Operation and Planning of Power Distribution Systems
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Lecture - 07
Load management

Discussion on demand side management, ok so. In fact, I gave an example to make you understand that how much benefit the utility can have if we can follow one of the approaches of demand side management ok.

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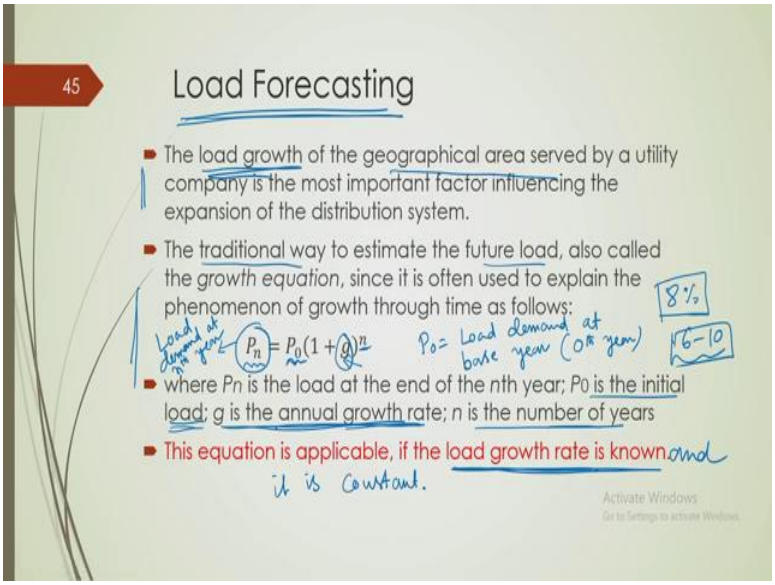

Here we will discuss load forecasting. Here we will discuss load forecasting and load management load forecasting and load management ok. Now, as you know this load, it is having a steady growth. Load demand is growing every year and year to year, ok and also load grows in a geographical area served by a utility company ok.

So, load not only grows in magnitude, but also it grows in spatial form; that means, new loads are coming in new areas, small cities, new developed towns and so on ok. So, load is a parameter which is continuously growing ok, for developing country as well as then developed countries, ok.

And, we can find out this load; we need to find out actually as a power system engineer and that process of finding out this future load demand is called load forecasting ok. And, it is an important area of research in electrical power systems.

It is an important area of research in electrical power system, ok and not only the power system researchers involve in this load forecasting. But, it is an area where people of computer science, people of others who know various types of forecasting techniques they also use means they also do research on this in this particular field.

Now, the traditional way to estimate this future load is very simple; we assume some you know growth percent or percentage growth or per unit growth or whatever you can call; if you know that then you can find out what would be the load demand after nth year. This Pn stands for load demand at nth year, ok; n is basically that after this; n can be any number 5, 10 or whatever.

And, Po is basically representing your initial load. Po is basically representing the initial load or the load Po is basically load demand at base year which we can call 0th year, ok and g is basically annual growth rate annual growth rate ok and n is the number of years. So, if you know that an annual growth rate which is to be of course, constant ok, then you can find out what would be the load demand after n number of years provided that you know that load demand at the present year, so, which is known obviously, to us ok. Now this sort of calculation has a drawback that here we assume that load growth rate is known and it is constant. Load growth rate is known and it is constant which does not happen in practical world that load will grow in a constant percentage.

That we cannot say that load will always grow at 8 percent for next 15 years. We cannot say that ok. So, it may so happen that it will vary from some value 6 to 10 or some value depending upon again that particular country or area which you are talking about ok.

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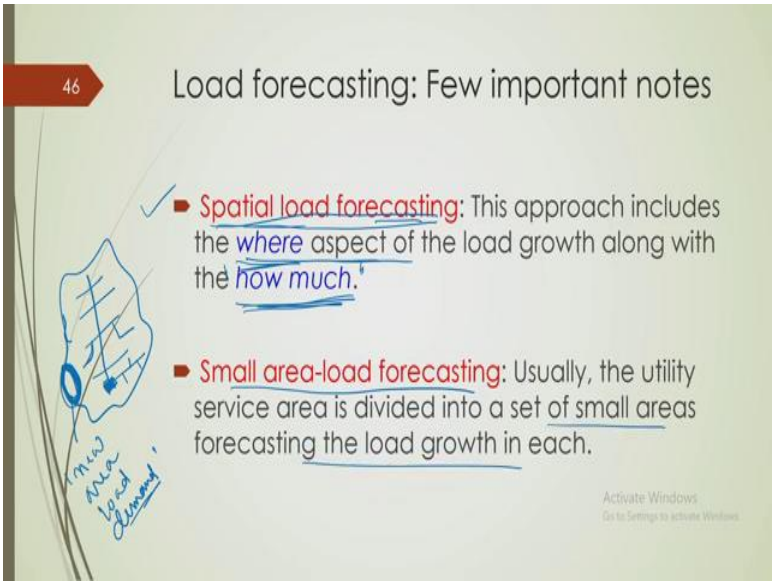

Now, there are two important notes ok. One is called spatial load forecasting; "where"; I mean in this approach we have "where" aspect in addition to this "how much". So, here not only that how much load demand you are having in the after 10 years or so is important, here also we have some factor that where this sort of load demand happens.

That means load not only grows with the exist for existing customer, load will also grow considering that new customers or new buildings or new residential complex new offices new industries will come up, ok. Suppose, this is a geographical area under which a particular you know utility is serving and they have a preexisting network like this.

