Commodity Derivatives and Risk Management
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Lecture 31
Spot Trading of Electricity in India (Part 1)

Hi all, welcome to the next session on Commodity Derivatives and Risk Management and we will be discussing different aspect of electricity as spot and derivatives trading. And one thing I would like to say at this point of time is that in India, derivatives trading in electricity is not permitted as per the CERC that is Central Electricity Regulatory Commission which is the regulatory body for all activities pertaining to the electricity generation, distribution, retailing, etc. however, we will be discussing very briefly about some of the derivative contracts which are listed in other derivative exchanges globally. now let us understand how exactly spot price of electricity is arrived at, if you recall in all commodities that is has been our focus on understanding how spot price is arrived uh, so or what re who are the players, who are the consumers, producers and what are the supply demand factors which influences the spot price.

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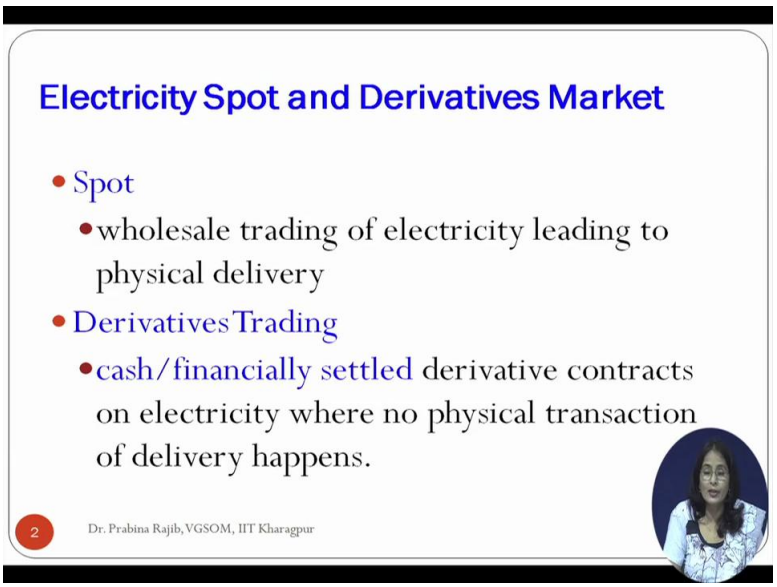

So let us understand little bit on how spot price is arrived at in the electricity market and as I all of this spot market is the wholesale trading of electricity leading to physical delivery. So in case of a spot transactions buyer and seller arrive at a price and which relates to delivery of electricity. And in case of a derivatives trading which is not happening in India, even globally in whichever exchange electricity derivative contract are traded it is does not lead to delivery,

these are financially or cash settled. At the end of the contract maturity buyer and seller pay money to each other based on whatever the price difference and the contract comes to an end.

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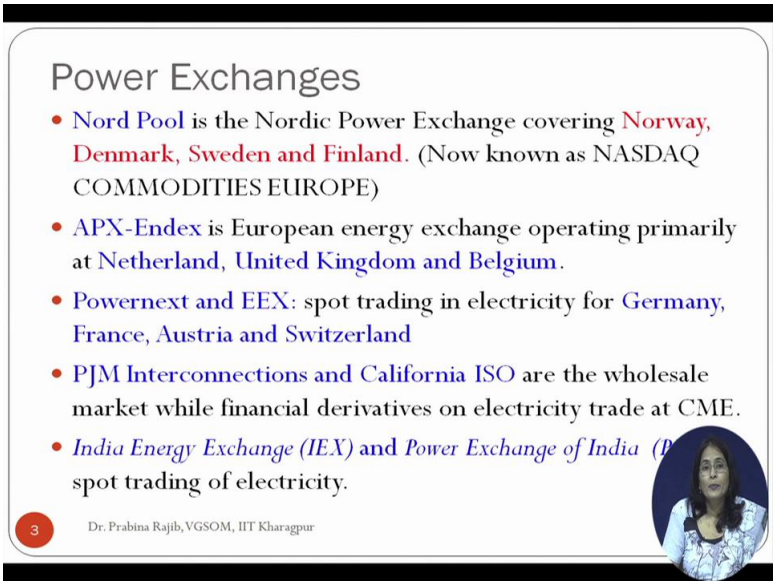

And which are important power exchanges, so you have you may have head organisation called Nord Pool, Nord Pool is the Nordic power exchange which covers at which covers the Norway, Denmark, Sweden and Finland market and it is now known as NASDAQ Commodities Europe, and in this particular exchange you have different derivative contracts pertaining to pertaining to electricity gets traded. Another exchange is APX indexes the European energy exchange which is operating primarily at Netherland, United Kingdom and Belgium, you have Power Next and EX, these 2 exchanges are for spot trading of electricity leading to delivery of electricity.

This they do not have derivative contracts traded, so you have this these 2 exchanges ensure that the electricity gets delivered in Germany, France, Austria and Switzerland and you have 2 other electricity exchanges that is your PGM interconnection and California ISO, they are wholesale market that is wholesale market leading to delivery of electricity, while the Chicago Mercantile Exchange is the exchange, where you financial derivative contracts on electricity trade. And in India we have 2 exchanges, this is your India Energy exchange and Power Exchange India limited and these exchanges are used for spot trading of electricity.

