Power System Operations and Control
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Module – 6
Lecture – 2
Additional Topics Relating to New Developments

Welcome to lecture number 2 of module 6 that is additional topics related to new development. In lecture 1, we discussed various types of demand side management programs and those are very useful for your utility as well as for customer point of view. We also discussed the various developments in the generation side transmission side and also in distribution side as well. Now, let us see what are the various demand side management options are available.

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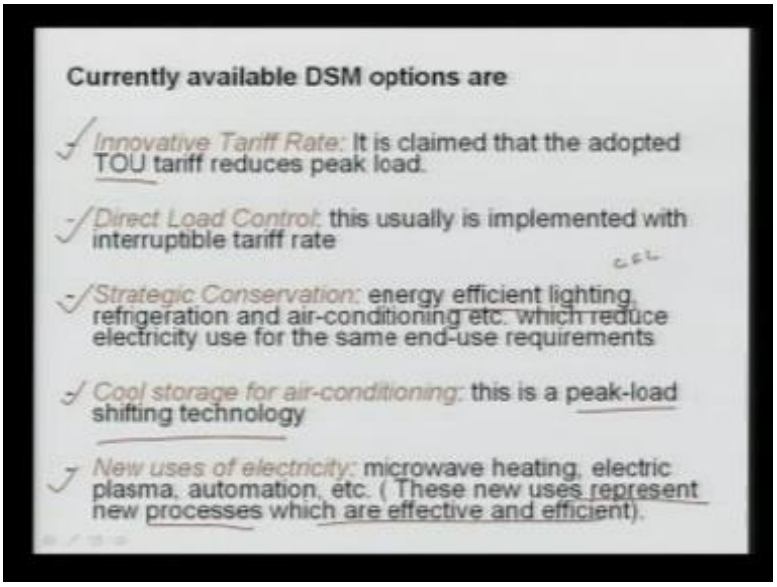

The currently available demand side management options are first one is your innovative tariff rate. It is claimed that the adopted time of use tariff reduce the peak load. Here normally if you will see in integrated power system where we are not operating in the commutative mode I will discuss later on in few slides that type of this tariff. We go for that is for throughout the day the tariff is safe. The tariff or you can say rate of electricity is not changing. So, what happen? People are not causes that what is the system demand with there is a peak or whether is half peak they keep on consuming the power. But if

you are going to use the time of use tariff means if it is the peak hours we can charge more then customer will shift from the high rate to the lower rate. So, we can reduce the peak demand on the system. So, this innovative tariff rate and again in the commutative power market the people are automatically they are just watching the price when the price is less they are trying to consume as much as possible.

Another is direct load control that is the second option. Here this is implemented with the interruptible tariff rate means if suppose tariff is higher then we can use some devices that can directly interrupt some of the load and then it is called direct load control. Second one is your strategic conservation policies. The energy efficient lighting, appliances refrigerator, air conditioning etcetera which reduce the electricity use for the same end use requirement. Means you can see right now, we are using lot of devices that is called CFL they are very much useful. Means for same light thus we can save a huge amount of electricity if you are going for that one year calculation. Also we can use the very efficient motors for your refrigerators and also air conditioning compressor etcetera. We can use and then you can reduce thus electricity use and our output is not compromised. Second one the cool storage for air conditioning. What we can do? Suppose your demand during peak hours for your air conditioning is more then we can what we can do?

We can cool we can have some cool storage during we can store that during the ((refer time; 03:18)) period and that we can utilize during the peak hours. So, what will happen? It will shift again your peak demand. So, this is basically peak load shifting technology that we are going for. And another that is shift option is that the new uses of electricity like we can use the microwave heating electric plasma automation etcetera. These new uses represent the new processes which is very effective and very efficient. So, these are the various demand side management options are available. Now, if will see in the planning prospective how we can include? Normally the traditional planning approach the demand side management options are not included and thus we require lot of incentive. So, that we can see what are the savings?

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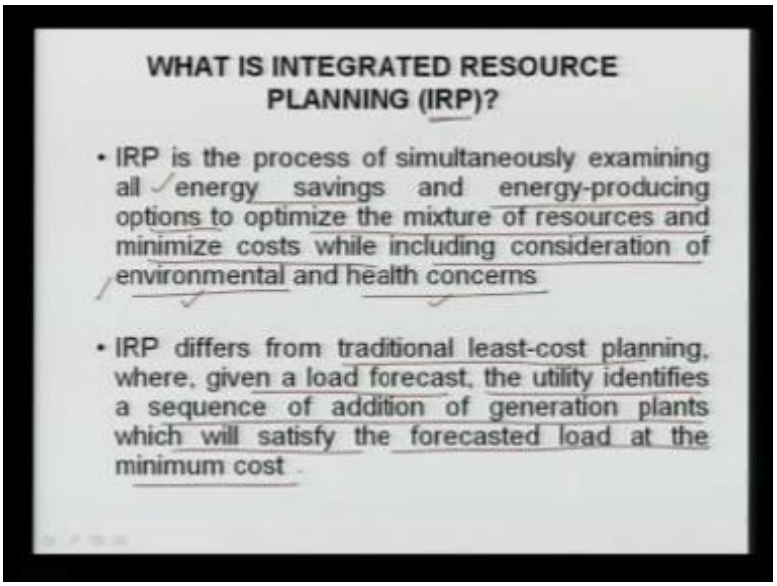

So, normally we go for the integrated resource planning. Now, question what is the integrated resource planning? That is IRP. It is very well known the IRP is the process of simultaneously examining all the energy savings and energy producing options to maximize the mixture of resources and minimize the cost while including consideration of environmental and health concerns. Means it is including your various hazards gases those are coming out from the power plants. Along with that we can go for the energy saving options in the distribution sides and the energy producing options on the supplier side.

We are going to maximize the mixture of resources with the minimization of cost means always you try to minimize the total cost with various constraints like your environmental health concern and we go for the planning approaches. So, IRP basically differs from the TRP that is a traditional least cost planning where the given load forecast the utility identifies a sequence of addition of generating plants which will satisfy the forecasted load at the minimum cost. In the TRP we never go for the demand inside option. All the way with the forecast of the demand the utility rate to decide what will be the generation what type of generation and where it will be located. Without looking the consideration of environmental without looking the energy saving option that it is called your TRP.

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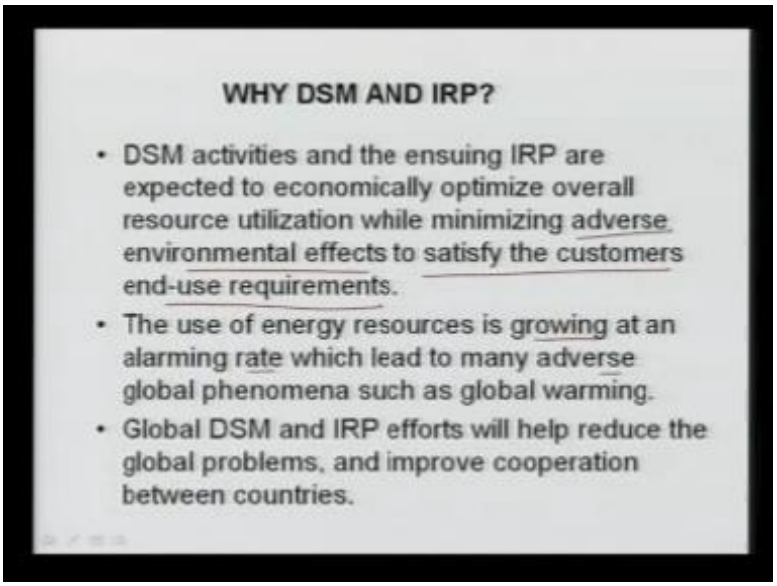

Now, question why DSM and RIP? DSM activities and the ensuing RIP are expected to economically optimize over all resource utilization while minimizing the adverse environmental effects to satisfy the customer's end use requirements. The use of energy resources is growing of course; the load is every time kept on increasing at an alarming rate which leads to many adverse global phenomena such as global warming. So, the global DSM and IRP efforts will help to reduce the global problem and improve the co operation between the countries. So, this IRP and the demand side option are very useful in current scenario. Now, let us so far we discussed about your generation side developments transmission side developments and also we saw the distribution side developments. Now, let us see what are the changes? What are the new developments in the operational side? In operational changes basically the power system which was vertically integrated. Means your generation transmission and distribution was almost in 1 utility.