So, this is a one feeder and these are the some lateral feeders, and they have many feeders like this, ok. Now, these are basically existing network by using which that particular utility is serving to certain number of customers, but it may so happen that new residential complexes are developed here; so, new area of load demand, ok.

Now, in order to serve this area you have to do the expansion of the existing network ok and due to this expansion for this expansion we need to know how much would be the demand of that new area, ok. This new area might be an industrial complex, might be a residential complex, might be a shopping complex or commercial complex and so on, ok.

So, on in this new area you have to supply power and that needs the expansion of the existing facilities and this is why we know we are basically interested to know where this new load demand comes in, ok. So, that is why in spatial load forecasting we have where

aspect that not only this load will grow for existing customer, load will also grow for in the form that new areas are developed you have to supply this load ok.

So, how much factor is basically the spatial factor you can understand, ok. So, there is another approach which is called small area load forecasting in which utility basically divide this area into a set of small area and then they forecast this load growth for each of the areas ok.

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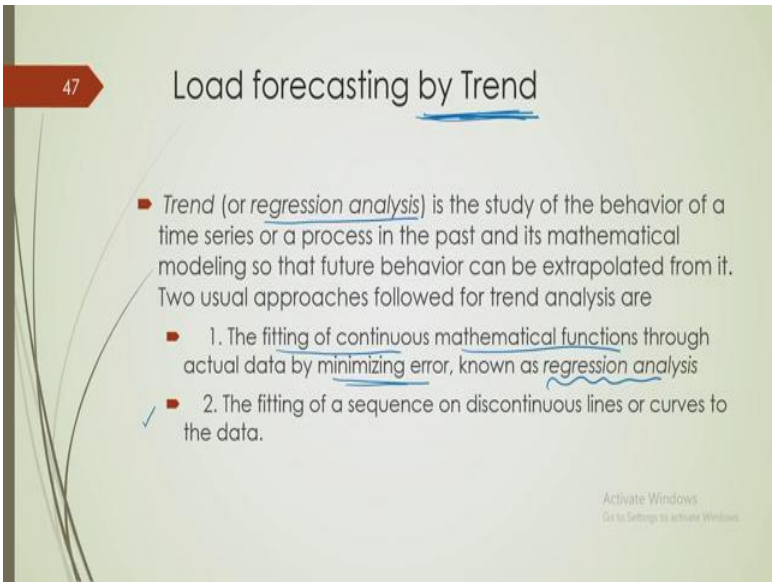

Now, this is one way of this load forecasting by trend or regressive analysis. So, based upon this load growth behavior of last few years we can focus that how would be the power demand.

How can we determine that? We can have this data of this load growth of last let us say 20 years or so and then we can fit this data to some characteristics ok. And, this fitting we can do so, by mathematical functions by minimizing this error. We call this analysis of the regression analysis ok and by using so we can find out that the characteristic of load growth ok.

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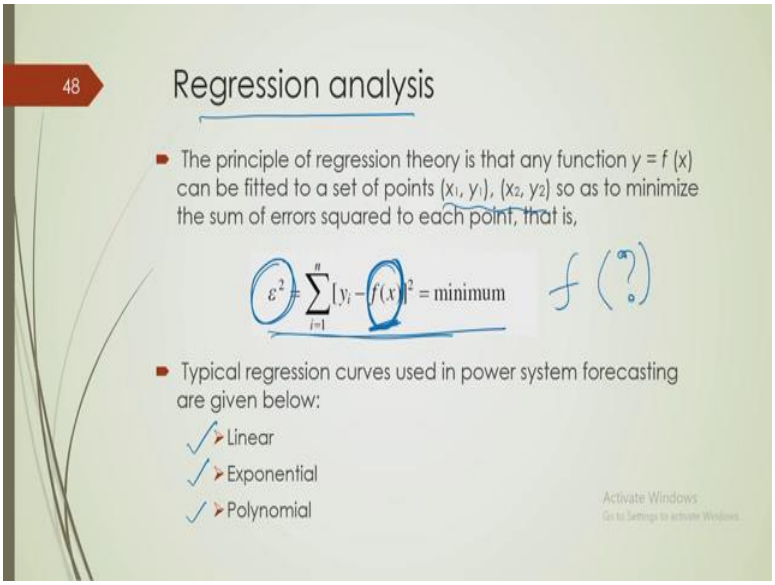

And, this as we said this regression analysis; if we have this sort of load demand we assume that a function f(x) which will relate this load demand with respect to this time interval, then you can do by minimizing this sort of error function.

This is not the only this type of this error function that people use; many people use different types of error function and then we can try to fit this characteristics considering different types of characteristics linear, polynomial exponential and so on ok. So, main essence is that to find this function f. So, here the main goal is to find out how would be the function f which will represent your load growth characteristic ok.

