Commodity Derivatives and Risk Management
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Lecture 32
Spot Trading of Electricity in India (Part 2)

Welcome to the next session on Commodity Derivatives and Risk Management and in the last session we were discussing different aspects of electricity trading and we discussed that predominantly a major part of the electricity which is produced by a generation company is delivered to a group of companies as part of long term power purchase agreement. Any seasonal variation in the production is also made through the short term bilateral contract that is a company and the generation company enter into bilateral contract.

Any excess electricity which is produced by the by generation company or companies which require some for some specific reason if they need some excess electricity for a sometime of the day or some time in a month, they come to the exchange platform and try to get a arrange a arrange electricity in this exchange platform. And in the last class we also discussed how this exchange platform solicits bid volume, bid quantity, bid quantity, bid price, sells quantity and sells price for every 15 minutes block for a given day and accordingly the price matching is done to arrived at a equilibrium price which is known as market clearing price and equilibrium volume which is known as a market clearing volume MCP and MCB respectively.

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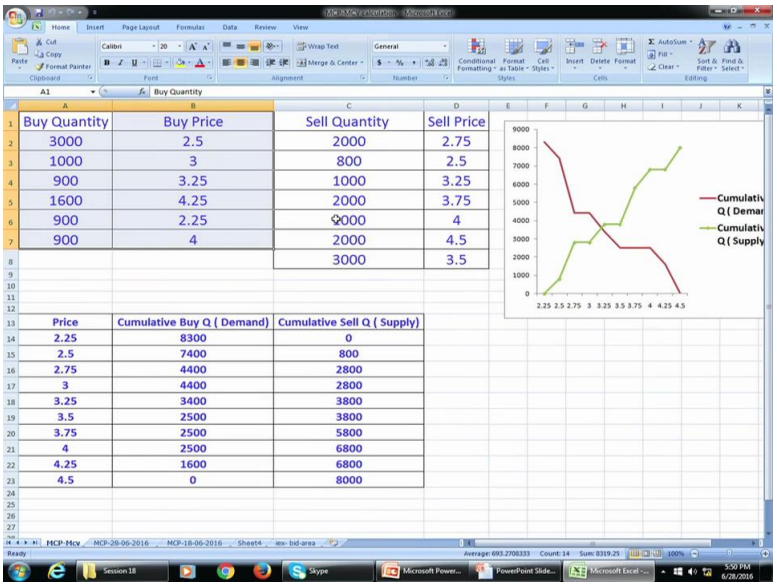

Buy Quantity	Buy Price	Sell Quantity	Sell Price
3000	2.5	2000	2.75
1000	3	800	2.5
900	3.25	1000	3.25
1600	4.25	2000	3.75
900	2.25	2000	4
900	4	2000	4.5
		3000	3.5

Price	Cumulative Buy Q (Demand)	Cumulative Sell Q (Supply)
2.25	8300	0
2.5	7400	800
2.75	4400	2800
3	4400	2800
3.25	3400	3800
3.5	2500	3800
3.75	2500	5800
4	2500	6800
4.25	1600	6800
4.5	0	8000

And just to take you through I will just show you the power point sorry the excel file which I was discussing. You remember that this company or a different buyers and sellers give different bid and bid volume bid price, sell volume, sell price that is buy volume, buy price and sell volume, sell price and the exchange tries to find out the equilibrium price and we discussed also how interpolation method can be found out to arrive the equilibrium price here and we discussed that the equilibrium price is the price at which a price where maximum volume can be cleared for that particular day that particular time of the time slot.

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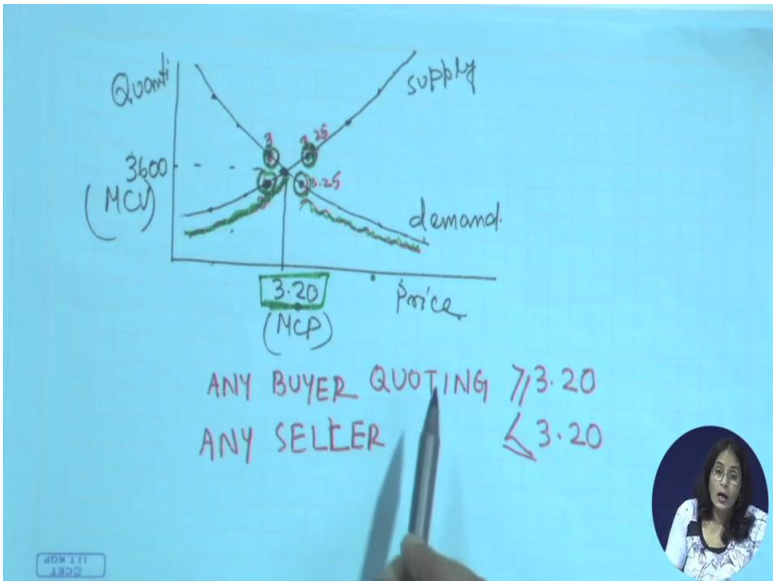

So we also discussed if you recall we also discussed with this particular, so you this is the demand curve, this is the supply curve, this is the price, this is the quantity and you had we were supposed to find out the interpolation between these four points to find out the coordinates of this intersection point. So let me repeat we were using the X, Y coordinates for these 4 points to find out the X, Y value for this intersection point and let us say this for the previous example, the intersection point is at 3.20 prices per kilowatt hour and the market clearing volume is 3600 units. Now so any buyer who has quoted a price greater than 3.20 he will be allowed to sell allowed to buy electricity and a seller which has who has quoted any price less than 3.20 will be allowed to sell the electricity through the exchange platform.

Of course actual delivery will happen to the grid, the seller will be releasing connecting its whatever generation it is doing to the grid and the buyers will also start their activities and switch on the machines or motors during that point of time. Now I also started last class I had also discussed about the market clearing price of maybe this little let me make it little bigger if it is visible to all of you.