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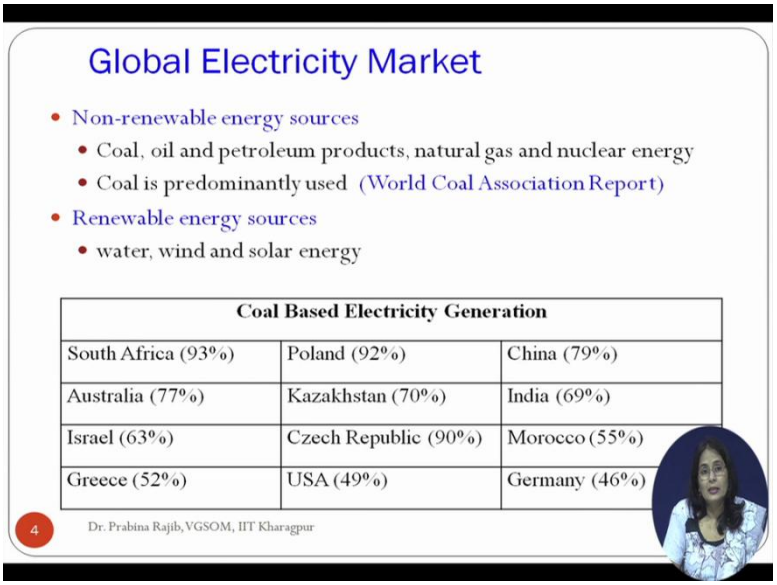

Now let us go to understanding little bit on global electricity market and if you can see this one mostly non-renewable energy source is predominantly used for electricity generation though renewable energy sources such as solar, wind and water is increasingly getting used to generate electricity. However, coal based electricity generation or thermal power generation remains the maximum or has the maximum share in electricity generation or coal has the maximum share in electricity generation, so you have if you see South Africa has 93% of the total electricity which is generated is based on coal so and so forth. Germany has the lowest which has got around 46% of the total electricity generated is based on coal.

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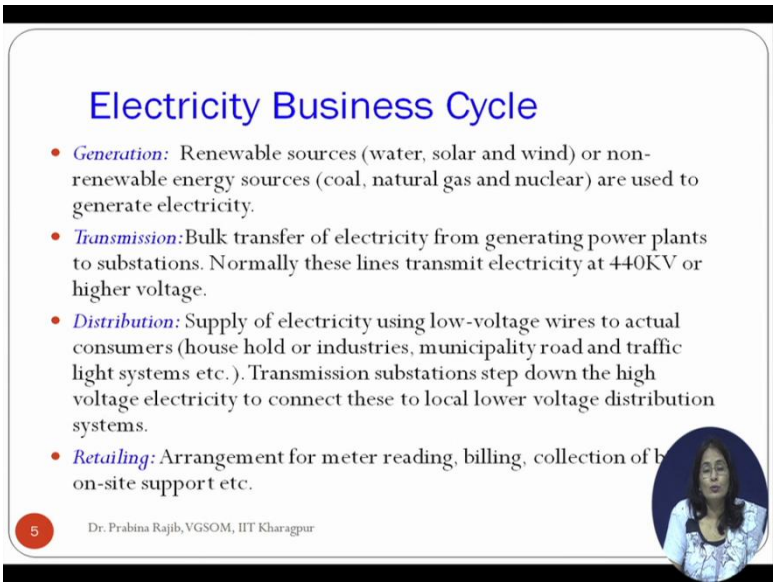

And just quickly take you through, all of you maybe knowing what are the different dimension of electricity business, so you have generation so electricity power generators or GENCO as we call them, so you have renewable they can use renewable sources or non-renewable sources. Beside generation you have transmission so long distance transmission interstate and interregional transmission is another set of activity. Distribution; from this transmission lines to actually delivering electricity to consumers, household and industries, this is done through distribution companies and you have your retailing, retailing is another set of activities which deals with arrangement for meter reading, billing, collection of electricity charges, online support, etc.

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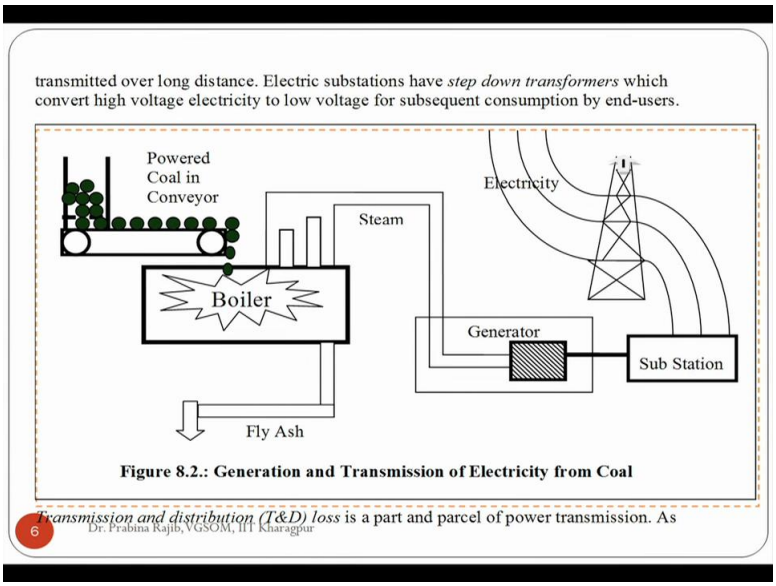