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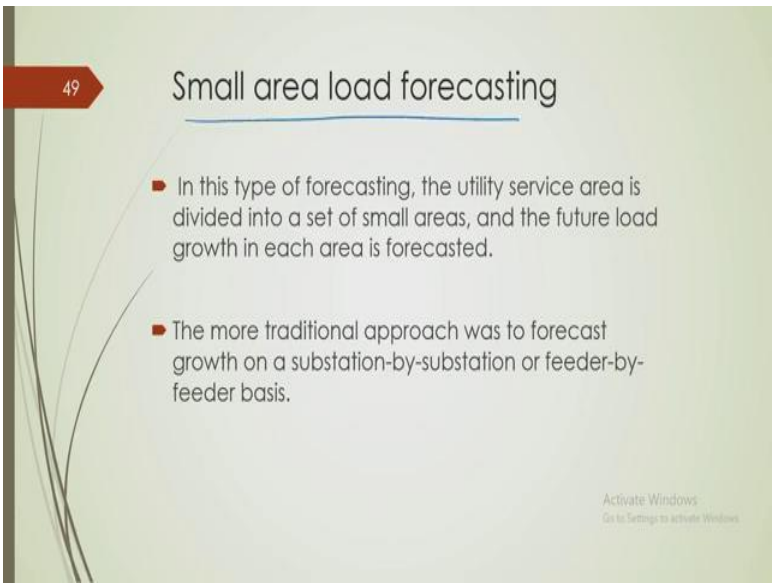

Now, there is something called small area load forecasting as I said where an area is divided into a small number of small area, and they use this forecasting for individual area either in substation by substation basis or feeder by feeder basis, ok.

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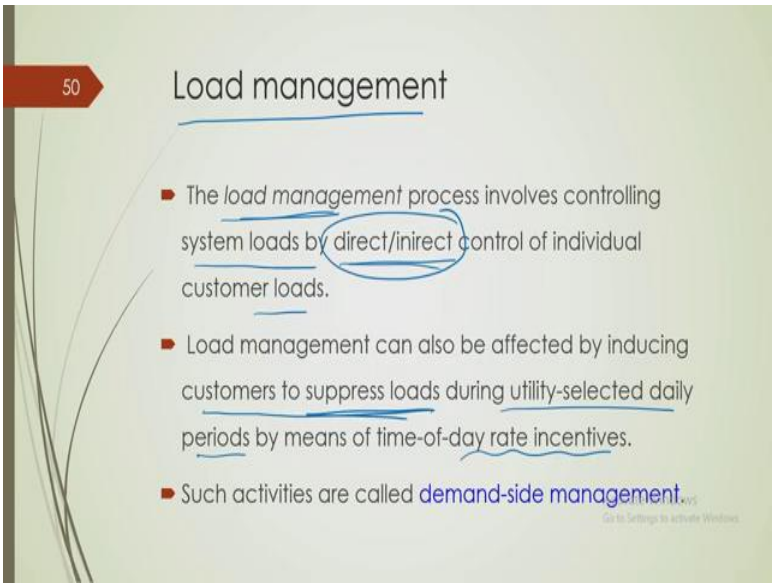

Now, we will do this; means load forecasting as I said it is a very big area. So, I do not mean certain event; discuss a detail on it; I will just touch it to give you some fact that why it is so important in power distribution system planning.

Now, there is another important thing which is called load management, ok. In load management what we do? It is a process to control some sort of loads indirectly or directly by the individual customers, ok. So, there is some indirect or indirect procedure by which we can manage this load demand because based upon this load demand the utility needs to schedule the generation and they need to arrange that much of generation available, ok.

So, the process which we can manage this load demand is called load management ok and there are some activities of this load management by which customers are encouraged to suppress their load when at a particular given period of time for example, you know during peak demand particularly we need to cut down this load demand; we need to reduce the load demand.

If you make some incentives that customer can defer some sort of their load demand during peak hour if they get certain amount of incentives, and these are such activities called demand side management. Again, it is another area of power system research ok. I will just give some basic idea on that.

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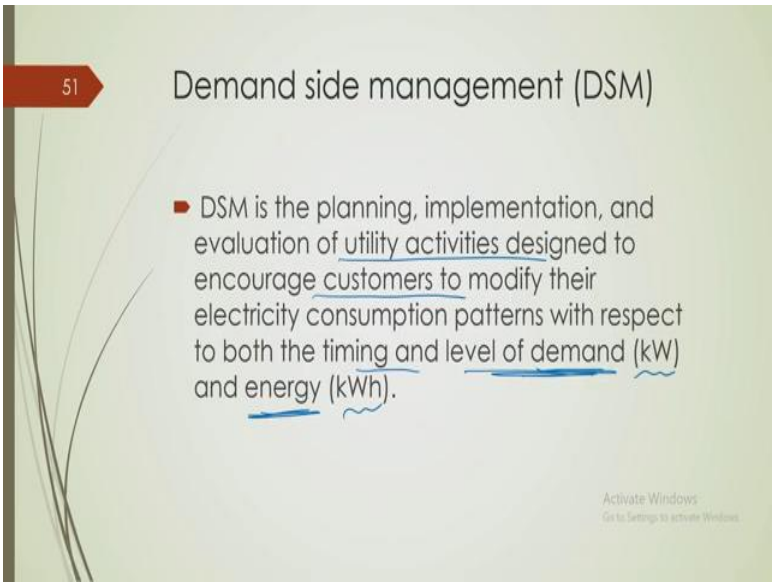

Now, what is demand side management? Demand side management is a planning or implementation and evaluation of utility activities designed to encourage customers to modify their electricity consumption pattern with respect to both timing and level of demand ok. So, both things are important that level of demand which is measured in kilowatt or megawatt and energy which is kilowatt hour of hour.

So, it is a planning process by which utility will encourage customers to modify their demand based upon some you know predefined rules or something. They not only try to reduce this level of demand, but also level of energy ok and this process is called demand side management.

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Now, what is the demand side management is important because as we know developing country like India, we have major challenge to meet this increasing energy demand and increasing peak load demand. These are the two important factors. If energy demand is measured in terms of mega watt hour or million of units (mu) and you know peak demand is measured in terms of megawatt in a level of megawatt for a particular country, ok.