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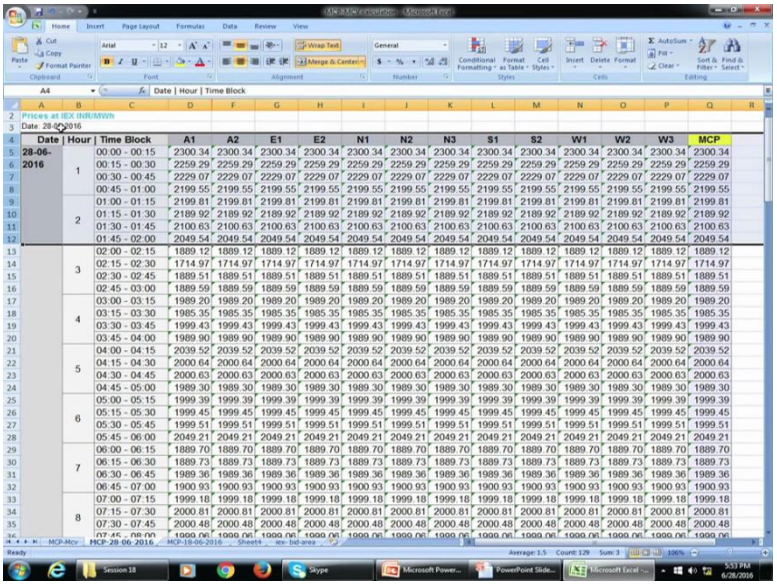

Date	Hour	Time Block	A1	A2	E1	E2	N1	N2	N3	S1	S2	W1	W2	W3	MCP
28-06-2016	1	00:00 - 00:15	2300.34	2300.34	2300.34	2300.34	2300.34	2300.34	2300.34	2300.34	2300.34	2300.34	2300.34	2300.34	2300.34
		00:15 - 00:30	2259.29	2259.29	2259.29	2259.29	2259.29	2259.29	2259.29	2259.29	2259.29	2259.29	2259.29	2259.29	2259.29
		00:30 - 00:45	2229.07	2229.07	2229.07	2229.07	2229.07	2229.07	2229.07	2229.07	2229.07	2229.07	2229.07	2229.07	2229.07
		00:45 - 01:00	2199.55	2199.55	2199.55	2199.55	2199.55	2199.55	2199.55	2199.55	2199.55	2199.55	2199.55	2199.55	2199.55
	2	01:00 - 01:15	2199.81	2199.81	2199.81	2199.81	2199.81	2199.81	2199.81	2199.81	2199.81	2199.81	2199.81	2199.81	2199.81
		01:15 - 01:30	2189.92	2189.92	2189.92	2189.92	2189.92	2189.92	2189.92	2189.92	2189.92	2189.92	2189.92	2189.92	2189.92
		01:30 - 01:45	2100.63	2100.63	2100.63	2100.63	2100.63	2100.63	2100.63	2100.63	2100.63	2100.63	2100.63	2100.63	2100.63
		01:45 - 02:00	2049.54	2049.54	2049.54	2049.54	2049.54	2049.54	2049.54	2049.54	2049.54	2049.54	2049.54	2049.54	2049.54
	3	02:00 - 02:15	1889.12	1889.12	1889.12	1889.12	1889.12	1889.12	1889.12	1889.12	1889.12	1889.12	1889.12	1889.12	1889.12
		02:15 - 02:30	1714.97	1714.97	1714.97	1714.97	1714.97	1714.97	1714.97	1714.97	1714.97	1714.97	1714.97	1714.97	1714.97
		02:30 - 02:45	1889.51	1889.51	1889.51	1889.51	1889.51	1889.51	1889.51	1889.51	1889.51	1889.51	1889.51	1889.51	1889.51
		02:45 - 03:00	1889.59	1889.59	1889.59	1889.59	1889.59	1889.59	1889.59	1889.59	1889.59	1889.59	1889.59	1889.59	1889.59
	4	03:00 - 03:15	1989.20	1989.20	1989.20	1989.20	1989.20	1989.20	1989.20	1989.20	1989.20	1989.20	1989.20	1989.20	1989.20
		03:15 - 03:30	1985.35	1985.35	1985.35	1985.35	1985.35	1985.35	1985.35	1985.35	1985.35	1985.35	1985.35	1985.35	1985.35
		03:30 - 03:45	1999.43	1999.43	1999.43	1999.43	1999.43	1999.43	1999.43	1999.43	1999.43	1999.43	1999.43	1999.43	1999.43
		03:45 - 04:00	1989.90	1989.90	1989.90	1989.90	1989.90	1989.90	1989.90	1989.90	1989.90	1989.90	1989.90	1989.90	1989.90
	5	04:00 - 04:15	2039.52	2039.52	2039.52	2039.52	2039.52	2039.52	2039.52	2039.52	2039.52	2039.52	2039.52	2039.52	2039.52
		04:15 - 04:30	2000.64	2000.64	2000.64	2000.64	2000.64	2000.64	2000.64	2000.64	2000.64	2000.64	2000.64	2000.64	2000.64
		04:30 - 04:45	2000.63	2000.63	2000.63	2000.63	2000.63	2000.63	2000.63	2000.63	2000.63	2000.63	2000.63	2000.63	2000.63
		04:45 - 05:00	1989.30	1989.30	1989.30	1989.30	1989.30	1989.30	1989.30	1989.30	1989.30	1989.30	1989.30	1989.30	1989.30
	6	05:00 - 05:15	1999.39	1999.39	1999.39	1999.39	1999.39	1999.39	1999.39	1999.39	1999.39	1999.39	1999.39	1999.39	1999.39
		05:15 - 05:30	1999.45	1999.45	1999.45	1999.45	1999.45	1999.45	1999.45	1999.45	1999.45	1999.45	1999.45	1999.45	1999.45
		05:30 - 05:45	1999.51	1999.51	1999.51	1999.51	1999.51	1999.51	1999.51	1999.51	1999.51	1999.51	1999.51	1999.51	1999.51
		05:45 - 06:00	2049.21	2049.21	2049.21	2049.21	2049.21	2049.21	2049.21	2049.21	2049.21	2049.21	2049.21	2049.21	2049.21
	7	06:00 - 06:15	1889.70	1889.70	1889.70	1889.70	1889.70	1889.70	1889.70	1889.70	1889.70	1889.70	1889.70	1889.70	1889.70
		06:15 - 06:30	1889.73	1889.73	1889.73	1889.73	1889.73	1889.73	1889.73	1889.73	1889.73	1889.73	1889.73	1889.73	1889.73
		06:30 - 06:45	1989.36	1989.36	1989.36	1989.36	1989.36	1989.36	1989.36	1989.36	1989.36	1989.36	1989.36	1989.36	1989.36
		06:45 - 07:00	1900.93	1900.93	1900.93	1900.93	1900.93	1900.93	1900.93	1900.93	1900.93	1900.93	1900.93	1900.93	1900.93
	8	07:00 - 07:15	1999.18	1999.18	1999.18	1999.18	1999.18	1999.18	1999.18	1999.18	1999.18	1999.18	1999.18	1999.18	1999.18
		07:15 - 07:30	2000.81	2000.81	2000.81	2000.81	2000.81	2000.81	2000.81	2000.81	2000.81	2000.81	2000.81	2000.81	2000.81
		07:30 - 07:45	2000.48	2000.48	2000.48	2000.48	2000.48	2000.48	2000.48	2000.48	2000.48	2000.48	2000.48	2000.48	2000.48