And I am not going in to detail of electricity generation using your power using your coal, so this particular picture I have taken from the World Coal Association which very clearly explains how the powder coal is used to generate electricity, so if you are interested more on how exactly it is done, so you can you can visit this World Coal Association website and get to know more about the whole process of electricity generation from coal.

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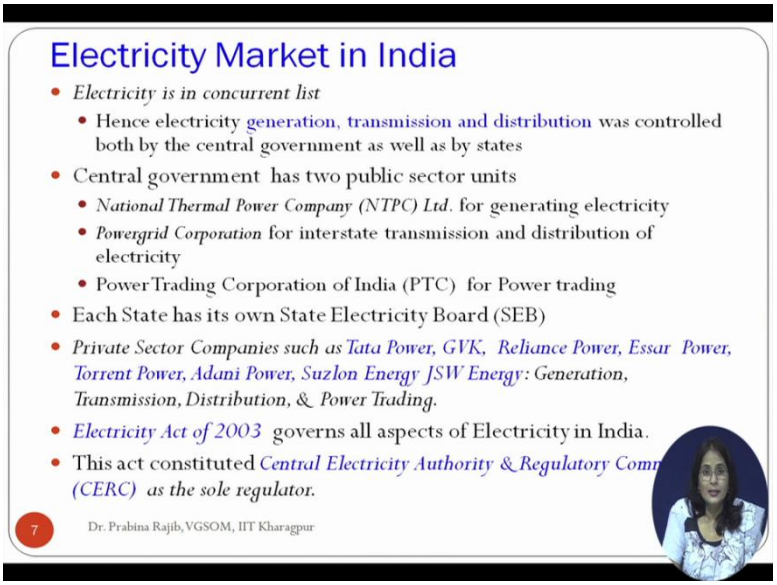

Now let us go to quickly understand electricity market in India, so electricity is in concurrent lease, so electricity production, distribution etc every and transmission distribution, production, retailing, everything us under your Central Government as well as State Government and some private sector entities also operate. So who are the major public sector bodies you have NTPC National Thermal Power Company which is interested with generating electricity, you have Power Grade Corporation of India which is responsible for interstate transmission of electricity transmission and distribution of electricity, you have Power Trading Corporation of India for power trading.

So these three bodies are under public sector under Central Government and each state has its own state electricity boards and there is an emergence of many public sector private sector companies which are in the business of generation, transmission, distribution and power trading. So you have Tata Power, GPK, Reliance Power, SR Power, Torrent Power, Switzerland Energy etc, and many companies in the Indian from India which are involved in generation distribution and retailing as well as transmission of electricity. And electricity act of 2003 governs all regulatory aspects of electricity in India and central electricity authority and regulatory commission that is your CRC is the sole regulator of electricity market.

And in this context I would like to discuss little bit about power grid corporation of India's responsibility, so what exactly power grid corporation India undertakes is that it creates the necessary infrastructure for interstate and interregional electric power transmission system, so all of us you must have seen when we travel by train or something we get to see this high voltage transmission line, so power grade corporation of India is responsible for creation and

maintaining of those power those grid lines. And power Grid Corporation of India also through its one of the joint one of its subsidiary has three centres that is your national load dispatch centre, regional load dispatch centre and state load dispatch centre and these three centres work in jointly, so that seamless transmission and distribution of electricity happens.

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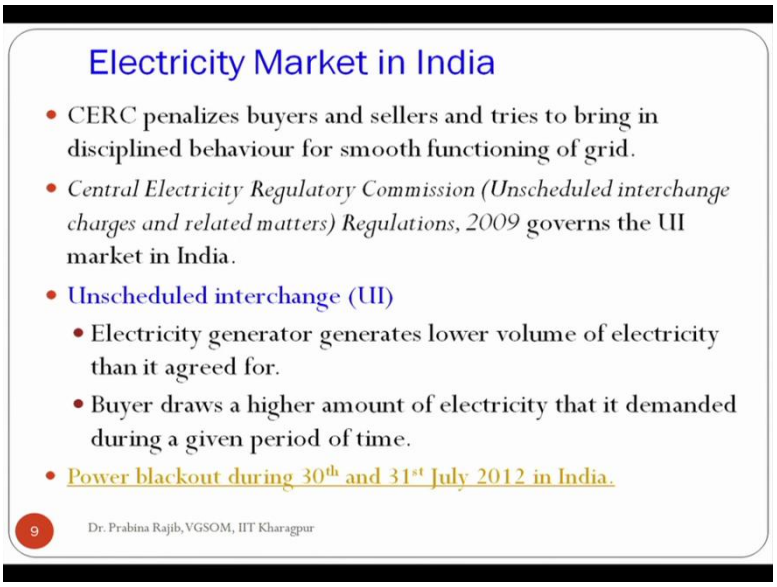