In several country your transmission and distribution in one side are generated at generation and the transmission in 1 side distribution may be away may be separated utility. But in over all I want to say in unbundled power system, the generation transmission distribution is managed by 1 utility that is called your vertically bundle power system. Now, in the current scenario what is happening the whole this power system? Power system consist of generation transmission and distribution now, it is in the restructure phase. And sometimes it is called some countries it is called the reform

some countries it is called privatization and some countries it is called in the deregulation. But of course, the power system the search tree is not the privatization. Means the ultimate aim is to provide the better survey to the customer and also we can provide the better choice to them on to the commutative rate of electricity.

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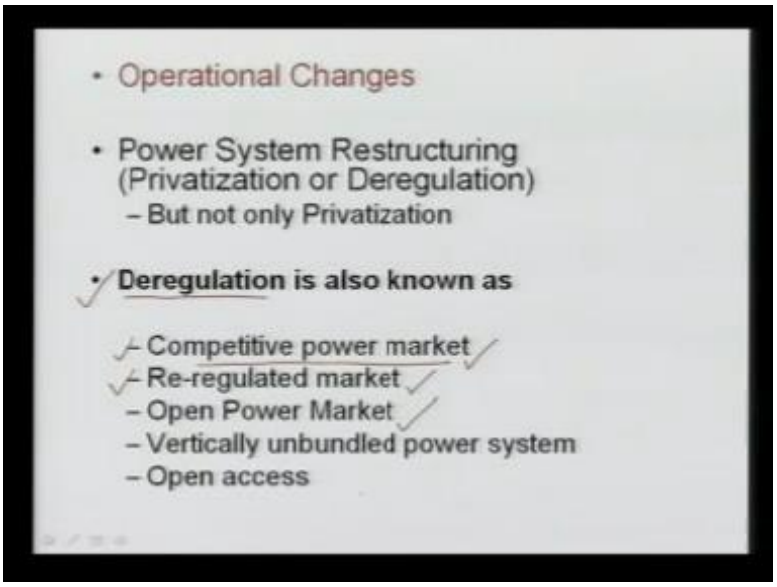

So, the de deregulation if you find the deregulation is very widely if remember I was also talking the regulation in the frequency control that was r. So, you do not say this deregulation means there is no r it is not related with the frequency control. It is a deregulation in the regulation policy that we are having we are going for the different regulations. Although the literal meaning of deregulation seems that there is no regulation but, it is not so. We are going for more and more regulation so the better word here and several times it is used the reregulated market where we are changing our the conventional regulation where it was operated by 1 utility and its intention was the different. Now, we are operating this power system in the commutative mode and that is why it is called commutative power market you can see at the commutative power market.

So, the deregulation is very widely used term in the power system restructuring and power system people. But other words are also equally important and the meaning is same that we can have the commutative power market. This is the reregulated, it is open power market and it is called vertically unbundled power system it is also called open

access why it is called vertically unbundled? Now, you can see here basically in this whole this is the dotted line so that it is 1 utility. Now, it is a vertically bundled power system means generation transmission and distribution business this all business is combined together. And it is owned and operated by 1 utility maybe 1 or 2 utility may be 1 transmission in generation in several country is 1 and distribution is an another company. But here you can say there is no company in the generation, there is no companies in the distribution. So, what is in unbundled we are doing? First we are just separating these 3 businesses separately. Means this line here and this we are just cutting means separating these 3 businesses differently.

So, it is called vertically unbundled (refer time 09:47)) you can say vertical here organization power generated here transmitted and finally, coming to the distribution business and it is going to the customer. But still it is not solving our purpose means we cannot introduce the company the generation all the generation is in 1 company then it is a monopoly. So, we want some another cut it is called here just you can see we can cut we can create several companies of generations itself. So that we can introduce the competition and this is called vertical cut it is vertical separation but, horizontal cut. Here it is a horizontal here the horizontal separation here this cut we are cutting the vertically here. Similarly we can also introduce the competition in this sector by having the different radial company different distribution company.

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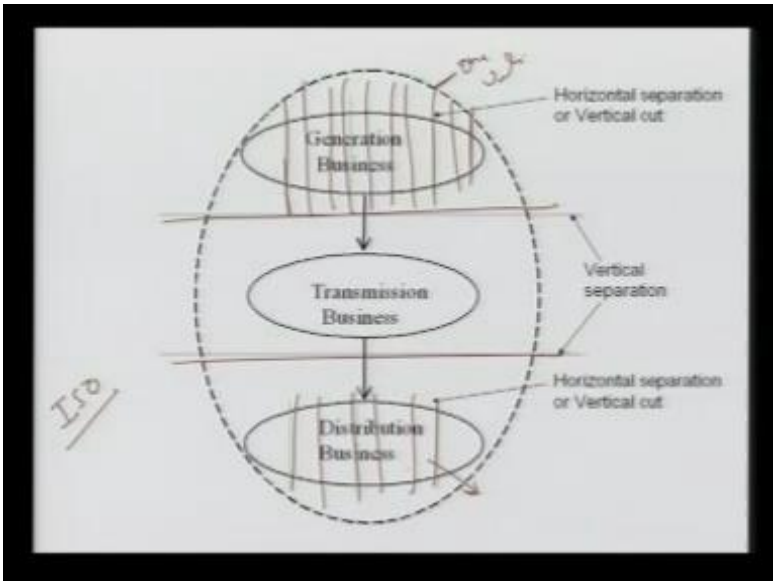

But we want that this transmission business should be always here it is in monopoly. Again the monopoly why because the transmission business is very critical business. It basically relates your generation and distribution by this rate. And you know there is something happens in one of the line other whole gird will be disturbed and other customers will be suffered. So, it is believe that the transmission business should have the natural monopoly. It does not mean that we cannot introduce the competition. It competitions in terms of we can introduce the competition, but the competition in terms of construction of the lines. But it should be operated and the managed by 1 independent utility that is called ISO independent system operators must operate. I will come to that point later. Now, let us see why thus we are going for the restructuring of electricity supply industry. The better experience of other restructured market such as communication, banking, oil and gas and the airlines are you can see the example. For example, you can say when this mobile business was introduced it was per minute 40 rupees for outgoing and for incoming it was almost 20 rupees.

But now, it is we are having 10 paisa 20 paisa per minute this is the age of competition. And with the help of competition the prices are very reasonable and just we are going to pay. So, the communication business is doing very well with the competition already we have seen the banking business lot of private banking they are doing very well. And always there is a competition in the operational management Oil and gas in several countries the gas prices and oil prices are keep on changing throughout the day. Air lines you can say earlier the traveling with the air lines it was a dream for the people. But now, it is even the individual person can travel in the airline. So, looking at these experiences the policy maker of electricity they also thought why not we can introduce same competition in this electricity business the competition among this energy suppliers and the wide choice for customers. So, they thought we can introduce the competition. In the generation business and that will give the choice to the customer. So, the customer can choose their supply. Now, question again arises why then earlier your electricity was regulated whether that time people where fool it is not so.