If you see this is the market clearing price prevailing on 29th June 2016, so if you see this is for the time block, what is a market clearing price 2300.34 and if you see in this is the price of megawatt hour, 1 megawatt hour and if you see this A1, A2, E1, this region, so India is divided into 12 regions, so any buyer and any seller from any region is going to pay the same price. So you have 2300 if a buyer is at A1 region and a seller is at a let us say N1 region, everybody is paying the same price. In fact whole of 28 January 2006 if you see for all these 96 blocks of data you have the same value across board, that is all regions are paying the same MCP.

And exchanges also inform what is the peak hour what is nonpeak hour, what is day night and morning all this detail is there in your, so I will not be probably uploading this detail because you can go to Indian Energy Exchange database and download the data for 28th June to see how the price is moving because this is a copywrited material, I am showing it for educational purpose. However, when you will be seeing the video I may not be making this particular worksheet available, of course the other worksheets I will make it make available to you all so that you can practice how MCP and MCB calculation can be done with different bid price bid volume and sell price and sell volume.

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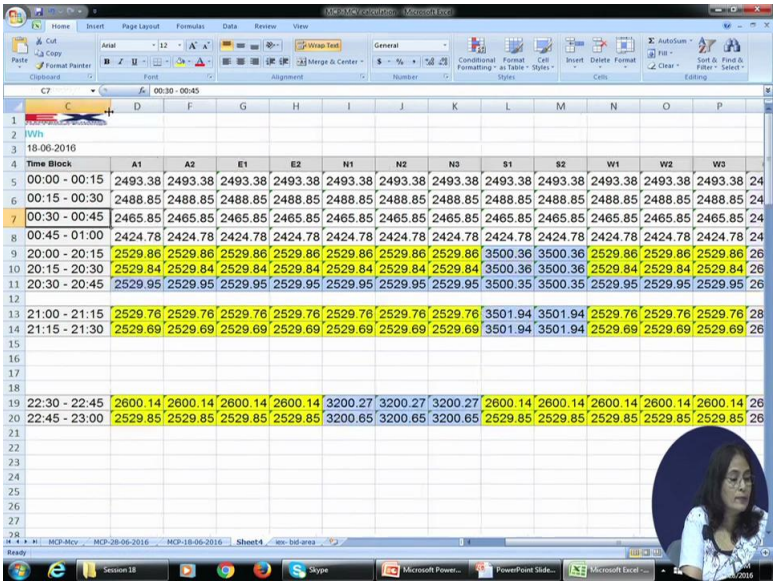

Time Block	A1	A2	E1	E2	N1	N2	N3	S1	S2	W1	W2	W3
00:00 - 00:15	2493.38	2493.38	2493.38	2493.38	2493.38	2493.38	2493.38	2493.38	2493.38	2493.38	2493.38	2493.38
00:15 - 00:30	2488.85	2488.85	2488.85	2488.85	2488.85	2488.85	2488.85	2488.85	2488.85	2488.85	2488.85	2488.85
00:30 - 00:45	2465.85	2465.85	2465.85	2465.85	2465.85	2465.85	2465.85	2465.85	2465.85	2465.85	2465.85	2465.85
00:45 - 01:00	2424.78	2424.78	2424.78	2424.78	2424.78	2424.78	2424.78	2424.78	2424.78	2424.78	2424.78	2424.78
20:00 - 20:15	2529.86	2529.86	2529.86	2529.86	2529.86	2529.86	2529.86	3500.36	3500.36	2529.86	2529.86	2529.86
20:15 - 20:30	2529.84	2529.84	2529.84	2529.84	2529.84	2529.84	2529.84	3500.36	3500.36	2529.84	2529.84	2529.84
20:30 - 20:45	2529.95	2529.95	2529.95	2529.95	2529.95	2529.95	2529.95	3500.35	3500.35	2529.95	2529.95	2529.95
21:00 - 21:15	2529.76	2529.76	2529.76	2529.76	2529.76	2529.76	2529.76	3501.94	3501.94	2529.76	2529.76	2529.76
21:15 - 21:30	2529.69	2529.69	2529.69	2529.69	2529.69	2529.69	2529.69	3501.94	3501.94	2529.69	2529.69	2529.69
22:30 - 22:45	2600.14	2600.14	2600.14	2600.14	3200.27	3200.27	3200.27	2600.14	2600.14	2600.14	2600.14	2600.14
22:45 - 23:00	2529.85	2529.85	2529.85	2529.85	3200.65	3200.65	3200.65	2529.85	2529.85	2529.85	2529.85	2529.85

Now this is on 28th June detail, let us go back to a randomly selected date I have just downloaded a date details pertaining to 18th June. Now let us see, see what I have I have deleted some portion of the 18th June data so that, I am making little smaller so that you can see ok now if it I am sure it is visible, if you see the market clearing price is 2493.38 for the hour 00 to 00:15 that is 12 'O'clock night to 12:15 on 18th June. But if you see this price that is your the price prevailing at 9 to 9:15 that is 20 to 20:15, if you see the MCP is 2019.31, however some location A1, A2 and all A1 to N3 people are buyers and sellers are paying 2529.86 while buyers and sellers at S1 region that is S1 and S2 region are paying 3500.36.