So the main responsibility of these load dispatch centres is to ensure that unnecessarily unnecessary load is not there in the transmission line. So they balance the load throughout the grid. And CERC has the power to penalise buyers and sellers and it tries to bring in a disciplined behaviour for smooth functioning of the grid and for that electricity, CERC has a guideline called or CERC has a regulation called Unscheduled interchange charges and related matters regulation 2009. So this unscheduled interchange happens when a electricity generator generate lower volume of electricity than it agreed for or buyers withdraw more amount of electricity or higher amount of electricity that it demanded during a given period of time.

So this behaviour is penalised by CERC, if you recall once such one such event happened during 30th and 31st July 2012 when most part of Northern India, Western India and Eastern India was were on blackout because of the grid failure. So the NLDC, SLDC and RLDC jointly worked in worked together so that the efficiency of the grid and load capacity load bearing capacity of the grid is maintained.

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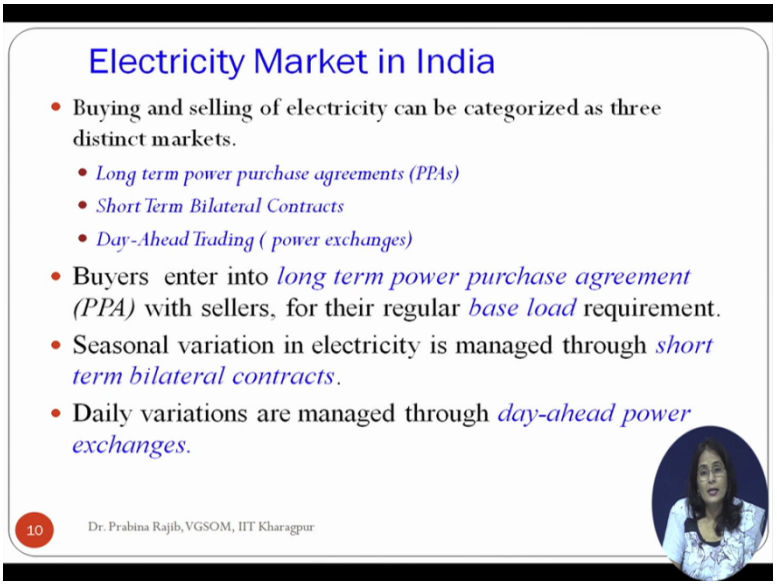

Now let us quickly go to the electricity market in India, normally whenever a company is generating electricity, it enters into a long term power purchase agreement with some other companies by which this generation company will be able to sell electricity to that company or those companies for a considerable period of time and this long term power purchase agreement can run into more than 7 years. So the base load which is which is produced by the electricity generation company that is as that is normally sold as part of the long term power purchase agreement and in its residual generation they do, they enter into short term buyer lateral cum contracts and any other residual electricity which they have that comes to the exchange platform for trading.

So when we are talking about IEX and Power Exchange India Limited, we are talking about this day ahead market in which the companies which have some surplus electricity they bring it to the exchange platform, so that buyer and sellers demand is met and price is arrived at. So if you see the daily variation or let me repeat, buyers enter into long term power purchase agreement with the sellers for their regular base load requirement, season seasonal variation electricity demand is managed through short term bilateral contract and daily variation is managed through day ahead power exchanges, where this IEX and PXIEL come into picture.

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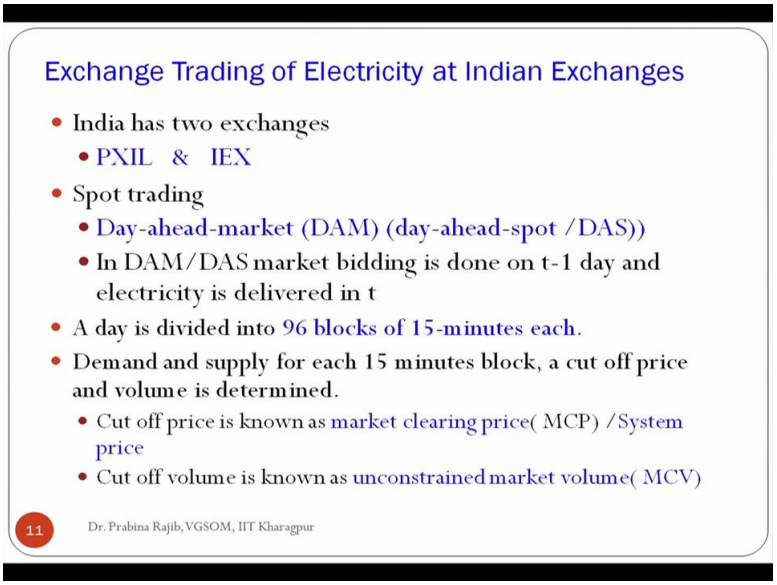

So let us go to how what happens at IEX or PXIEL we will discuss in detail, so India has got two energy exchange this power exchange India limited and India energy exchange, so you have as part of this exchange you have spot trading of electricity, so when we are talking about spot trading of electricity, we mean that the price the buyers and sellers give their bid today based on the bid the order matching happens and all this happens on T - 1 Day. So the buyers and sellers negotiate the price at the exchange platform on T - 1 Day and electricity is delivered on the next day. And a buyer or seller can enter into buy or sell bid for 15 minutes blocks of blocks per day, so that means day is divided into 96 blocks.