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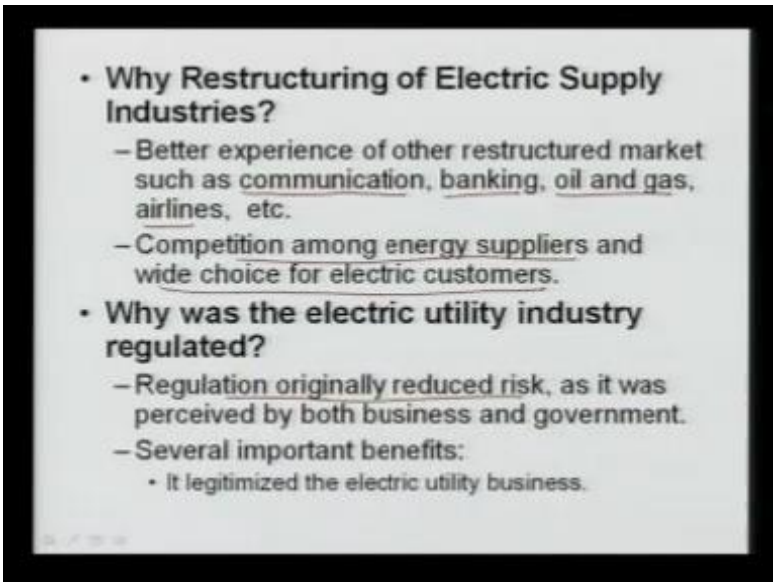

Because that time it was the need to go for the regulation regulated vertically bundle power system. The reason behind that this regulation originally reduced the risk as it was perceived by both industry and the government. Several advantages important benefit of regulated regulation at that time was that it is it legitimize the electric utility business. It gave utilities recognition limited support from the local government in approving right of way and easement. You know if it is in private and people will not allow passing the transmission line through airlines. So, the right of way means if you are going to concern the transmission line you require used 20 meters space that will before you have to cut several trees etcetera. So, it was not popular if it is in the private hand and there will be lot of problem also in the development of new power plants it requires huge areas huge space and that it also not possibly which is not in the government hand.

So, now, the technology and everything is measured whole this business is now, measured. So, now, it is time high time we can say to improve to implement the competition wherever it is possible. In the beginning phase since the investment was very high so it was not possible for the private investor to come into this business. Because they were not thinking what will be return so it is showed if you are it is in the public or you can say government sector. It is showed return on the investment and regulated as might be means regulated in a return on the investment was approved. And earlier it was 3 percent was approved that electricity board will be getting the profit on that.

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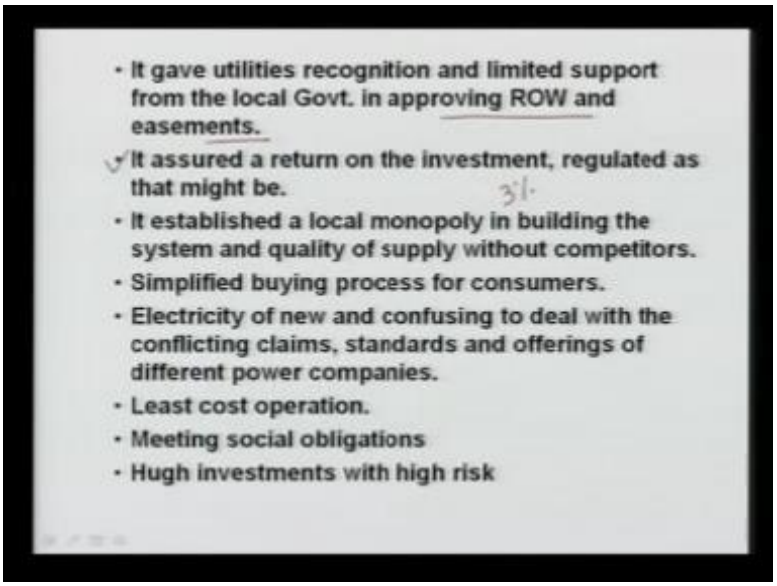

It establishes a local monopoly in building the system and the quality of the supply without competitors. It was also believed that we should go for the local monopoly and so that we can provide the good quality without the competition. The major problem in the competition is the detoriation in the quality. People are keep on going for the lower and lower prices, but the quality is detoriative. So, at that time it was the error that it was believe that we have to go for the proper quality that people should realize that this is the quality and then it was regulated. Another reason for that that it simplified the buying process for the customers. Now, you can say unless until the price is changed. If government is not going to change and price is not change. The price for whole month it is almost fails.

So, the people are knowing how much energy they are going to consume? What is the connection based on that conduction, means what is the power of that they are supplied? So, they are going for the 2 part direct basically. And they know how much they are going to pay and how much they have ((refer time; 16:00)) so it was very simplified process that is a buying process for the customer without any confusion. Means you con see your energy meter and you know what is your connection based on that you can pay your energy based. But in this competitive error that is totally different means for every half an hour like in UK every half an hour the price is change. So, it is very difficult to monitor what will be the rate and instance you are may be in office so how you can going to consume?

So, the price that is a half hourly is hourly it is changing in the competitive mode. So, it is very difficult so, you have to go for the time up huge meters. So, that you can pay accordingly so, the here in the regulated market this is very simple consuming energy multiplied by the rate you should paid. Another reason for the earlier deregulated market was that electricity was new and it was very confusing to deal with the conflicting claims standard offerings. And the different power companies when I was discussing the evolution of the power system we saw that there was the different voltage level where available at the same time we had the different frequency levels also. So the frequency and your voltages where different then everyone was claiming that his frequency and his voltages is the efficient and extended 1.

So, it was very confusing to the customers and also to the government then government thought if we are going for the regulation we can have some standard in terms of voltage. Standard in terms of frequency and you can say that is why in European as well as Asian country we are having the frequency of 15 hertz. However in US and Canada the frequency is 60 hertz. So, we they adapted 60 hertz we adapted 50 hertz supply. Similarly, in the voltage level you can see in the different country in the voltage level are different. In our country we are having the voltage level for the transmission it is 400, it is 220 k v it is 132 k v and also now a days we are going for 800 k v voltage system. So, these are the transmission voltage system. However, in other country you can find here it is a instead of 400 they go for 345 here they go for 150 and so on and so forth there voltage levels are there.

So, the voltages again in the different and so it was need at that time that we have to go for some regulation so that make some standard for inter connection. Why if you are going for the different voltages here that is you are going for standard for the different voltage I am talking that you can make the inter connection pass (refer time; 18:32)) and you know the inter connection at lot of advantage. Another was that we can go for least cost operation means we can operate the utilities with the minimum cost of generation. Because you know the system demand is keep on changing so that we can set the generators those are cheaper they can generate continuously those are expensive generators they can be only allowed to run when the system demand is more. So, we can go for the economic disperse if you are having 1 utility. If you are it is operating with the different utilities then there is no sense of economic disperses. So, they are just going to

beat and they are going to generate based on that. Another major claim for the regulated electricity market was to meeting the social obligations. Social obligation here as I said now, you can see the cost of electricity that we are paying in the urban area that is same as in rural area.

However, for the customers who are the way is not densely populated we are going for the several Kilo meters lines and then we are feeding for few customers. So, the cost of total cost it will see for providing those customers is very expensive. However, in the urban it is very densely populated and the T and D requirement it will carry over on them it is very small. So, that the social obligation means some of the customers even few customers are very far away from the gird. But still we provide the electricity this is the obligation after government, but in the competitive power market it is there is so special obligation. Another reason for the regulated market was that this electricity sector is not a very simple sector. In this one the huge investment in terms of generation, in terms of transmission, in terms of a distribution (refer time 20:20)) etcetera that was required. So and it was huge you are going for huge investment of course, there is huge rise that whether you are recovering the cost and you can see what is the condition of our state electricity board? Although it is not only let us that is they are not getting proper return but, they are some other consumable operation another things are there due to that these are in the (refer time; 20:44)).