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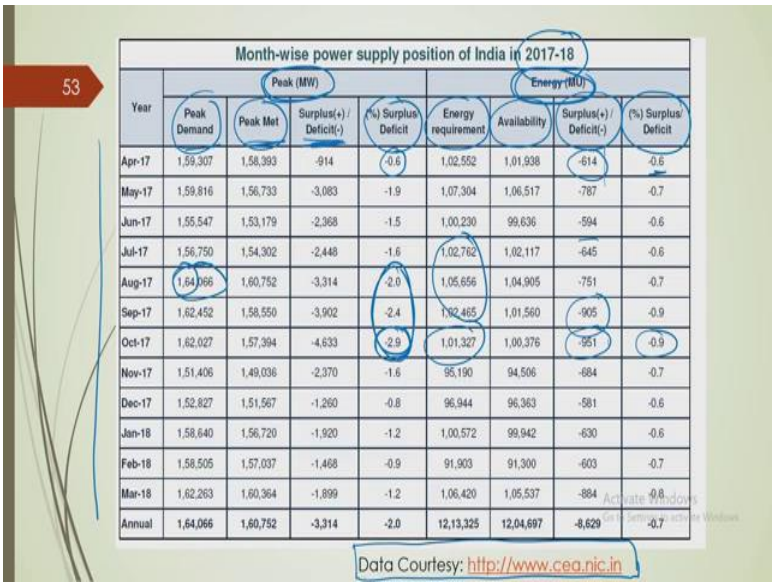

Now, if I give a statistics then probably you will be able to understand. This statistics again I sincerely acknowledge for Central of Electricity Authority India for having this data. So, they have their annual reports from which I derive this data in 2017 – 18. So,

here you can find out monthly peak demand and this peak met ok, and what is the surplus and deficit amount of power that is available and what is the percentage of this deficit and supply, ok.

Similarly, here as I said two important factors; one is peak load demand; another is energy consumption in million units ok. So, here also we have this energy requirement the availability and the surplus of deficit; these are all in million units and percentage of surplus and deficit, ok. So, this is the monthly report for April starting from April 17 to March 18. You can find out that how was the peak load demand of the country.

It is in an order of 159,000 megawatt ok or 159 gigawatt to sometimes 151 gigawatt, sometimes 158 gigawatt, sometimes in 164 gigawatt particularly in the month of August when we have a peak summer in the country and then this basically column second column is representing that how much amount of peak this is the peak demand. Or if you plot this Indian load curve, then this is the demand; this is the maximum demand of all this you know month throughout a particular month.

Now, this second column is representing how much peak was met and this is basically surplus of deficit you can see almost all this month; we have deficit of you know of meeting this peak demand and that deficit normally typically lies from minus 0.6 percent to minus 2.9 percent.

So, these are the times when we have this summer in our country. So, and this October is also festive time of this country. So, power demand increases and so, as the deficit of this meeting this peak demand. Similarly, this energy requirement also if you look at it is higher particularly during this summer time and also this festive time and then it will get reduced when this winter comes in the country.

And, these are the availability of this energy and these are the surplus or deficit energy almost every month you can see we have this deficit of energy and this deficit in terms of a percentage typically lie in between 0.6 to 0.9 percent which is according to the percentage not much higher, but we have in a order of minus 614 to minus 905 to 951 million units of shortage of meeting this energy demand, ok.

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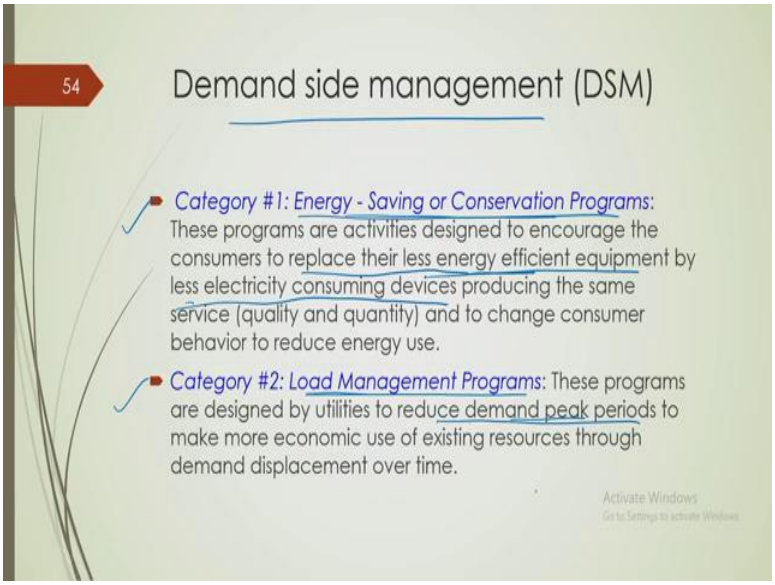

Now, we have some approaches called demand side management. What are those approaches? These are the some programs which we take for energy saving or conservation program or load management program. So, one is these. There are two category of demand side management.

In one category, energy saving or conservation program is taken. This is for example, to replace the less energy efficient equipment by replacing this less energy efficient equipment by less electricity consuming devices. For example, you know some few years back we had incandescent lamp which is now replaced everywhere by more energy efficient lamps ok. Particularly in lighting sector there is a huge change now everywhere you will get LEDs which consume very small amount of power, ok.

Now, there are some approaches or category of load management through which for reducing this demand or peak period ok, alright. So, this will use for existing resources through demand replacement over time. So, this is basically a process through which these customers are encouraged to reduce the demand peak period ok.