And based on the demand and supply bidding the price at which buyers are bidding the bid volume, bid price, sell volume and sell price determines what helps and exchange to determine what is called a market clearing price or a system price, and volume which gets cleared is known as your unconstraint market volume, so or MCB.

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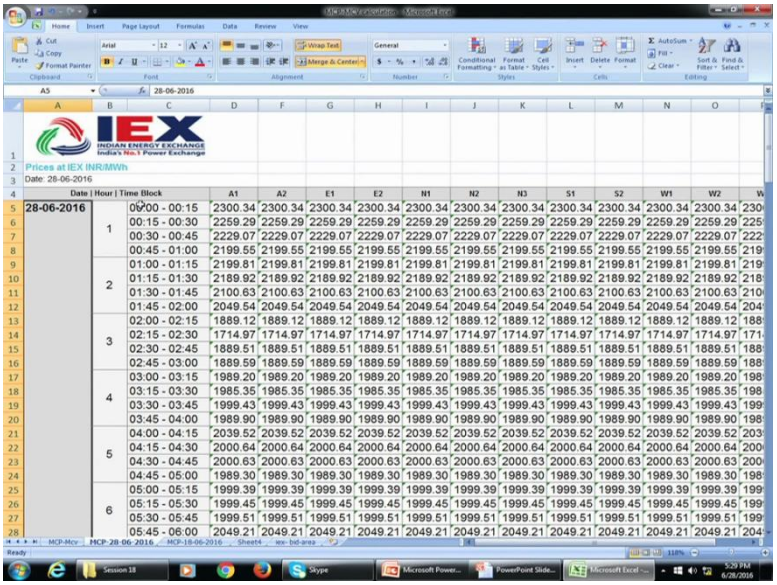

Now let us go to take an example ok before I go I will just take you to I hope you are able to see this detail. Yes, if you this is the detail which I have downloaded for from India Energy Exchange for today, this is the 28th June 2016 this the price which is prevailing at India Energy Exchange, so let me even make litter bigger, so if you see between 00 to 15 hours that is 12 'O'clock sorry 12 to 12:15 in the night, so buyers and sellers have agreed to buy and sell electricity at a price of 2300.34 per megawatt hour, and India is also divided into 12 regions, so A1, A2, E1, E2, N1, N2 so on and so forth.

Now let us take an example how, we will take a real life example to understand how this price is arrived if you see this right most column shows the word MCP that is your market clearing price or system price, let us make a note of it that is your 2300.34 and in fact if you see the whole of the first row is also 2334. So let us come to let us take example how exactly this 2334 has been arrived upon.

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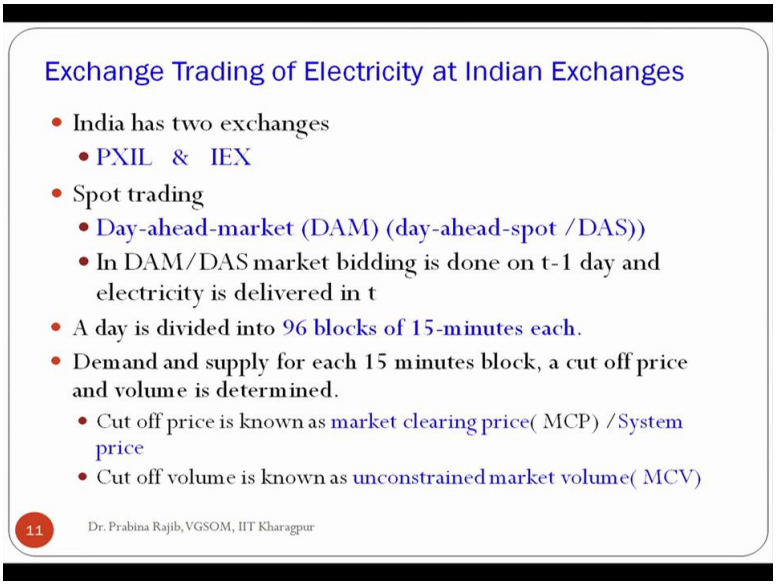

Now typical in your macroeconomics you must have seen a classical picture of demand supply and intra demand supply interacting with each other and most of the textbook will say that when the demand and supply the intersection point tells us what is the equilibrium price and equilibrium volume, exactly the same concept is applied here, now let us take this example.