Now, let us see what are the forces? We saw the advantages of the regulated power system. We also saw the motivation behind this electricity restructuring that is the day regulation or you can say commutative mode of operation. The forces behind restructuring here I am talking here the forces behind the deregulation. Means why we are going for the commutative electricity market why not in the present form which we are having. The first reason that is it is the force is the high tariff and over staffing. High tariff was the reason for the California. The California state the cost of electricity was more than 50 percent then its neighboring state. The regulators of California State they thought that if they will go for the commutative mode of operation of electricity business they will reduce and they redid and they find it.

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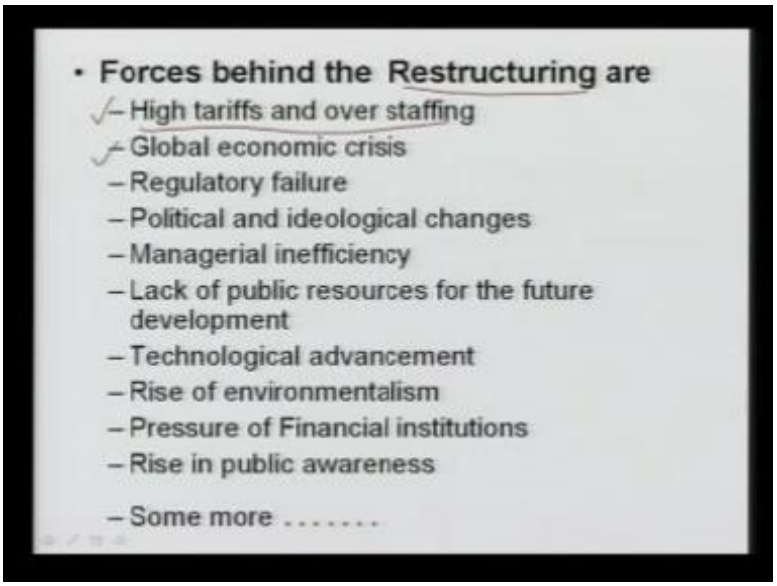

So, this, in the high tariff, in the several other countries like an Asian countries and like American countries also. The tariff was very high and then they went for the deregulation to reduce the tariff. Another reason for deregulation if the global economic crisis. In nineties there was an economic resection and that time the utilities were not getting the proper funds to develop its business. So, they thought that why not they should privatize they should sell it and they can get it money and then it started the privatization. And after that privatization then if it privatize why not we demand for the competition among these private companies. So, this whole process is started after this global economic crisis itself. In several Asian country and you are like American country was the reason for that. Regulatory for layout means several countries the regulation is not in operating in proper fashion.

No doubt there are a lot of rules and regulations are there but, the people are manipulating and the whole system is in regulatory failure manner. So, this may be the reason even though in our country also the regulation. Regulatory failure is one of the reasons. Another is your political and ideological changes this is the case of you UK. In UK when there was in 1994 there was a general election the opposition party declared in the manifesto that if they will come into the power they will privatize whole the business not only electricity all the business. They won in majority and they privatize all the business and energy was one of them. So, this was the reason of the politicians they thought with they go for competition. They will go for the privatization. They will

achieve lot of objective means again objective with that they will reduce the cost of electricity at the same time.

They will meet the objective that they can they will supply they will give electricity with the choice of customers. Another reason is your managerial inefficiency. Means the management has whole it is in alarming state in the several Asian country as well as the ((refer time; 23:34)) American country like in your Chile Argentina whole this managerial ((refer time; 23:39)). And this is the reason that they went for the deregulation. Lack of public resources for the future development as we saw that the demand of a electricity is increasing at the alarming rate. You can also imagine just 5 years back people were using simple fans or some people were using cooler. But now it is it will going to CT you will find every next house will have at least one AC air conditioner. So, you can see how the demand is increasing again in terms of production in terms of different style and you can say luxurious life style of the people.

This demand is keep on increasing and due to that increase here we have to go for the various generations. Now, we can see in our country that is why we are having a huge (refer time; 24:29)) of energy generation. We have not having enough generation so that we can mean the demand of the customers. So, what we do? We go for the load setting. so and why the utilities are or you can say cities are not building power houses, because they are not having enough fund. So, the lack of public resources is one of the reasons. So, what is happening? The utilities are going for the private they are inviting the private investor to build own and operate the power plants. Here you can see in UP electricity board several plants were sold out, because they were not having enough fund to operate the business. For example the ((refer time; 25:06)) and your ((refer time; 25:07)) that was sold to NTPC, because there was a huge ((refer time; 25:12)) of that organization.

Another is your technological advances means there are lot of new technologies like combined cycle power plant. They are very efficient, they can very easily started, they are can be put into the ((refer time; 25:26)) within 1 or 2 years. So, these devices these power plants are coming in and due to that that there is again that competition is started. Other reason is the rise of environmental is, because lot of environmental people they are very much ((refer time; 25:44)) against that there is a some cut off the tress if some area will be submerged they are going for ((refer time; 25:49)). So, it is not possible to go for the hydropower exploration. So, option again we are having the limited coal reserve oil

and gas reserve so, what are the option? Nuclear also people are very much concern about that hazards of nuclear you assume know.

So, we have to again go utilize our resources so that we can utilize and we can reduce our prices. Another reason is your prices from the financial institutions that are a very big reason. You can say the Orissa state was one of the examples for that normally the World Bank give the loan that you have to restructure your business. In Orissa it was at the condition for the World Bank loan that the Orissa is still ((refer time; 26:37)) board must be restructured. Means all the 3 segments like the generation, transmission and distribution must be divided into 3 different entities and there should operate even though in different fashion. Distribution was also divided in several zones and they should operate in the competition. Here in the UP also we saw that there is a pressure from the World Bank that we have to divide the generation transmission distribution business. And you can see generation is already away from this whole. And now, that now that transmission and distribution that is called UP power corporation earlier it was UP electricity board where generation transmission and distribution was in 1 utility upsiv.

Now, we are having for the ((refer time; 27:18)) that is looking after all the generation in the UP that it is belong to a state government. So again there is more that again we are have the separate transmission and distribution different entities right now. So, this is the financial pressure from the institution like World Bank, ADV they are giving loan with the condition that you have to restructure your business then they will allow to go for. Another is your rise in public awareness. Now, people are very much aware. Earlier people where whatever we were providing they will taking as it is. But now, it is people are very much causes they need good quality of power, they need uninterrupted power, they need several different and also at the cheap rate so, the customers need choice. We want that we should not take electricity from 1 company. If that company not providing better we can shift to another company. So, this is the now, customers are also very much aware and that is also giving a lot of pressure to the policy makers and regulators that they have to rethink and they have to further use ((refer time; 28:24)) of this business.

Similarly, there are several other smaller and smaller forces behind this restructuring. And again I just I am want to mention the reason for the restructure for each country is totally different. Means it may be combination of several here it is not only 1 it may be

the combination of several reason, but again it is totally different from the different country. Now, let us see why now, the deregulation is appealing means it is a very looks very attractive. First it is believed that it does now regulation is no longer necessary. Now, you can say the reason behind that the primary reason for the regulation was to faster the development of electricity supply industry, infra structure which has been achieved. Means though main reason for the regulation now, it has been achieve so, there is no need to go for the regulation now, it is a time to go for the deregulation.