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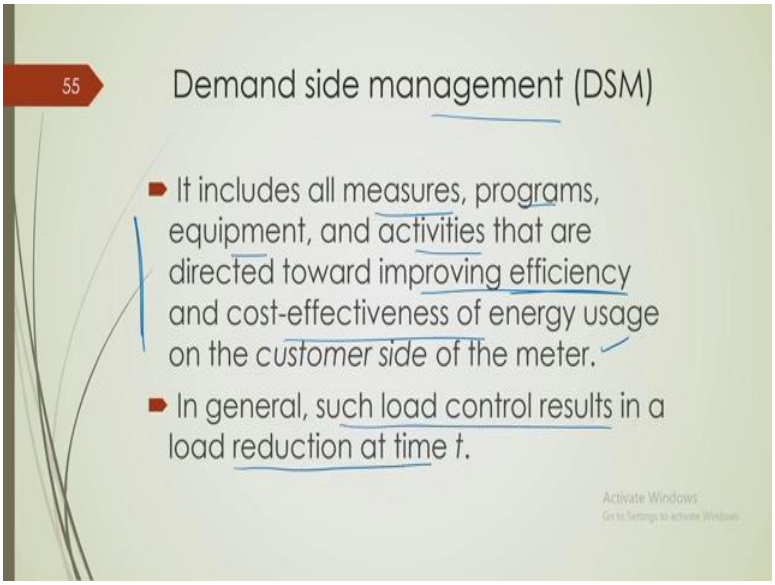

Now, this demand side management includes measures, program, equipment and activities that are directed toward improving the efficiency and cost-effectiveness of energy usage for the customer side of the meter ok.

So, this is a typical definition of this demand side management by which there are some activities by which we can improve the energy efficiency, we can improve the cost effectiveness and we can improve also this our load curve ok. In general such load control results in load reduction at time t, ok.

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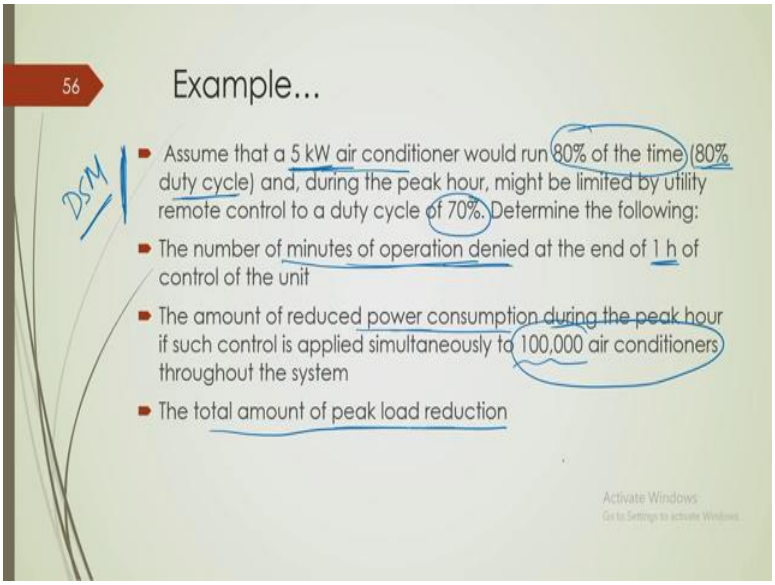

Now, there is an example here ok. Now, we have a 5 kilowatt air conditioner which runs 80 percent of the time; that means, its duty cycle is 80 percent. It on it remains ON for 80 percent time, ok.

Now, if we can reduce this duty cycle to 70 percent ok, so, then what would be the of number of minutes of operation it is denied for 1 hour of time? What would be the amount of reduced power consumption? If we have 100,000 of such air conditioners and what would be the total amount of peak load reduction?

So, we have some air conditioners; it is operated at a duty cycle of 80 percent; that means 80 percent of time it will be ON and I want to reduce this duty cycle to 70 percent. That means instead of 80 percent time, it will be on or, I wish to make it ON by 70 percent. This is a typical type of demand side management; this is a typical type of DSM, ok.

Now, if we can do so, then what would be the number of minutes of operation denied? At 1 hour of time and what would be the reduced power consumption if we have 100,000 of such air conditioner? and what will be the total amount of peak load reduction?

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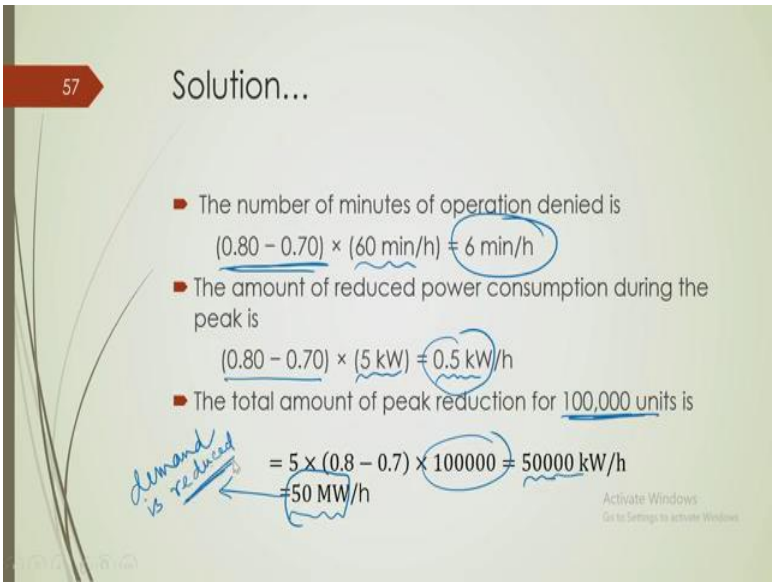

So, it is very simple question, but this will give you some facts; some numerical fact through which you can appreciate that even for the reduction of 10 percent of duty cycle may result in a huge amount of power. Now, if you reduce this duty cycle from 80

percent to 70 percent, then per hour you are denying the operation for 6 minute; that means, additional 6 minute I am forcing this air condition to be switch off or to be non operational ok.