Let me repeat, when the market clearing price is 2619.31 in some regions buyers and sellers are paying less amount of money while the in some other region buyers and sellers are paying high amount higher amount of money. Similarly let us go to this particular this particular let us say this one 22:30 to 22:45 that is 10:30 to 10:45 the market clearing price is 2650.03 while some region they have paid 2600.14 and some region that is your N1, N2, N3 have paid 3200.27 you know, this three regions have paid a higher amount. Now the next question comes why this some regions payment is more than the MCP and some region payment receipt is less than MCP. This is to do with the congestion, if grid availability is not there even if buyers and sellers are interested to deliver some X unit of electricity at a given point of time but because of the congestion of the grid, this amount cannot be delivered.

So if a region is considered as a surplus area, so that means there are more sellers than the buyers than the price will be suitably reduced to arrive at something called constraint market clearing price and a different market clearing volume will be arrived for this regions. Ok let

me repeat, whenever this there is a high demand for electricity in a given region than the total amount which could be delivered to this region because of the grid unavailability, so the price will be reduced and vice versa when there are more buyers than the sellers, the price will be increased, so that is the reason why you have even if the market clearing price is X, some regions buyers and sellers are paying less than X rupees and in some regions buyers and sellers are paying more than X rupees.

So in fact the this kind of a in rows are highlighted by Indian Energy Exchange in their website on a daily basis for every day to indicate which are the period where you have a congestion exist, so whatever buyer and sellers are wanting to buy or sell could not be delivered because of the grid congestion. Now what are these bid areas, I mentioned about the bid areas so if you can see this link these are different bid areas.

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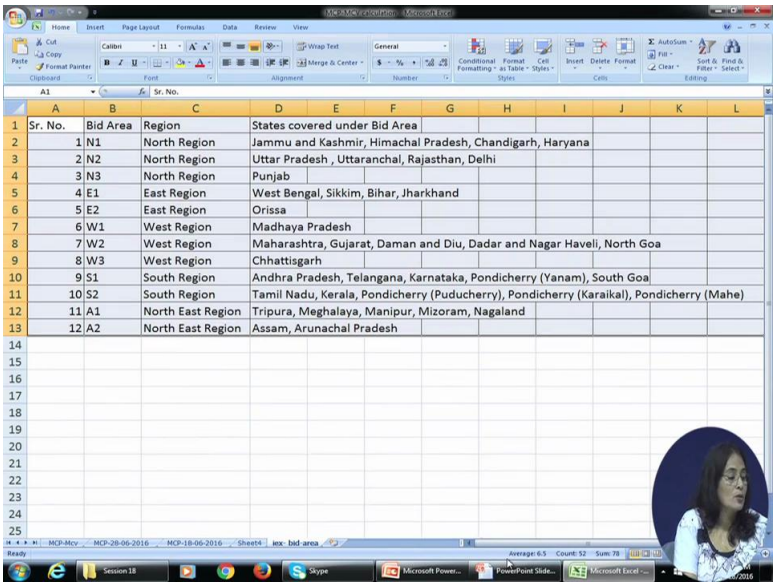

Sr. No.	Bid Area	Region	States covered under Bid Area
1	N1	North Region	Jammu and Kashmir, Himachal Pradesh, Chandigarh, Haryana
2	N2	North Region	Uttar Pradesh , Uttaranchal, Rajasthan, Delhi
3	N3	North Region	Punjab
4	E1	East Region	West Bengal, Sikkim, Bihar, Jharkhand
5	E2	East Region	Orissa
6	W1	West Region	Madhaya Pradesh
7	W2	West Region	Maharashtra, Gujarat, Daman and Diu, Dadar and Nagar Haveli, North Goa
8	W3	West Region	Chhattisgarh
9	S1	South Region	Andhra Pradesh, Telangana, Karnataka, Pondicherry (Yanam), South Goa
10	S2	South Region	Tamil Nadu, Kerala, Pondicherry (Puducherry), Pondicherry (Karaikal), Pondicherry (Mahe)
11	A1	North East Region	Tripura, Meghalaya, Manipur, Mizoram, Nagaland
12	A2	North East Region	Assam, Arunachal Pradesh

So N1 is your Northern region, N2 is Northern region off course N1, N2, N3 is 3 whole of Northern India is divided into 3 categories so on so forth E1, E2, S1, S2, A1, A2.

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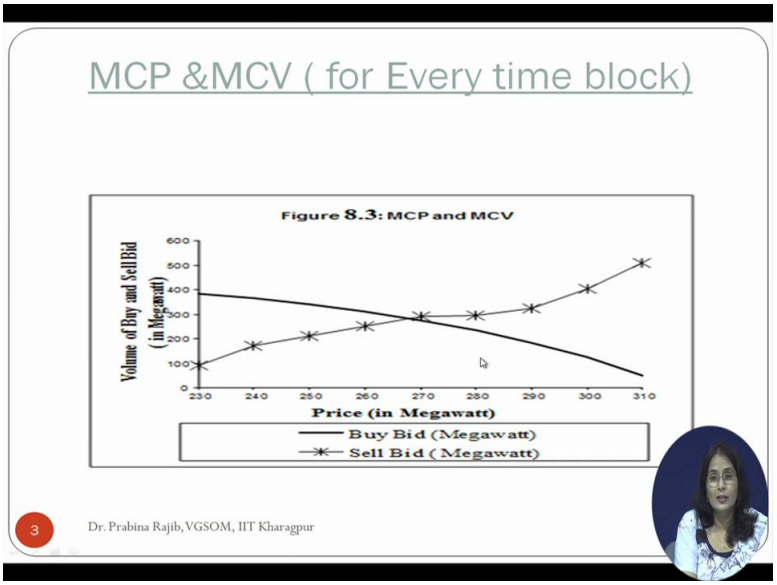

And this is this is already I have discussed that MCP and MCB which gets calculated this again looks very text bookish because this is a very smooth curve, so its normally does not the curve is not so smooth as we saw it in the excel diagram.