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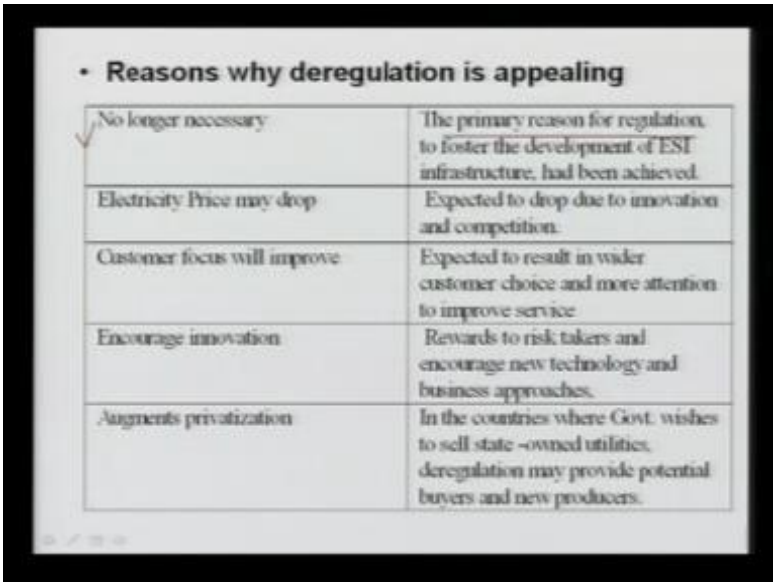

It is also expected that the deregulation will reduce the price. So, the electricity price may drop and it is expected that the due to innovation and the competition means new technologies are coming then we are expecting that price of electricity will drop. Another reason for appealing the customer focus will improve means expected to result in the wider customer choice and the more attention to improve the service. Because if the customer focus will improve means customer will get the choice. And if they will get choice then there will be possibility there will be more attention to improve the service. For example, you can see suppose you are having a supply from your utility that you are getting if there is something happen if you are making a complaint people are not listening. It may be it will take even though for several weeks for the 2 voltage. But in the competition is now, you can take the example of the mobile communication business if there is certain problem you can called to the service server center they will give id number and within 24 hours your problem will be solved.

So, this is the competition that basically give more attention and that will improve the quality of the service as well. Another reason for your deregulation that will increase innovation means you can have more different technologies and we require it. Because our resources are keep on exhausting your coal reserve is ((refer time; 30:50)). Your gas and oil are reducing hydro it is very difficult to construct and also that is also limited. So, we have to go for several new renovations we have to improve the efficiency. We have to go for the new technologies like your wind power solar and other so that we can. So, it is believed that the competition will give the innovation so that people will the competitors will try to improve their efficiency in terms of operational as well as output efficiency. So, the reverse to risk takes up and increases the new technology and business approaches. Another reason for the deregulation is that it will augment the privatization, because utilities are not having enough form.

So, it is believe that the private companies will be coming and they will be setting on the different utilities and then they will be completing to each other. So, in the country where the government wishes to sell state one utility the deregulation may provide the potential bias and we produces. So, we can go for the new producers, we can sell the state government utilities and then we can introduce the competition so this is the right way to go for that. Now, let us see what will be the transformation? So, let us see what are the various transformations that is taking place due to the de regulation of electricity sector? First transformation as we saw that the vertically integrated system were vertically integrated means your generation transmission and distribution in 1 hand. Now, this change to vertically unbundled system where your generation transmission and the distribution were the different 3 entities. In this vertically integrated system the reduce regulated cost based operation was there means the utilities are operating based on the regulated cost based. Means we are operating the cost and again it is regulated by the regulators or you can say government body.

So here the prices are decided by the cost of generation and which is again regulated monitored controlled by the government. But in the commutative power mode or unbundled power system the it is unregulated price based operation is no 1 is controlling. It is the marketing deciding in the price. So, that it is the price based operation. So, this is known as the monopoly where the vertically integrated and 1 is you can say the monopoly system, but here it is nothing but, your competition. Now, another here in the

monopoly system the electricity is treated as a service, because the government here is the regulated cost based. So this electricity is treated as the service, but in competition this electricity will treated as a commutative whenever in competition any item any value anything that is treated as commodity. So, here electricity will be now, change from service to the commodity. And the service will basically will be taken by the consumers. So, we are the consumers, but in the competitive power market you will become the customers. Because the customers gets choice and consumers get privilege. So, we are getting the privilege of electricity again the several things.

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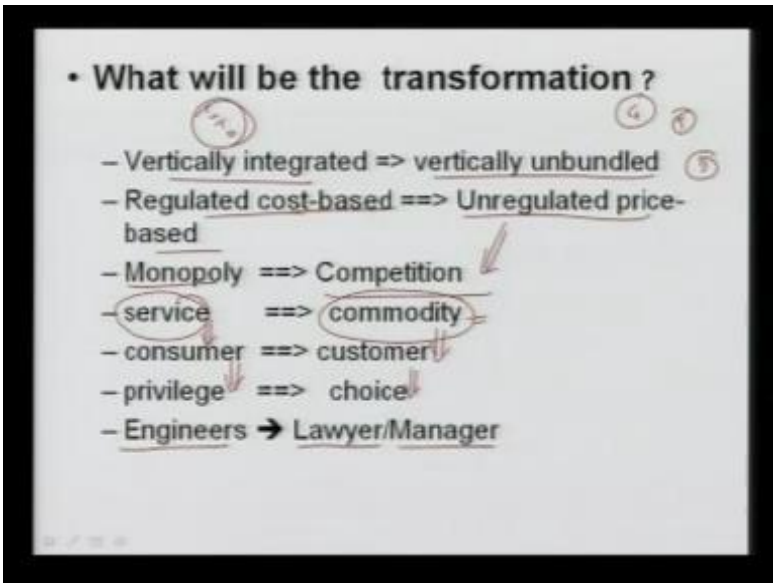

And of course, another change here in the vertically integrated markets those were the electrical mechanical engineers. Now, they are transforming to become the lawyer and manager along with their B.Tech degree. So, there is a lot of transformation in that area. Another is the if you are going for the deregulation there are number of questions to be answered before moving for the deregulation. First question is that whether this restructuring good for your society? If it is good then only you have to go for the your competitive power more. Another is what are the key issues in moving towards the restructuring? Why we are just moving from your vertically operated system to your unbundled power system what are the reasons? Without reason if your current electricity sector is operating and doing very well there is no need to shift.

So, you have to identify the problems and then you have to see whether that problem is going to be solved or not. Now, you have to also see what will be the implication of the current market industry participants? Means presently what will be happens those are old generating stations what will happen the old power plants etcetera? Means already the existing market participants whether what will be the obligations to this? We have to also see what will be the new type of participants will arise? For example, you can see there will be some brokers, there will be some aggregators, there will be Retail Company, there will be several distribution company, there will be Wire Company, there will be your settling coordinator, there will be power exchangers so many company will be arising. And again you can say only the consumer customer is going to consume the electricity and the supplier or supplying the electricity.

So in between there are so many new participants they are arising and there intension will be to take money from this market then whether cost will decrease or increase you can decide. If you are decided that you have to go for means you have seen this implication of current industry, you have seen the new one also. You have thought you have also decided the key users then you have to also think what should be the structure. The structure of each and individual countries totally different. You have to see how it is going to be operated? What, how you are going to accommodate you're the current industry the market participants? So it is the, you have to decide the structure the structure no doubt in general. This 3 types of structures are they are that is the pool type, bilateral type and multi lateral type.

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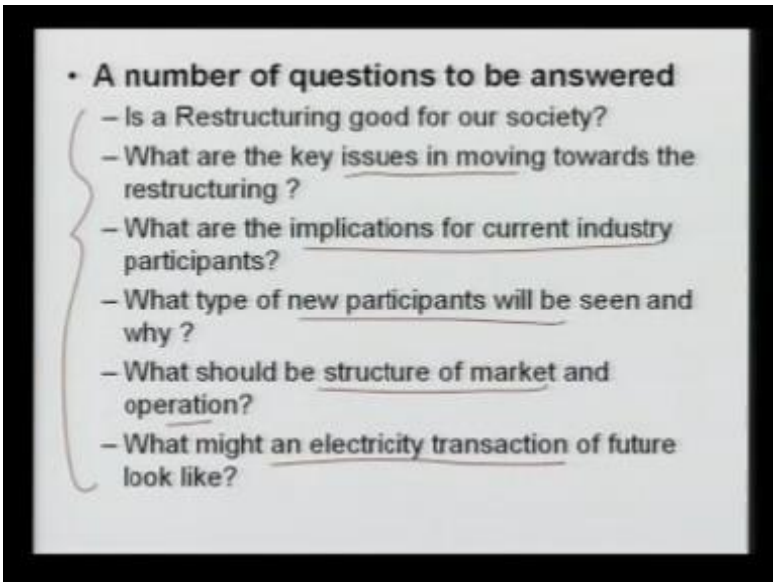

But again the normal operations structures are different for different country it should not be borrowed from the western countries. Then you have to also see what type of transactions of future will look like. So, these are the major questions if you have satisfied and you have answered then only you can go for your restructuring or you can say deregulation of electricity market. Now, let us before going for this what will be the potential problems let us see the some milestone of the restructuring. You can see this first country which went for this restructuring was Chile and it went in 1982 almost 24 years back. After that the UK which went for the competitive power mode of operation in nineties.