And, this since it is rating is 5 kilowatt this will reduce 0.5 kilowatt of 0.5 kilowatt power per hour ok and if we have 100,000 such air conditioner then if you multiplied this with 100,000 then we will get 5 50000 kilowatt that is eventually equal to 50 megawatt of power which you can reduce, that much of demand is reduced.

And, that will be eventually very helpful to meet this peak load demand. If you look at these statistics which I discuss few slides back that we have not only deficit of energy you know supply, but also we have a deficit of meeting this peak demand ok. So, if we can have typically this type of demand side management, we can shape megawatts of power ok; similarly million units of energy as well ok. Let us continue and finish it by showing you several possible options for demand side management ok.

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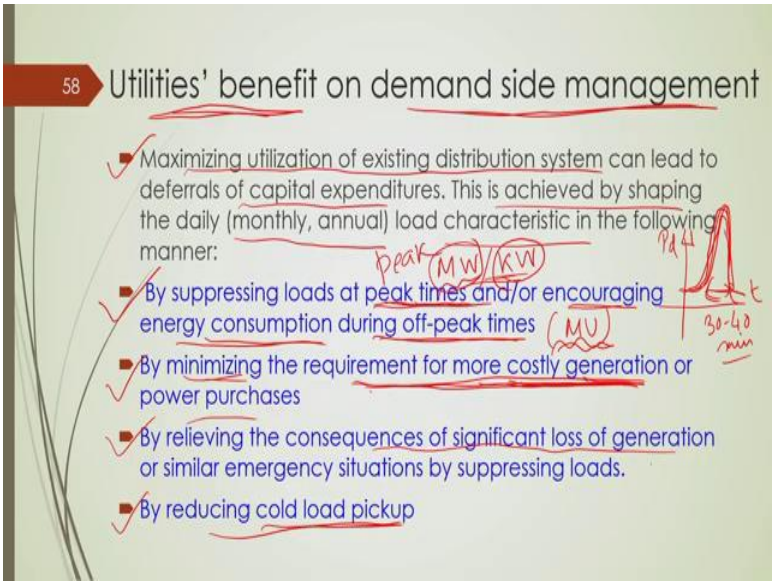

So, before I go to that I should discuss on the utilities benefit utilities benefits on demand side management; that means, demand side management is nothing, but a program for forcing or for by taking some approach you can create your own load curve or you can make your own load curve although the loads are of customers end ok.

So, here it is a program by selecting which you are basically diverting this customers demand in such a way that you can create your desired load curve ok which is basically the main goal for this demand side management for an electric utility ok.

Now, you can see that what are the benefits that electric utility can get. One is first of all this maximizing utilization of existing distribution system which can lead to the deferral of capital expenditures which is very important ok. So, basically if you can shape this load curve according to your desirable shape that you wish to have, then obviously, that you will need you can differ this some of the important or expensive capital expenditure that you need to meet that load curve ok.

So, as you have seen that load curve it is basically depends upon how customers are using their load, ok. Now, there is as such no role for a electric utility for shaping that load curve, but if they can take an initiatives that is such kind of initiative like demand side management they can somewhat influence to shape to make this load curve according to their desired shape ok.

And, thereby they can reduce their or they can basically avoid the need of their expensive capital expenditure I will come to that point ok. And, they can also shape this they can this can be achieved by shaping the daily or monthly or annual load characteristics ok. So, as what I was trying to tell you that it is nothing, but to make this load curve according to a desirable shape.

Or this is nothing, but this program is nothing, but to make a load curve which according to your desirable shape and size and characteristics by forcing this customer by encouraging these customers with some different approaches or some given approaches ok which I will discuss.

Now, how can we do so? We can suppress certain amount of loads particularly during peak hour or peak duration hour or we can encourage this energy consumption during off peak time. As we have seen that two things are you know concerned to us one is you know peak demand that is in power system point of view that is in megawatt or kilowatt.

Megawatt is the level of peak demand for a bigger network, i.e., a transmission network; kilowatt might be a you know a peak load for a small distribution network ok. So, this we need to reduce. This is basically peak megawatt or peak kilowatt ok and also utility

should encourage this energy consumption ok during off peak hour and this thereby they can shape the units of energy or million units of energy which is mu.

In fact, I have my last lecture. I have shown you that for a utility point of view there are two concerns. One is to meet the total energy demand of the customers that is in terms of million units and one is to meet the peak load demand which is in megawatt ok for a bigger network and these two are the bigger challenges.

And, that is why you know this sort of arrangement this demand side management is done to you know reduce or to minimize these two aspect – one is megawatt demand; one is million units of energy ok. Now, if they can do so, then they can reduce or they can minimize the requirement of more costly generation ok or maybe power purchases from the neighboring grids, ok.

Now, how can they avoid this costly generation? As you know that if your load demand or this peak load demand, it is very sharp peak ok, so, during that time there are two options for an utility operator. One is either they can schedule the generation such that it can meet that load demand or they can go for load curtailment, ok.