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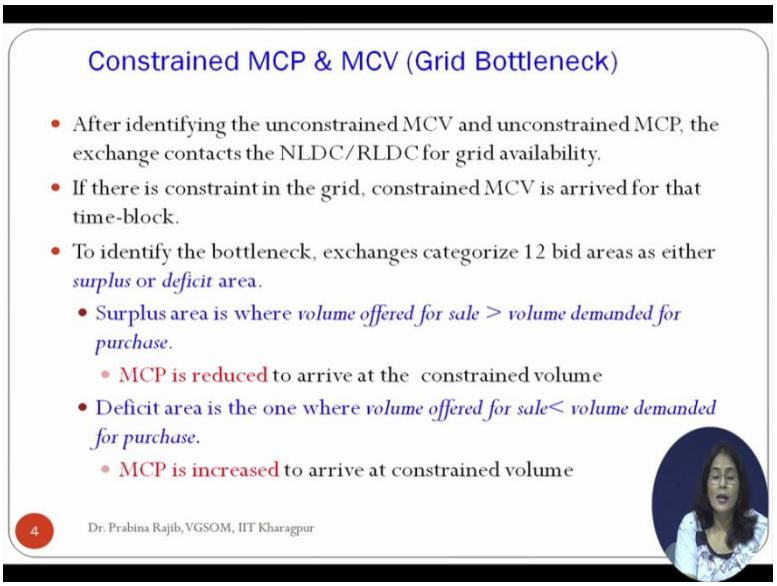

So this aspect I have already discussed that is what is a constraint MCP and MCB, so whenever there is a grid bottle net the MCP market clearing price is suitably modified and what we get to pay or receipt or buyers or seller pay or receipt is the different MCP which is known which are known as constraint MCP. Accordingly the market clearing volume for those regions are also adjusted.

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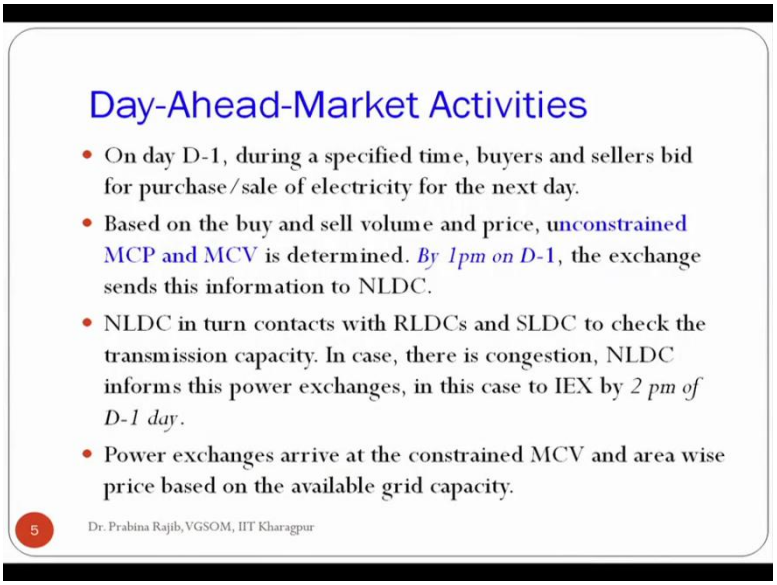

Now how exactly the whole thing happens Day T - 1 by 1 pm all buyers and seller whoever is interested to bid, buy or sell so bid price bid volume, sell price, sell volume they give it to the exchange, they send it to the exchange before 1 pm or any specific time 15 minutes block, so for every 15 minutes block they a buyer can bid for all 15 blocks or some 15 minutes block depending upon his or her interest.

So the order matching order matching happens by 1 pm, so the exchange sends the unconstraint MCP and MCB to the NLDC that is your National Load Dispatch Centre to check whether this amount of market clearing volume can be cleared or can be transacted through the grid whether grid has the capacity to take because already as part of the long term power purchase agreement and bilateral agreements different buyers and sellers are buying different generator companies and distribution companies are withdrawing and supplying electricity into the grid.

So whether depending upon the grid availability, if grid is available than this same information will be through the NLDC, RLDC and SLDC will be informed back to the exchange and exchange will accordingly by 6 pm exchange will be exchange will be informing to the to the buyers and sellers. If there is congestion, the NLDC will inform the power exchange by 2 pm and power exchange will arrive at constraint MCP and area wise price based on the availability of grid capacity. So at this re calculation of MCP MCP and MCB is known as congestion management or market splitting and that is the reason why in the last session we discussed something about NLDC, RLDC and SLDC.

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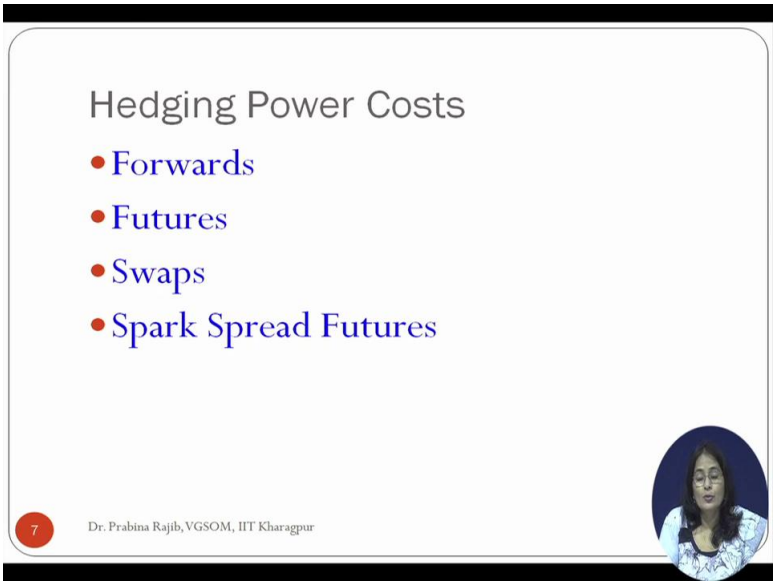

So now let us quickly go into some forward some derivative contracts which are available for power producers to hedge their risk of course these contracts are not available to this futures and swaps futures and spread futures contract. Any derivative contract which is traded as part of the exchange that is not permitted in India, however forward contracts are available to Indian generation power Generation Company or distribution companies because in fact long term power purchase agreements are nothing but the forward contracts.