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After that you can see this several developments are not listed all you can see the Argentina, Sweden, and Norway in 1992, Bolivia and Columbia 93, Australia in 1994. Again the Australia the limited part new Zeeland went on the de regulation in 1996. And you can say this 1998 the California the USA and several other states are also go for and in 2000 several states of America as well as your EU that European Union countries they went go for the competitive mode. So presently you're Singapore this also operating the commutative power mode several lakh in the American countries also in the year of as well as you can say north Sweden along with us Canada and your USA they are operating in the commutative power mode. So, these are the milestone of this one. Now, let us see the market how we can define that the various types of market are existing? Earlier it was simple energy market. Means people are bind energy from the utility and they were paying for the money.

But now, you can say in the competition the market is open and several market are going to be arise. If you will define the market by the commodity which are going to be traded that we can say this energy market, the transmission system market and ancillary market. Energy market is market where we are actual energy actual power we are bind that is the how much you are going to consume this power output of generators? The transmission system, because for competition we require the transmission system as well. And then here this transmission system market is another market that is the running parallel to this energy market. The ancillaries of this market that is another very ((refer time; 39:13)),

because in conventional or you can say regulated power market this ancillaries are was with the utility. And ancillaries services are nothing but you can say you have to go for that reserves we have to go for the even the reserves is your static reserve stall capacity spinning reserve. We also have to go for the voltage control, we have to go for the frequency control all these are the imbalancing the power that is the ancillary structure.

So, they are we are having another market. So it is we are having 3 markets they are running parallely. It is not necessary that all these 3 markets must run in each and every country. In some country it is only energy market and ancillary is the mandatory. Some country energy and ancillary are running parallel. In some country all 3 are running parallel. So, the market if it will define by the time frame for the trade then it is called day ahead market. If it is if it is hour if traded for means hour ahead market and it is a real time. What is the day ahead market? Day ahead market suppose we are talking today and we are talking for the tomorrow it is mid night 24 hours. Here we are just going to settle our market and let suppose 10 AM today. So far they starting from the zero or for tomorrow mid night to the mid night of the next day here 24 hours block here you can say one hour block. Here your this market is settled means what we are doing? We are forecasting demand for these particular hours.

Based on that we are inviting the bids from the customer suppliers and then we are saying we are clearing the market we are asking that which generator will be generating at which hours. So, it is decided here and this is called hour ahead, because electricity we require for this day. We are just clearing the market here it is called day ahead market. Under the market we go for the hour ahead market means if you are talking here for the 9 AM at 8 AM. We are again forecast the 9 AM load, because the load forecasting here always there will be error in the forecasting. So, the actual demand 1 hour ahead what will be there then we can also auction generator to participate in this market they should bid that what rate of the power they were going to sell in this hour ahead market. So, this is called 1 hour ahead market. Another is your real time you know when the time has arrive let suppose 9 AM has arrive and that we know that there is some mismatch. Means there is some increase and decrease in the power then we have to ask the generating company bid for the increment and decrement of the power.

And based on that we have to settle the market why it is required? Because we required the total balance load and the your generation must be balance and so that we can

maintain the frequency of this system. So, it is a balancing market sometimes called that is the real time market. So here the 3 markets are running at the 3 different parallel again. You can also see the if you are going for the auction type based on the auction we can divide the single side or the double side. Means if the bids are only allowed from the supplier side then it is called single side bid. If you are inviting bids from the customer side or retailed company side also then this is called double sided bid and then we are going to matching.

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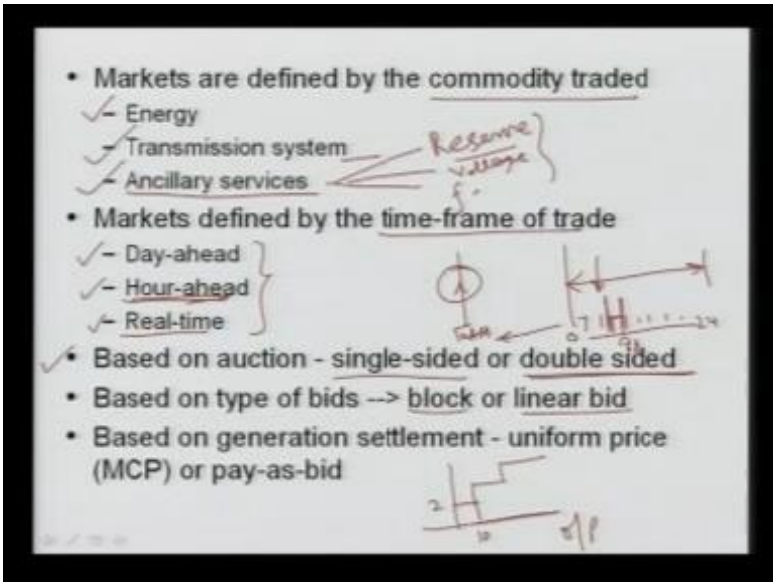

Based on the type of bids again it is required at what is the type of bid? Means whether its we are going to sell blocks of your power or your linear bid. Means a generating company here it is a output here power and it can sell like this here. He can say that first 10 megawatt he will sell at 2 rupees and next here 15 he can sell at the 3 and so on. So, it is a made black biding his bid means whole 100 megawatt suppose utility having 100 megawatt capacity. So, it can say I will sell this first 10 megawatt 20 megawatt at this rate next 20 at this rate next 30 at this rate. So he can go for the different it is the flexible. So, it can bid why it is that increasing? Because the cost here it is keep on increasing the quadratic characteristic. So, it is called block biding. It is it may be that the linear bid that we can also you can bid like this that if you the output is increasing the price is also increasing and this is called the linear bids.

So, again the market is decided by your block bid or linear bid in this version. Another is your generation settlement. Generation settlement is basically whether you are going to have a uniform price or the pay as bid price. Uniform price means once the market its cleared all the generators are getting the same price and that price is the marginal price. Means the generator who is going to dispatch loss in the merit order loading that will set the market clearing price. In this uniform price that is MCP there is a lot of debate whether we have to go for uniform or not suppose the generating company here. Let us suppose our load here I will give one example here for this 1. Let us see this example.

