DISCOM is going to pay coal price plus some premium. So, the coal price plus the premium amount is going to be the negotiated price. If the coal price increases, then DISCOM is going to give a higher price, if the coal price goes down, the DISCOM will pay a lower price to the generation company. So, in this context of forward contract agreement related to long term power purchase agreement, normally price is not fixed, price is negotiated. The way the price is going to move that part is fixed, but not the exact price to be paid and received by both parties. Now in addition to the long-term power purchase agreement, companies also enter into short term contracts. So, generation companies and DISCOMs distribution companies enter into short term agreement and this short-term agreement is mostly for seasonal variation in electricity demand by distribution companies and this is managed through the short-term contracts. So, this is also an example of a forward contract. For example, all of us know we switch on ACs in the summer months and electricity consumption increases significantly. So, if a distribution company knows that its power distribution requirement is going to be higher in the summer months. So, it may enter into a short-term power purchase agreement only for some months in the summer. But long-term power purchase agreement is normally for a long duration, and it is for buying or selling electricity throughout the year. Now in addition to the long-term power purchase agreement and short-term contracts, the daily variation requirement in electricity is managed through the power exchanges. So, that is the focus of our discussion and as I mentioned in India, we have three power exchanges IEX and HPEX and PXIL. So, the daily requirement of the generation companies and the distribution companies if generation companies are producing electricity which is not part of a long-term power purchase agreement, it has not entered into short term contracts to deliver that electricity. So, the company is going to be coming to the exchange platform to sell that electricity to some other counterparty. So, that is what we are talking about, the spot exchange of electricity, or we call it a day ahead market. Now let us understand what exactly a day ahead market very briefly we will be continuing with the discussion related today ahead markets up in a greater detail in the subsequent lecture session but let us remain 5 to 7 minutes let us understand what exactly the day ahead market. Please note that spot trading of electricity through Indian exchanges is known as the day ahead market or it is known as a day ahead spot market. And in this market the bidding is done on t minus 1 day and electricity is delivered at day t .Basically the buyers and sellers of electricity distribution companies as well as generation companies will be bidding on t minus 1 day that is one day prior to the actual delivery of electricity, they will be giving price and quantity bid, buyers will be giving the amount of electricity they want to buy at what price. Similarly, sellers will be giving a bid on the quantity of electricity they would like to sell at what price. So, that bidding will be done on t minus 1 day. Please note that a day is divided into 96 blocks of 15 minutes each. So, the buyers and sellers will be

giving the buy and sell bid, quantity and price bid for every 15 minutes in a day. And based on the demand supply for every 15 minutes block a cut off price and a volume will be determined and that will be done through the bidding process. Please note that we will take some real-life examples to understand how exactly the bidding is done and how exactly the equilibrium price and equilibrium volume is arrived at. And the bidding which is done for every 15 minutes block is known as double sided anonymous close bidding auction process. And through this bidding process the market clearing price and market clearing volume is arrived. So, market clearing price which is MCP and market clearing volume is nothing, but the equilibrium price and equilibrium volume. Again, as I said that we will take real life examples to understand how exactly this MCP and MCP arrived at. And more detail about the process of MCP and MCP arrival is very clearly given in this particular document prepared by India Energy Exchange. This is one of the very nice, very well explained documents. So, I would again urge each of you to browse this particular or download this particular article and go through to understand more on the concept of market clearing price and market clearing volume. And in this context, I would like to also discuss a little bit on double sided anonymous close bidding auction process. Please note that in the initial part of our discussion on the lecture series we have discussed a lot related to different types of auctions. For example, we have discussed reverse auction, forward auction, we have discussed about first sealed bid auction, second sealed bid auction, multiple price auction, uniform price auction. If my memory serves me right, I think we have spent about one and half sessions on understanding different types of auctions. But at that point in time knowingly I did not discuss the double sided anonymous close bidding auction because I felt that we will be able to do a justice to understanding this concept when we take a real-life data. So, in the next session, session number 51 we will be understanding the concept of double sided anonymous close bidding auction process and how the same process is arrived how the same process is used to arrive the MCP and MCV. Now please note that with respect to Indian electricity trading India is divided into13 geographical locations and buyers and sellers will be giving price and volume bid for a specific location. For example, as you can see the India is divided into different location N1, N2, N3, A1, A2, S1, S2 and all this. So, total 13 geographical locations India is divided and when I am mentioning that the buyers and sellers will give a price and volume bid for a specific location. That means, for example, if a generation company is injecting power to the grid at location A2. Let us say in location A2 if some particular company has an electricity generation unit and once the electricity gets generated the company injects the same electricity to the grid which is connected to A2. So, the company which when it wants to sell electricity from A2 grid, it will be giving price and the sell quantity for the location A2. Similarly, if a distribution company's customers are withdrawing from let us say N2 location then the DISCOM will be giving a price bid and the quantity bid for the N2 location. So, with this we will end today’s discussion related to electricity spot trading. Let me summarize what we

discussed. Today we understood the concept of electricity business, the concept of generation companies, transmission companies, distribution and retailing and the role of regulators like central electricity regulatory commissions in maintaining the grid stability and how the electricity regulatory commission. LEV is fine which is popularly known as unscheduled interchange such that the buyers and such that the distribution companies and the generation companies maintain discipline in terms of the quantity of electricity they will be injecting into the grid or the quantity of electricity they will be withdrawing from the grid. And with respect to the spot trading of electricity we have three electricity exchanges which are your India Energy Exchange, Power Exchange India Limited and Hindustan Power Exchange. So, these three exchanges offer a day ahead of the market. We will understand more on the concept related to demand supply matching and how the price and volume market clearing price and market clearing volume is arrived in the day ahead market in the next session. With this I end today's session and I eagerly look forward to interacting with all of you in the next session.