The second option is somewhat not much you know encouraging options because load curtailment again gives some sort of less reliability of your system or it is something that a customer should not welcome ok.

So, therefore, they have to meet this a sharp peak demand a sharp peak demand like this so, a sharp peak demand. Now, in order to meet this sharp peak demand, so, suppose this is power demand with respect to time and these sharp peak demands may sustains for few minutes maybe half an hour or 40 minutes. But, either you have to reduce that peak or you have to schedule the generation such that it can meet this peak demand. There are two options left for an electrical utility operator.

So, therefore, in order to schedule this generation such that it can match this sort of load demand an electric utility use often the costly generation option like one of the costly generating option is diesel generator for our country India.

Because diesel is a costly item, ok and its generation cost/generation price is much higher, but there is a advantage that it is a quick starter. You can start within few minute

and accordingly you can utilize it during this peak hour, but it is a costly generation option.

But, eventually if you can shape this load curve according to your generation available, then you need not to exercise this option like costly generating options ok. And, also you can relieve the consequence of significant loss of generation ok. If you can shape this load curve in such that it is less than your available generation and then even if there is a loss of generation if a generator trips these existing generators can match the load demand ok.

And, also it reduces the need of cold pickup what is cold pickup. Cold pickup is the basically process to start a generator at the very beginning condition or that means, that you do not have the generators in running condition you are starting it at the very beginning condition.

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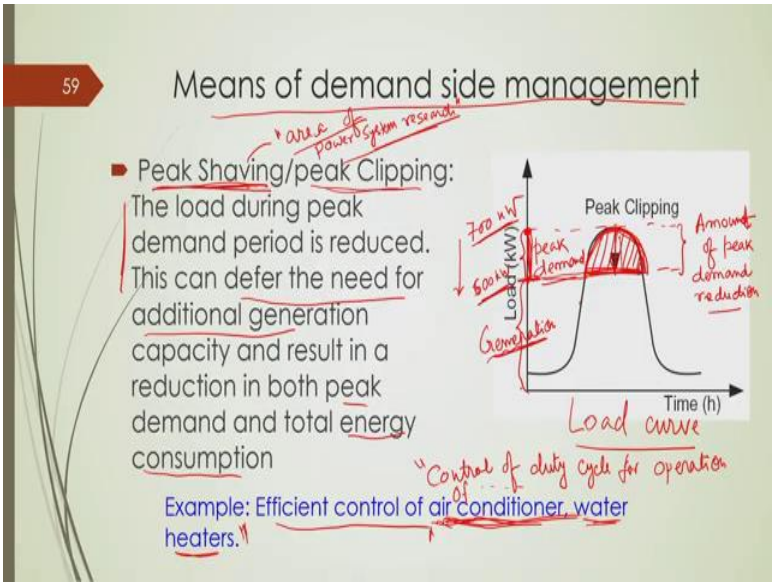

Now, what are the approaches for this demand side management? Ok. So, here you can see there are many approaches I will try to discuss this one by one. The one of the approaches is peak shaving or peak clipping that means that suppose this is my load curve; this is my load curve and this is of course, this peak ok. So, this is my peak demand this is my peak demand.

So, if you can reduce this peak demand according to this arrow for some extent like this person then obviously, your peak demand will reduce from this value to that value; that means, that is the amount of peak demand you can reduce. So, this is amount of peak demand reduction, amount of peak demand reduction.

Then if you can reduce that much of peak demand, then you need only that much of generation that much of generation to meet this peak load demand. So, you need that much of generation which is lesser than this value of course, ok. Now, this is an advantageous for utility, ok. So, if you can cut down if you can clip or if you can shave this peak demand to some extent then they need to have that much of generation and that is of course, an advantageous ok.

Now, based upon this peak shaving; peak shaving is again one area for area of power system research. So, peak shaving is an area of power system research ok; peak shaving or peak clipping it is an area of power system research and there are several approaches. If you make a literature review you will find there is a voluminous you know literature exist on this particular topic that is peak shaving of by you know power system load ok.

Now, if you can reduce this amount of load, then you can also defer the need of additional generation as I was talking about. For example, suppose previously this load demand was 700 kilowatt ok and if you can reduce this peak demand to 500 kilowatt or maybe 600 kilowatt then it means that as if that you avoid the need of 100 kilowatt of generation.

So, that means, you need to avoid this additional 100 kilowatt of generation ok. So, if you do not do so, then either you have to have this additional 100 kilowatt of generation or you need to curtail this load. So, there are two options only left. Now, in order to meet this you know 700 kilowatt this extra 100 kilowatt from where it will come? Either you have to establish a new generation unit or new generators or you have to purchase in higher cost from the other you know neighboring rates.

So, both options are costlier options and you can defer this now how can we reduce this sort of peak demand. In fact, this peak demand reduction also leads to significant amount of energy consumption. This energy is, as I have shown you in the hatch area, in the shaded area ok.

Now, how can we do that? There are many ways of doing that and people are you know proposing different approaches. One of the approaches is efficient control of air conditioner, water heaters. So, these are the two types of loads that we normally you know use during this peak demand time.

For example, in India, when we have very hot summer we use this you know air conditioning system to large extent and this increases our overall load demand. And, that is why you know in this peak load curve you have a significant amount of or significant portion of this your air conditioning load ok. So, this peak demand accounts for significant amount of air conditioning load during hot summer in India ok.