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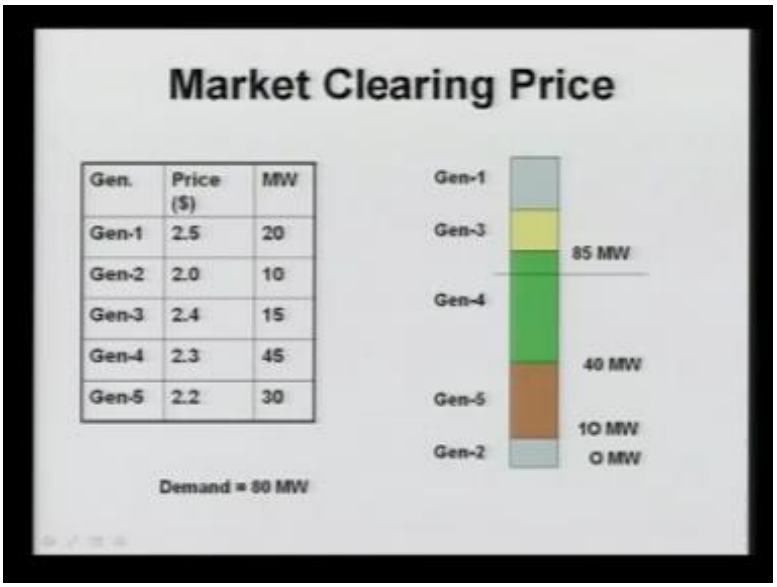

So it will be more clear. Let us take our demand is 80 megawatt and we are having the 5 generating companies they are selling that here 20 megawatt this generator is selling at 2.5 it is a single black they are selling. Here the generator two is saying that he will sell ten megawatt at the 2 dollar again 2 dollar per megawatt hour. Of course this a this is not ((refer time; 44:53)) merit value will be anything, but here we can decide here. And this here the 15 dollar at this rate and 45 is going to sell at this 1 and 2.2 dollar is going to sell at 30. Now, what we do? In the market clearing mechanics we just rank them in the merit order means that which one is the cheaper. You can say generator 2 is cheaper the 2 so we have taken generator 2 and it is going to sell 10 megawatt capacity. Now, we have to bring generator 5, because it is a 2.2 just have than this. So, we have added it is selling 30 so we have reached now, 40 mega watt.

So, this is your 30 here this is your 10 megawatt now, the 40 megawatt we have reached. Now, we have to call next higher that is generator 4 and it is it has capacity here that is 45. Now you can see and then we have to rank 3 and 1 here this I have written and all those 1 in the different color. Now, our demand is only 80. Here you can see the 80 demand and this demand is coming here what happens? We have to load the generator according to their merit order those are cheaper they will be dispatch first. Here we are talking unconstraint dispatch we are not talking that vector is a some congestion or any congestion or occurring in the power system or not. So, for this you can say now, what will do? This generator is the lost generator which is going to dispatch and this generator is not dispatch completely.

So, what we are doing? So, this generator is generating 30, this generator is going to generate 10 and this generator is going to generate 40 megawatt that is total we are getting 80 megawatt. So, this generator the price was how much is 2.3 and 2.3 dollar. So, he is the setting the market clearing price and inform market clearing price what happens? All the generator this generator was biding here at the 2.2. But it is also expected that this generator will also get this rather than this. So, even though this any generator can bid at zero, but the market the price which is going to get it is decided by the market. If market decide price this all the generator are getting the same price whether irrespective of their biding value. So those are very cheap generator then never take risk the bid at 0 value. So, in uniform market cleaving price this is called MCP. The price which is set by the lost dispatch generator that will be given to the all the generators and this is called uniform market cleaning price.

This is the highly debatable people say why if this generator is willing to sell at 2 rupees why we are giving higher value we should take only 2 rupees. In that case it is said pay as pay means what they have bid you have to pay according to that. But the economic say that this uniform market clearing price is better than pay as pay market. Because there is 1 that if this company will be getting profit. He will try to explain his business and that will be good for this market. Also here if this some people are very risky there are very continuously operating so they can bid they do not know the market. Here if you are going to pay as bid what will happen? This generating company will try to see that what will be market clearing and you will try to bid more than that. So there is a possibility that this company let us suppose earlier it was bidding at 2. Now, he is

thinking with the price will be 2.3 at 2.4. Let us suppose you think that price will be 2.4 what will happen?

Now, you can see this generating 2 will be coming up and then market clearing price will be increased to this one, because this will be deciding factor. So, in that way there will be more competition and the market clearing price probably will be higher than in this market. So, the mostly this uniform market clearing price is the better choice for going for this. So, let us see that how we are just going to in the market clearing there is different types of markets are also available that is your pool market, bilateral market and what are those market? So, let us see what are the potential problem in this deregulation we saw the competition is very good the always advantages I have explained several advantages are the deregulation. Now let us see of course, whenever there is some advantage of any system there will be some I am not telling more may be less but, always there will be some problem.

So, the potential problems in the deregulation market is enormous it is not less. First we can see the congestion what will happen? The congestion means congestion is still existing in the congestion market. But that is managed by the utility who is owning operating the whole business. But in the competitive power market the congestion is more why all the customer will try to get the power from the cheap generators. And therefore, the transaction will be keep on increasing and the possibility of the congestion will keep on increasing. And how you are going to manage the congestion we generator is going to be reducing the power which is going to increase the power it is again the lot of distribution settlements are required.

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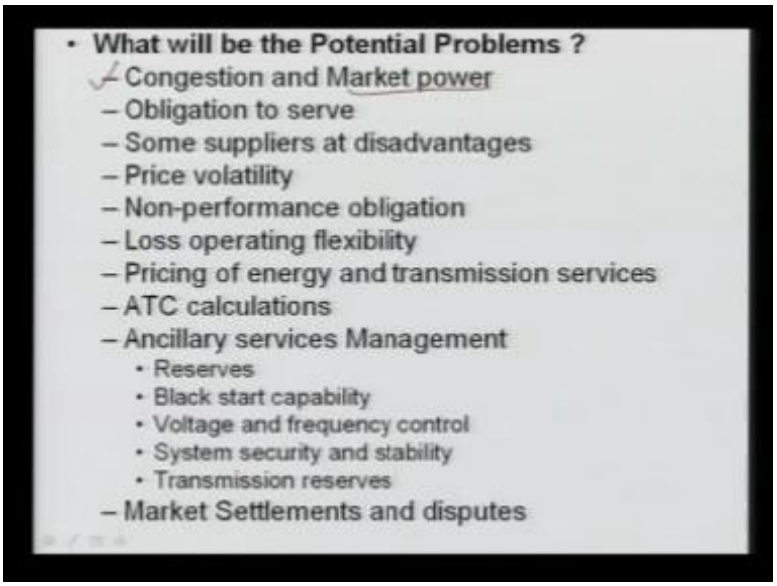

Another is your market power as I said here if the electricity market the number of supplier for very limited and therefore, what happen? There is a possibility that they will try intensely try to increase the price if they are try to bit higher value knowing the demand then what will happen? The possibility of the market power is more and market power if the abuse to any competition. The market power source that market power is that that if anyone is intensively trying to increase the price then and it is draining the wealth from the customer to the supplier it is a market power. This market power that is it is not the many is taken by the individual generator who is exercising the market power, but this money is distributed to all the generator all the generators are getting benefited. So the market power is the abuse, because we have the limited suppliers it is not possible that we can go for thousands of suppliers. Another is obligation to serve which is not possible in the competitive power more. Only the government has to take the initiatives and special steps to go for the obligation to serve.

Some suppliers will be at the disadvantage as I said, because some of the poor suppliers those ((refer time 51:24)) those technically they are not good and there may be sometime there are very frequent tripping and etcetera is there. They cannot complete or they cannot come to the market power they are also very expensive. So those some suppliers will be at the disadvantage the price volatility the price will be keep on fluctuating as I said every half an hour in UK every hour in Australia as well as the USA the price is changing so the price volatility is here it is a keep 100. For example when the demand is

more the price here may be less and it may be several time in the evening. So, this price volatility is one of the issue in the competitive power market when the demand is more if they will bid higher people will be consuming and the price of electricity will be more. So there are some mechanics to reduce this price volatility price fluctuation or ((refer time; 52:16)). Another is non performance obligation. Suppose supplier company is saying and he is ask to dispatch means he would not the weight and ask to dispatch and he is not dispatch in the power at that time so that will create the cost in the market.