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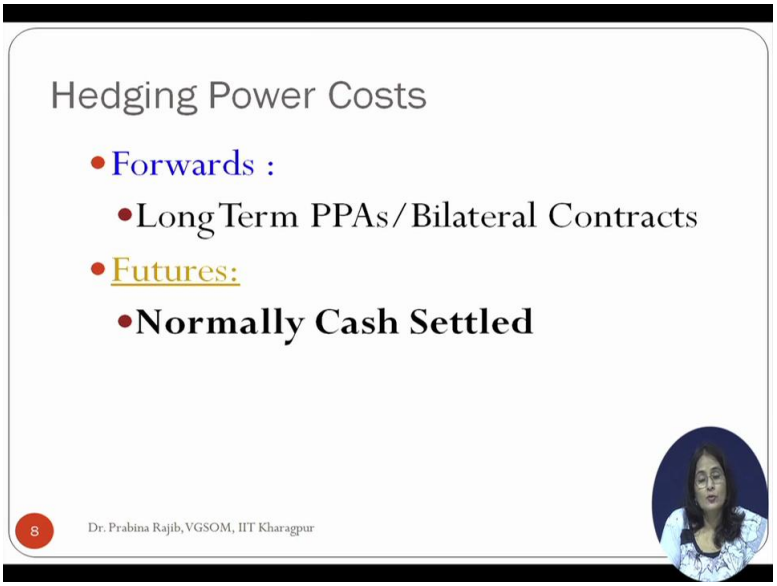

So let us go to discussing little bit on this forward contract, so as I mentioned long term power purchase agreements and bilateral contracts are forwards contracts, futures contracts of course it is not available to be traded in Indian exchanges they are normally cash settled.

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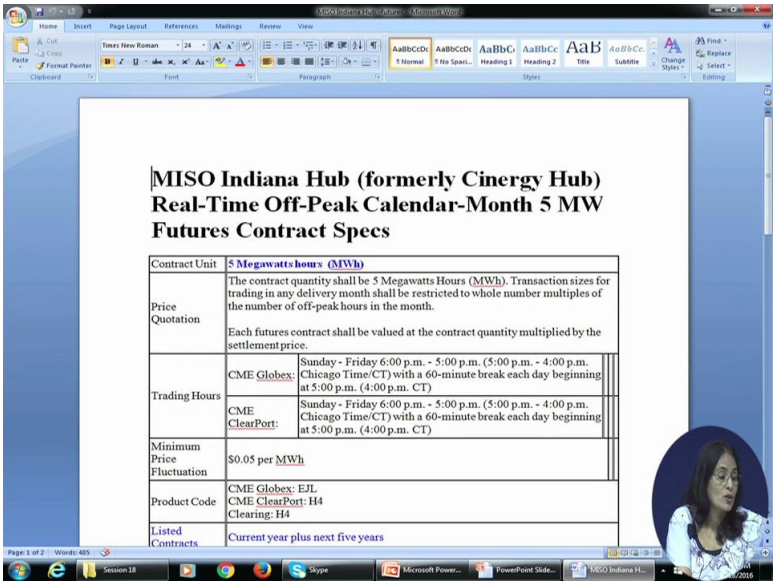

In this context I want you to have a look at this particular contract which trades at CME (Chicago Mercantile Exchange) and you have what is a contract unit, it is for 5 megawatt hour and what is what a settlement procedure is, if you see this is the contract shall be cash settled. So what is a maximum duration for which a buyer or seller or futures contract is futures contract can enter into position current year + next 5 years. So today being June 28th, so they can enter into contract for July, August, September, October, November, December of 2016 and a contracts up to 22. So it could be monthly contract, it could be some sequence of month contract, so it strip contract so it varies from companies to company depending upon their actual position in the physical market, they can come to the exchange platform to mitigate the price risk.

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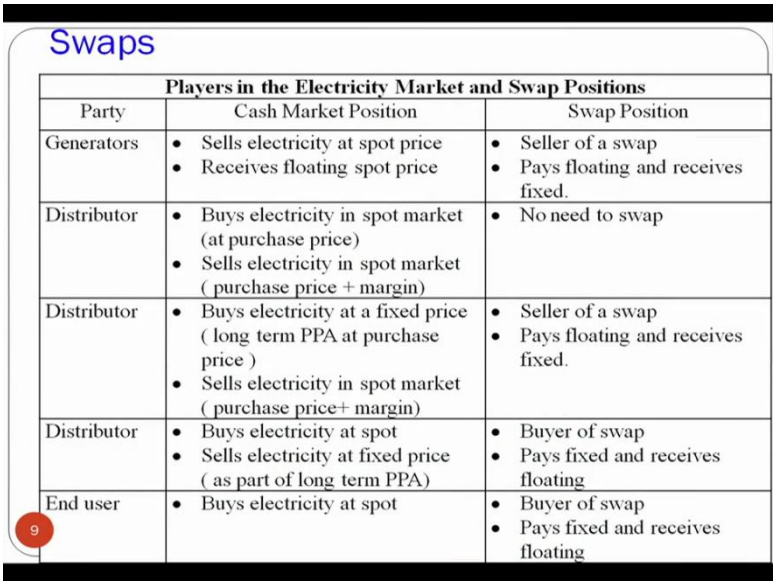

Now let us go to swaps, so if a generator is entering into a long term power purchase agreement it is basically agreeing to sell electricity in the forward market at a fixed price, so generators can also generator distribution companies and individuals can also enter into swap contracts. Swap contracts are bilateral OTC contracts, so what could be the position of a swap contracts, in case of generators, generators fear that the electricity price is going to go down, so they will be happy to receive a fixed price and pay a floating price.

So many US many US power producer have entered into swap contractors swap contracts, so as part of this contract they receive a fixed price and pay a floating price so they become seller of the swap. Again distributors could be buyer of the swap or seller of the swap depending upon what kind of a position spot market position they have. Let us say you have a distributor which buys electricity in the spot market, it buys electricity in the spot market, but it has already or it also sells electricity in the spot market. So it buys from the spot market and sells at a margin so only risk it is expose is that margin loss so it does not need to enter into a swap contract.

Now let us go to another case of a distributor where the distributor buys electricity at a fixed price, distributor has already entered into long term power purchase agreement, it buys electricity at fixed price but sells electricity in the spot market. So what is the fear, if electricity price goes down it will end up getting it will end up earning less, so what it will do, it will be selling a swap that means it will receive electricity it will receive a fixed price and pay a floating price.