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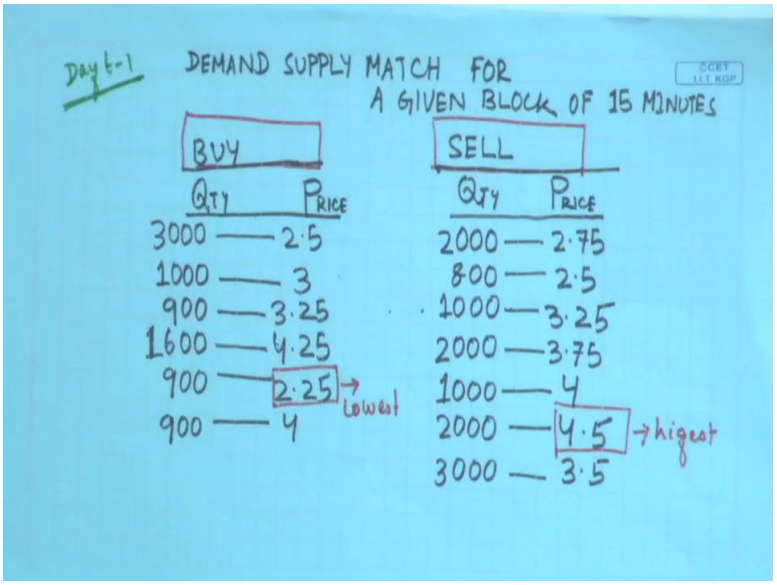

So you have let us say on day T - 1 that is suppose yesterday T - 1, yes, so umm, so in the T - 1 you have uh, let us say different buyers are bidding and different sellers are bidding, so the buyers do not know what sellers are doing and sellers do not know what the buyers are doing, but they are interested to buy and sell electricity for 15 minute block let us say starting at 10

am in the morning to 10:15 am. So if buyer is interested to take electricity from the gird and similarly seller wants to inject the electricity into the grid during this 10 to 10:15 hours and at what price they will be buying or selling and they come to the exchange platform for arriving this particular price and on day T - 1 they will be giving different bids, let us take example of different bids, let us say this is your randomly these bids are coming for this particular time lot, 3000 buy volume, quantity 3000 units comes at a 2.5 rupees that is your kilowatt hour price.

So some company is interested to buy 3000 kilowatt hour at a price per price of 2005 rupees per kilowatt hour. So you will have similarly different if you see the lowest price is 2.5 and highest price is 4. So this is, sorry the lowest price is 2.25 and the highest price is 4 rupees per kilowatt hour and different corresponding different quotations have come. Similarly on T – 1, different sellers are also quoting different price, so you have if you see you have the highest sell price that is the sell price 4.5 rupees per kilowatt hours was bided by a party who is interested to sell 2000 kilowatt hour of electricity at this time period. Now the question is how we arrive at the equilibrium or the interaction between supply-demand.

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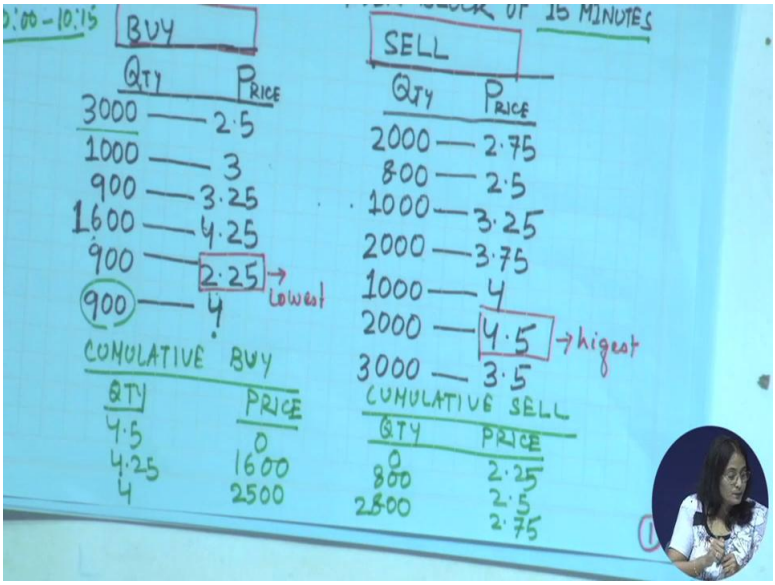

It is a very simple exercise, let us start with the, let us start with I hope you are able to see this ok let me ask this question to you, let us say if let us say the buy price, so if you have, we have to calculate something called cumulative buy, so cumulative buy that is quantity and price. So let me ask you a question, how many units are desired at a price of 4.5, how many of units of electricity have been desired to be bought at a price of 4.50? No, so you have 4.5 it is zero. Now let us go to 4, in a 4 or no we have 4.25, so at 4.25 how many units are desired,

we have 1600 units are desired, so in 4.25 we have 1660 units. Now let us go to 4, so how many cumulative units will be desired? If somebody is interested to buy electricity at 4.5 or 4.25 he will also be very happy to buy electricity at 4, so what will be the cumulative buy volume at a price of 4, so it is going to be 1600 + this 900, if you see this, this is corresponds to the four, so it will you will have 2500.