So, for this there is a huge penalty is going to be impose that is called imbalance penalty in several country it is implemented. Loss of operating flexibility in another concern that you know when it was in 1 hand 1 utility was operating all the business transmission distribution and your generation. But now the different companies', different distribution company, different your generating company and that is and even though may be the owner of the transmission companies will be different and it is been operated. So, we are losing the operating flexibility which we had in the our regulated market. Another concern is that the pricing of energy how much we have to charge from the customer and also how much we have to pay for the transmission services? Earlier it was a complete calculated value, but now, it is a different segment. So how much we have to pay for the transmission service who is going to make the new transmission line etcetera. Who is going for the planning etcetera all this thing are always questionable. Some technical problems like the ATC available transfer capability calculations are also very important. Because we have to have the past computation and we have to post in the market.

So, that the builders can know and based on that they can bid for supply as well as for consumption of the power in that moment. Ancillary service management is one of the concern that reserve margins who is going to provide the reserve. What will be the cost of reserve? Who is going to start first when complete system is dark or the area will dark? Let that is called black start capability when the system is collapsed then we will start 1 by 1 during that you can see there is no output of power but, huge investment. So, again the black start capability is 1 concern voltage and frequency control who is going to do all the things and the system security and stability who is going to monitor earlier it was 1 utility who are looking for all and of course, the transmission reserves. So all these questions basically then regulators ((refer time; 54:31)) that we should have one independent system operator that is called ISO. Means independent system operator in

some country it is called ISO some country it is called market operator and so on so forth. So, they are they are they are not having any wasted in interest in either of three business that is generation transmission and distribution and it is the independent government control body.

So, they are looking of all the things. Here even though other the problems as well they are just monitoring here to this body you can say supreme and its monitoring the market. As I said since there will be lot of participants there will be lot of disputes lot of settlements are required and of course, there is another concern of ((refer time 55:13)) electricity market. So, these are the you can say potential problem of electricity market. Now, let us see the 3 type of market that is existing 1 is called the pool market and another is called your bilateral and third one is your multi lateral markets. Let us see what is the pool model? In the pool basically here this 1 pool has usual. In this pool what happen all this generating companies are selling power to this pool and the customer here they are taking the power here.

This C customers various customer are connected. So, the power which is coming from these generating stations are basically into 1 pool and it is consumed by the customer. And this body is basically independent system operator who is operating and the deciding the market at which rate they are going to bid and at which rate they are going to pay to the ISO. So, the energy is flowing from the generators and then finally, coming to the customers here in this way. Now, here the customers are not knowing which generator is supplying power to the particular customer. Means they are not knowing the suppliers here and it is that is called pool you can say this is the pooled. Thus all are selling and they are drawing the power from the customer so this is the pool market. In the bilateral market what we except here the power will be no doubt will be flowing here but, money here will be flowing here. Means the generator here g one will having conduct with the customers and he is going to supply the power.

No doubt that power will be flowing over the transmission line of this network here the various lines are there. Power will be coming to this, but there is a the price is not concerned of this pool. Price is mutually agreed by the generator here and the customer this is the multi lateral means bilateral 1 to 1 relationship. We can also go for some expansion of this multi lateral means this generator can sell power to the different

customers. So, it is group of customers are even though this customer can go for group of generators it is called multi lateral type of operations.

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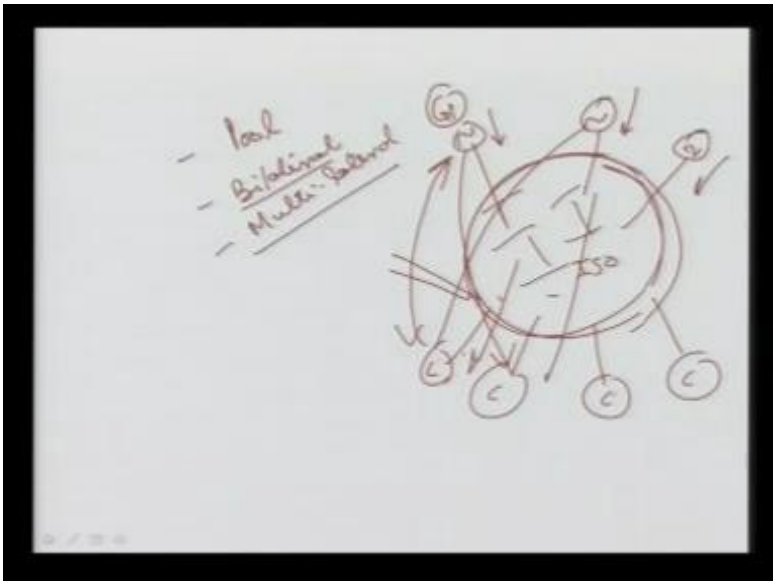

So basically this is the true competition that customer will have the proper choice. But in the practice now, we are having your combination of pool plus bilateral and multilateral type of markets and they are operating very efficiently. So, at end I want to say this electricity market is totally different from the other market. And this electricity market is very risky and it has a special characteristics. Now, you can see this electricity is not a storable in the bulk quantity. Now, you can go for the close and other market that you can store that one in the bulk quantity. Here we cannot store the electricity in the bulk amount although we can store in terms of a small amount of power we can store in battery bulk it is not bulk amount of power. Also the end user demand is typically constant. Means whether the price is more or less our end user is almost constant. But If you can see the potato if you are going to buy potato if the price is 20 rupees you will start consuming less potato. So, that is varying that is your demand is reduced so you are having the demand elasticity. But in the electricity if the price is 2 rupees or price is 5 rupees we are consumption will be almost the same.

So the end use demand is typically constant. Here the trading is directly related to the reliability of the grid. Means if something happens then if the grid will distributed all the customers all the generating companies will be in the problem. Here the demand and the

supply should be exact means ((refer time; 58:54)) it is generated that must be consumed. But for other commodity you can store it. So, here this is the supply and demand matching. The electricity price is directly related with the other commodity like your volatile like your gas coal gas and other price that will also keep on changing. And also the cost of continuity is more than the cost of electric. Means if your supplying the electric that is called energy or serve ENS is always higher than the actual cost of supplying.

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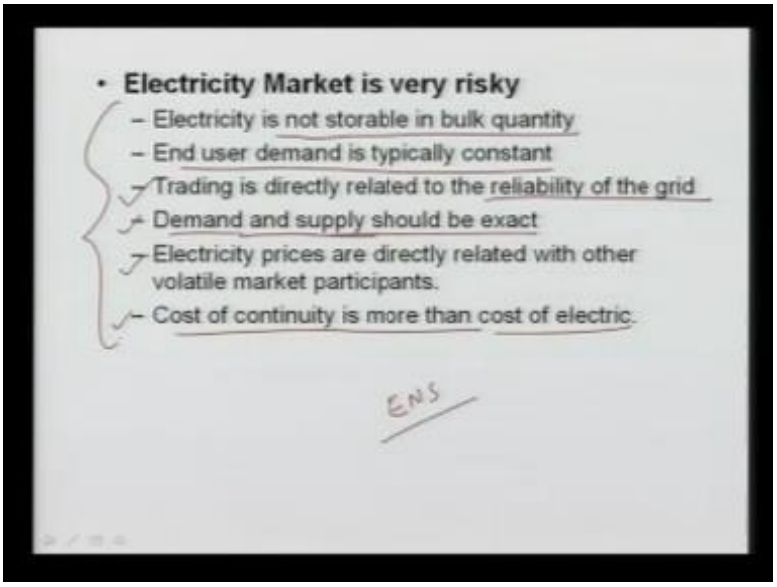

So, if you are not supplying power it is very expensive then supplying the electricity. So, this electricity market is very different than your normal consumption market. But this market is very useful and overall even all this problem that market is existing and the several countries are adapting the combinative mode of operational due to the several advantages. So, with this now, whole this course now, its ends with this module number 6 we had the 6 modules. And then we explain several in this 35 lectures and this ends this complete module and hope you have understood.

Thank you.