Similarly if you can have a situation wherever distributor is buys electricity in spot but sells electricity at fixed price, in that case the distributor is going to take a buyer position that means it will pay fixed and receive a floating rate. End user end users fear is that electricity is going to go up and they can enter into a contract to pay fixed and receive the floating rate. Of course in India specifically many companies have their own captive power generation plants so they are they are not much of in need to enter into swap agreement because whatever their own requirement they generate through their captive power generation units.

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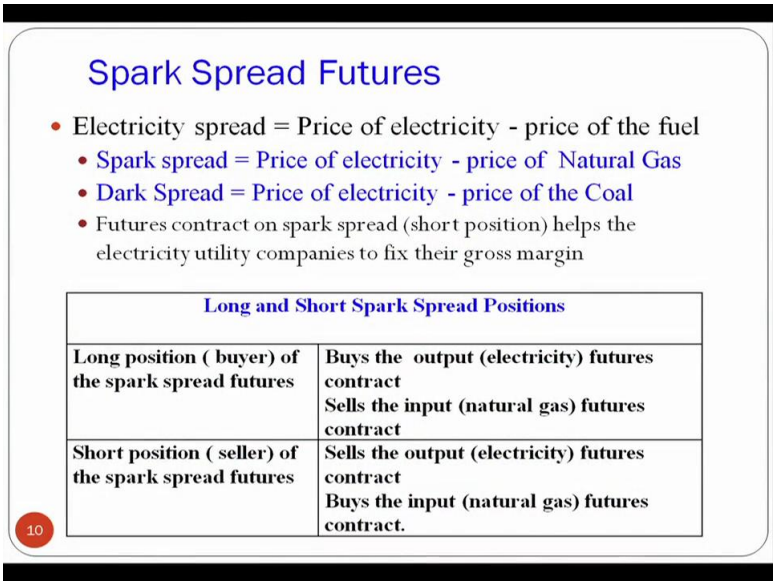

In this context quickly I will take you through something called electricity sorry spark spread futures contract. So in with respect to soybean we discussed crush spread, with respect to with crude oil we discussed crack spread and with respect to this electricity today we are discussing 2 different spreads, this is called your spark spread and dark spread and futures contract on spark spread and dark spread are traded at CME, so what exactly is the spread, so spread is nothing the is the price of output - the price of input.

So in this case price of electricity - the price of natural gas or the price of coal, so if a company is using coal fired plant thermal power generation plant so it will be calculating or its profit will be governed or profit will be known as the dark spread because the price at which it will be selling electricity and the price at which it will be buying coal is going to govern the margin. Similarly you have a in case of a power generation company which is using natural gas, its spread will be known as spark spread it will be price of electricity - the price of natural gas.

Now, if an electricity generation company fears that its spread is going to go down, it can enter into a short position short spread position on either spark spread or a dark spread. By doing so it will be entering into a contract to sell electricity futures contract to it enters into sell electricity future futures and simultaneously buys a natural gas future or coal future. So this kind of a contract futures contracts are available for trading at CME and at Nord Pool, however it is not available as I mentioned none of the futures or option contracts are available for electricity generators or producers and distribution companies in Indian case. And there is also another interesting dimension which I thought of discussing because this Indian energy exchanges also trade the renewable energy certificates. So what are these renewable energy certificates?

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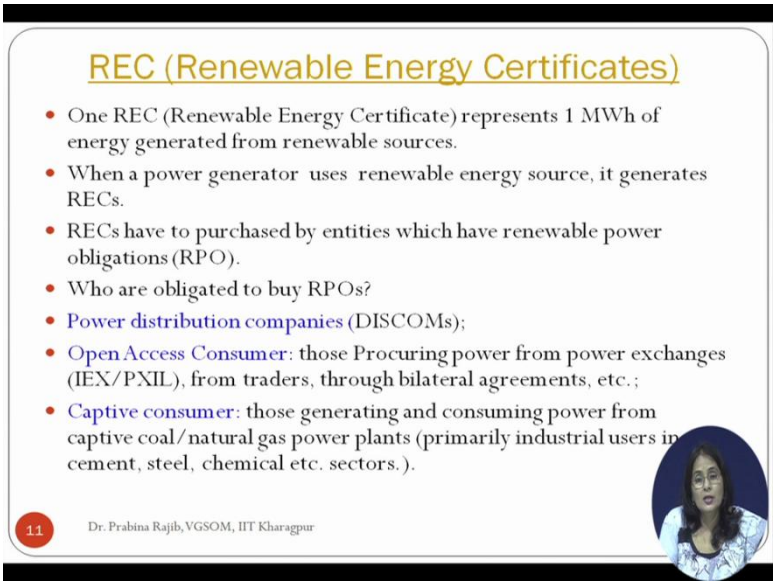

Whenever a power generation company is using renewable energy sources such as solar, water, etc for generating electricity then it gets or it starts owning the renewable energy certificate. So what exactly a One REC is? One REC represents 1 megawatt hour of energy generated from renewable sources. So if a company is generating 1 megawatt hour of electricity and using renewable sources then it can own a One REC that is renewable energy certificate.

So REC is now any power generation company cannot by merely producing electricity of generating electricity by using renewable energy sources naturally will not get entitled to own this REC, there is a process of accreditation a independent party does accreditation and does a registration and so that a company which is using renewable energy sources can own this

renewable energy certificates and once a company owns this REC they can take it to exchange platform for selling it to other parties which are obligated to buy this REC.

There are some companies which have to purchase RECs, specifically companies which are electricity companies which are using non-renewable energy sources they are mandated to buy RECs. So if you see this slide, who is obligated to buy RPO's or Renewable Purchase Obligations. So if you see as per the government of India regulation, it is the power distribution companies that is DISCOMs are also required to buy RPO's and open access consumers like big industries and companies which are buying electricity from power exchanges and companies which are buying electricity as part of the bilateral agreement they are also have to they also have to buy these ROPs and captive consumers like those companies which are also have their own power generation unit and they use coal and natural gas power plants. primarily industrial users in cement, steel, chemical sectors etc have to every year buy a certain number of renewable purchase obligations so that their carbon emission they are reducing their carbon footprint.