Similarly, similarly let us go to the sale, so you have a cumulative sale, if you have a cumulative sell contract so you have a quantity and price, let us start with a lowest price. Suppose the lowest price is 2.25, in the whole system the lowest price is 2.25, so at 2.25 please tell me how many units of electricity has been or has been indicated to be delivered. If you see 2.25 does not feature so you have a quantity delivered is zero. Now let us go to 2.5, so how many units has been how many units has been interested to be delivered, so you have 800, so you obviously the person who is interested to sell at 2.5 2.25 you will be very happy to sell at 2.5 but because the quantity is zero, so cumulative value is 800 here.

Now let us go to the next price 2.75, is there somebody interested to delivery, yes this is 2000 so how much is going to be the total cumulative deal, cumulative mount is going to be 2800. So at a price of 2.75 how many total amount is willing to be delivered is 2800, so I have prepared, let us go to the, just give me a minute please.

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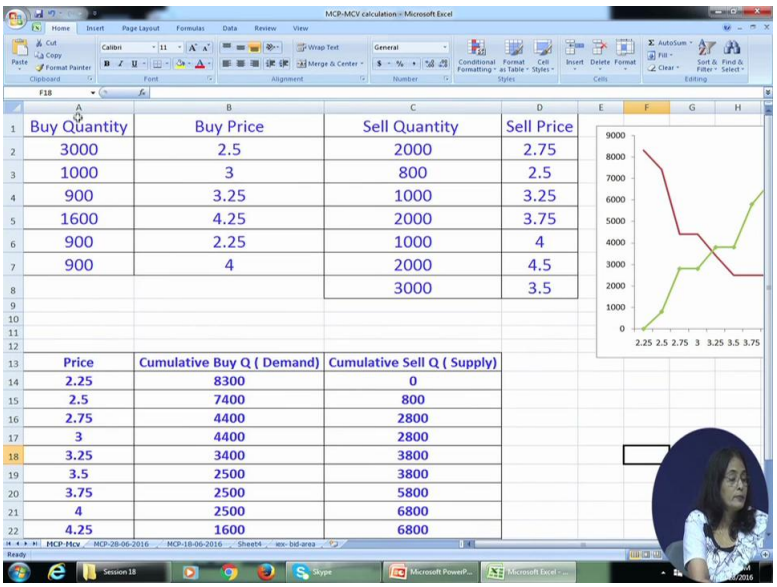

Ok, yes so if you see this if you can see this particular, this is what I discussed, this is your buy quantity and buy price, sell quantity and sell price and this is your cumulative detail buy quantity, if you recall this at a 4.5 as a buy price nobody was interested or nobody was

interested to buy any electricity, On 4.25 it is 1600, 4 it is 2500 so on and so forth. Similarly at 2.25 nobody was interested to sell electricity and 2.5 800 units were willing to be sold at 2.5 so and so forth and at a 4.5 you have 8000 units were interested where available to be sold.

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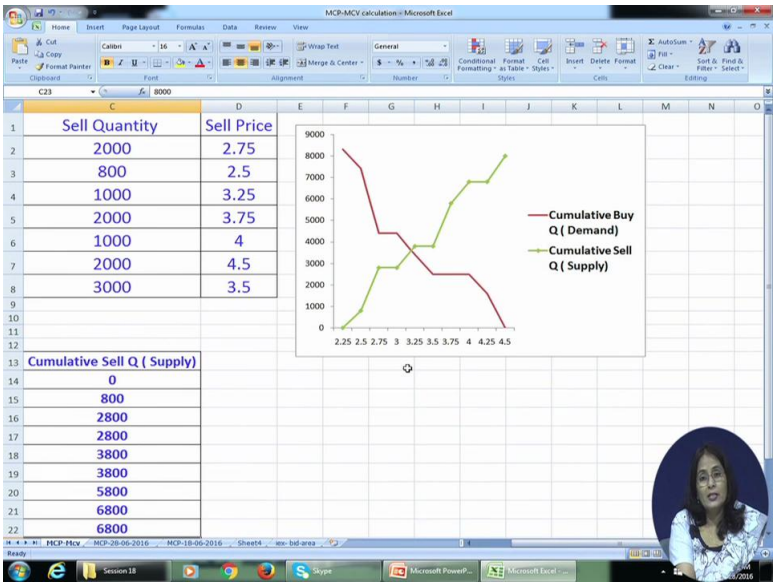

Now you have a classical supply demand curve, so this is what exactly the supply demand curve looks like. In textbook this diagram is very smooth, but in real life this is with this kind of a discreet data point supply demand curve looks like in this manner, so if you see this one the X axis has price and Y axis has quantity, so let me repeat here, X axis has price and Y axis has quantity, so this you have to be a little you have to remember that this particular diagram has price in the X axis and quantity in the Y axis. And this is your cumulative sell curve as the price increases more volume are available to be sold. And as price decreases less amount are interested to be bought, so this is what your supply demand curve and if you see this one, now how do we find out this interaction point.

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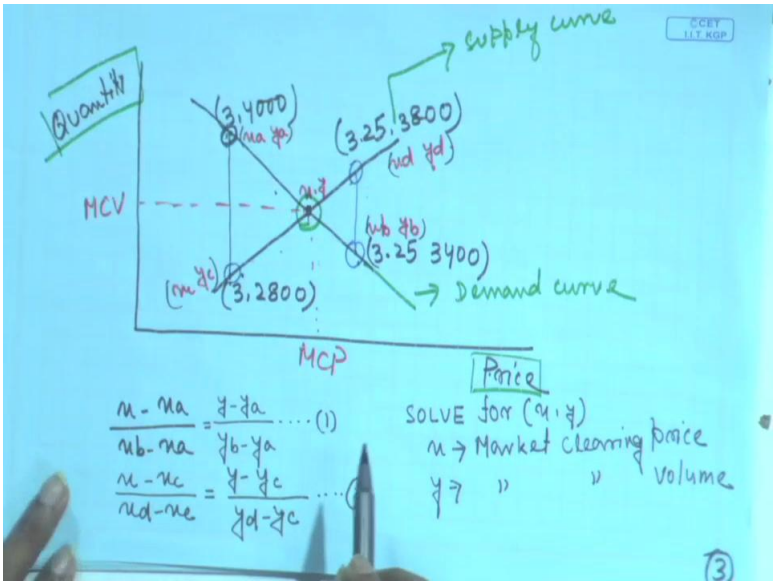

So this interaction point is if you see 1, 2, 3, 4, between 4 and 5 of the cumulative sell points and this is again 4 and 5 of cumulative buy points, so you have to use some mechanism to find out exactly what is going to be the interaction point. Let us quickly take how this has been done. If you see this I have already if you see this one, this is your this is your demand curve, this is your supply curve but we are only taking this is your 3 and this is your 4th and 5th point in the previous graph, this is 4th point 5th point, this is your 4th and 5th point. Now how do we find out the X and Y and we know this is you have price in this axis, you have quantity in this axis, now what are the coordinate of this particular point, this is 3 and 4000, coordinate of this point is 3.25 and 3400, coordinate of this point is 3000 and 2800 and coordinate of this point is X, Y value is 3.25 to 3800.

Now using your interpolation formula we will be able to find out, this is your interpolation formula, we want to find out what is going to be the value of X and Y. So using the this is the interpolation formula I am sure all of you must be knowing; so when you solve these 2 equations 1 and 2, what we will get is the market clearing price or market clearing volume. So whatever the X coordinate will get for this and the Y coordinate is going to be market clearing price and market clearing volume.

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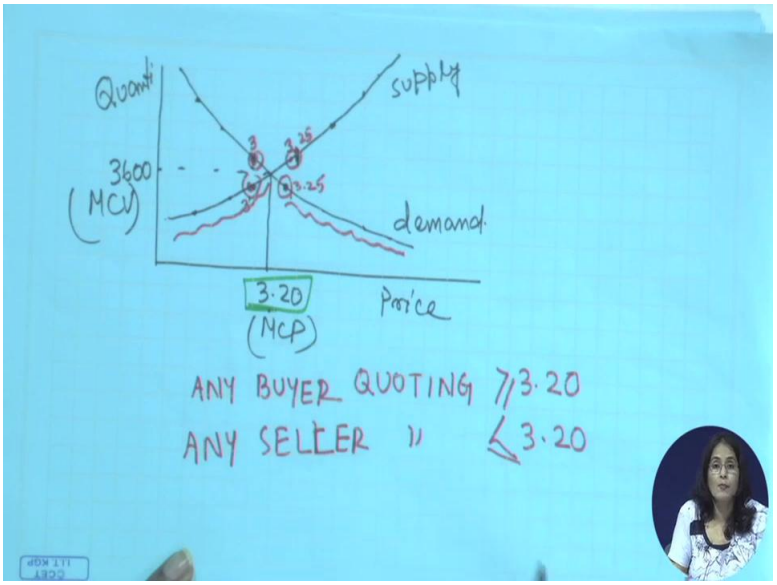

Now let us say this is again manually drawn so it looks kind of a smooth. This the total graph and this is your points, 3 and 3.25, this is your 3 and 3.25 the X coordinate of the 4 identified points. Let us say when you use the formula we find out what is the market clearing price or the equilibrium price is 3.20, that means any buyer who has quoted more than 3.20, he will be able to buy electricity and any seller who has quoted a price less than 3.20 will be able to sell electricity. Now let us focus into this particular graph so any seller who is here in this range whose bid is in this range, that seller will be able to delivery and a buyer who is in this range, means a buyer who has bided a price more than 3.20, he will be able to get the electricity, he will be able to buy electricity. And a seller who has bided less than 3.20 will be able to sell the electricity.

So this is how the exchange is going to calculate the market clearing price and market clearing volume for every 15 minutes, so on a given day depending upon the buy-sell order you will have 96 market clearing price and 96 market clearing volume for a specific day. Now we will be continuing with our discussion on the remaining part of electricity contract and electricity spot trading and futures trading in the next session and as usual I am going to end up this session by saying that looking forward to interacting with you all in the next session, thank you all of you.