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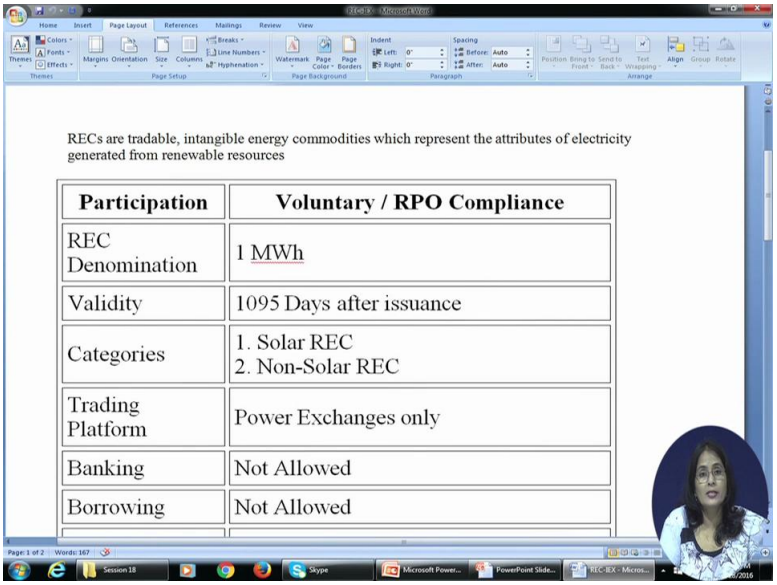

Now let us go to so this particular slide shows the silent features of the renewable energy certificates, pleas save this one, what is the denomination of REC, REC is 1 megawatt hour validity is 1095 days after issuance. So the body which is interested to for accreditation of renewable energy certification that company will be issuing RECs to another generation power generation company which is using renewable energy sources and this company which owns the REC can sell it to another party within this 1095 days of issuance and this RECs can be solar RECs and non-solar RECs and where this can be traded. They can be traded only at

exchange platform it cannot be done between OTC it cannot be OTC transaction between one company by two companies entering into a contract and saying that we have exchanged the REC with each other.

Banking is not allowed that means you if you have to buy X unit you can buy X unit only this year, you cannot buy X + unit previous year and say that previous year I had bought some X + units hence I will be I should be permitted to buy a lesser REC this year. So companies which have RPO, they have to buy the mandatory unit every year. Borrowing; they cannot they cannot borrow they have to buy those RPOs and transfer type, transfer type is single transfer only, that means if a generation company has generated REC and has sold REC to another counter party, that counter party cannot sell it to another party, so the life of REC comes to an end with a single transaction that too within 1095 days of issuance. So if the company which is owing REC has not been able to sell that REC within this mandated time, this company is not financially benefiting from the ownership of the REC.

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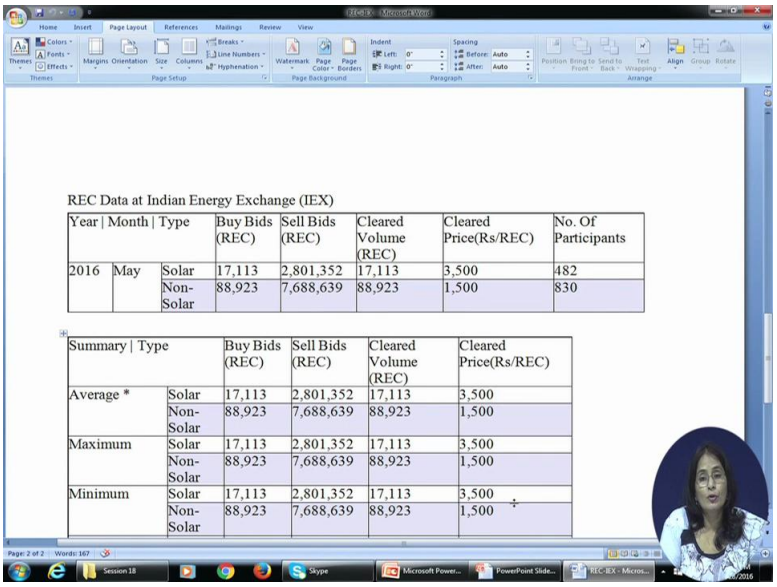

Now let us take this REC gets traded once in month at Indian Energy Exchange platform, let us see what is the total amount of REC which has been transacted in the month of May at IEX. And if you see this particular panel you have a solar and non-solar and if you see exactly the same way the market clearing different buyers and sellers give different bid volumes, buy volumes, sell volume, buy quantity, sell quantity, buy price, sell price and the order matching is done exactly the way electricity MCP and MCB is cleared. So the solar during 26 May how many units of how many buy units were demanded so by bids came is 17113 and if you see how many sell bids were there 2800 to that is 2.8 million RECs were

came to the exchange platform to be sold while 17113 units were demanded, so obviously cleared volume will be 17113 and what is the clear price, clear price is 3500 rupees per 1 REC.

So buyers paid 3500 rupees for every REC they bought and how many participants were there 482, in case of a non-solar it is even the number of sell bids is 7 million and similarly you have a clear price is 1500 and number participants. So, more detail about the buy volume shift highest buy bids, lowest buy bids, sell bids and all that this is mentioned here. So with this I will be winding up our discussion pertaining to electricity. as I mentioned in India derivative contracts on electricity do not trade in exchange, however companies enter into long term power purchase agreement and short term bilateral contracts and right now whatever trading is happening it is for spot delivery and both exchanges IEX Limited.

And Power Exchange Limited also have intraday trading that is you can bid it bid buyers and sellers can bid today for delivering electricity on the same day at a later point of time. And we discussed about market clearing price and market clearing volume, we also discussed about constrain market clearing price and unconstraint market clearing price and volume and we also briefly discussed about the RECs the process of issuance of RECs and the process of trading of RECs at Indian Energy Exchange limited. And we also briefly discussed little bit about the spark spread and dark spread futures contact so if you are more interested on understanding what are the different kinds of futures contract option contracts traded in international exchange, you can go to CME or you can go to Nord Pool, so that is commodities NASDAQ commodities Europe it is now re constraint as NASDAQ Commodities Euro.

So you can visit that website to understand more about differ kinds of derivative contracts on electricity. So with this I am let us conclude this session and I will be interacting with you with respect to other commodities in the next session, so thanking all of you.