Now, if you can control this air conditioner you have I have given an example. If you can have a access that you can control this ON and OFF of the air conditioner or rather you can control the duty cycle of the air conditioner then obviously, you will be able to cut down this peak; you will be able to reduce the peak.

Similarly, you can also control this duty cycle of this water heater, as well. So, if you can control this if you have control of duty cycle for operation/of operation of you know air conditioner and this water heater, then you will be come up with reduced amount of peak demand ok and that eventually results in your shaving of this peak demand ok. So, this is one of the approaches.

Now, how do you control this? What sort of infrastructure development is required to control such air conditioner? Because, air conditioner is at customer end and its operation now I mean still now it depends upon the customer's choice, but utility do not have any option to control the air condition. They cannot simply tell the customers, ok, I have peak demand, so, you need to reduce this or you need to control your air conditioner nobody will listen.

Unless this utility has some access or some control of this customer's air conditioning system to regulate their operation, this is not possible. Now, what sort of infrastructure we require? What sort of additional control logic is required? All these things are of research problem and people are working on this.

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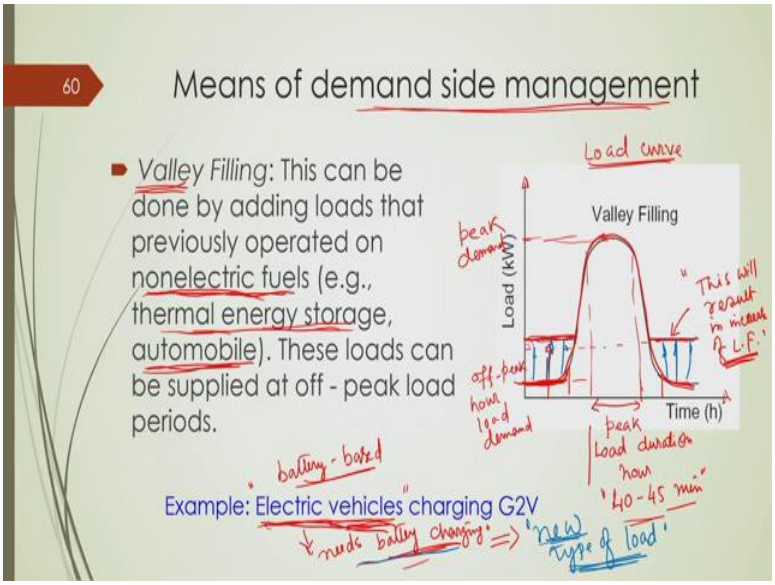

Now, this is another type of demand side management, another approach for demand side management which is not related to the energy consumption or neither it is related to the energy consumption nor it is related to the peak load consumption rather it is related to fill the valley.

You look at this load curve; you look at this load curve ok. In this load curve what you can observe that this is the load curve. So, one thing you can observe that you have a very less off peak hour load. So, this is my off peak hour load off peak hour load demand and we have a very sharp peak. This is your peak demand and you know this peak demand sustains for some small period of time. This time is basically peak load duration hour.

And, this normally peak load duration hour as you know is normally a few minutes, i.e., may be 40 to 45 minutes or maybe even 1 hour to 2 hours. So, in 24 hours this duration is very small ok and thereby if you have such kind of load characteristic, your load factor will be poor because your average load will be much lesser than this peak demand.

So, average demand will be somewhere here ok. So, if you know that load factor is a ratio of average demand to the peak demand. So, if average demand is much lower than the peak demand obviously, this load factor would be poor; that means, most of the time of a day the utility needs that much generation only and only for few minutes they need that much of generation which is much higher.

So, it is basically not economical options for the utility because they have these generators during most of the time of the day; their generations need to be cut significantly and only for few minutes they need to be at their peak value or rated value ok. So, this is not an economical option because every generator has some efficiency and that peak efficiency occurs at certain amount of load demand ok.

Now, this off-peak hour sometimes called valley of this load characteristic and if you can increase this valley to some value like this then obviously, this will result in increase of load factor ok. So, if you can increase this off peak hour load demand or valley to some extent, then you will be able to increase the load factor. So, this if load factor increases so, this would be you know beneficial for the utility.

Now, the question is how can we do so? Because, again load as you know it is not in the hand of the utility ok. So, what we can do? There are various options available; one is that some of the loads are still non-electrical loads ok, for example, you know thermal energy ok.

Thermal energy is not an electrical load; those countries which need heating, i.e., space heating, they can either do it from by using electrical appliances or by direct transferring and direct you know heat transfer.

So, this you know thermal energy if you can convert to the form of electrical energy then you can fill this valley ok and also there is a you know huge energy demand in the automobile sector and this automobile sector till today mostly operates in fossil fuel based IC engines ok internal combustion engines which are not related to any electrical demand.

But, things will slowly change to this electric vehicle. Now, you know you might be having this term known to us at least for us if you go for a any newspaper article or various news will come in media that electric vehicles would be the future to replace the existing IC engine based automobile industries ok.

So, one of the forms of this electric vehicle is battery based; so, battery based electric vehicles. Those electric vehicles need some charging. So, they need battery charging. So, when they need a battery charging, this will come as a new type of load. So, this will come as a new type of load.

And, the question is how can you charge this battery? When you will charge this battery? When you will charge this battery based upon that this you know load demands of this battery charging will vary.

And, if you can encourage this customer for filling this valley during this you know off-peak hour by charging this their battery then this will be beneficial for the electric utility ok. They can increase the load demand during off peak hour and they can utilize their generation available during off peak hour ok.

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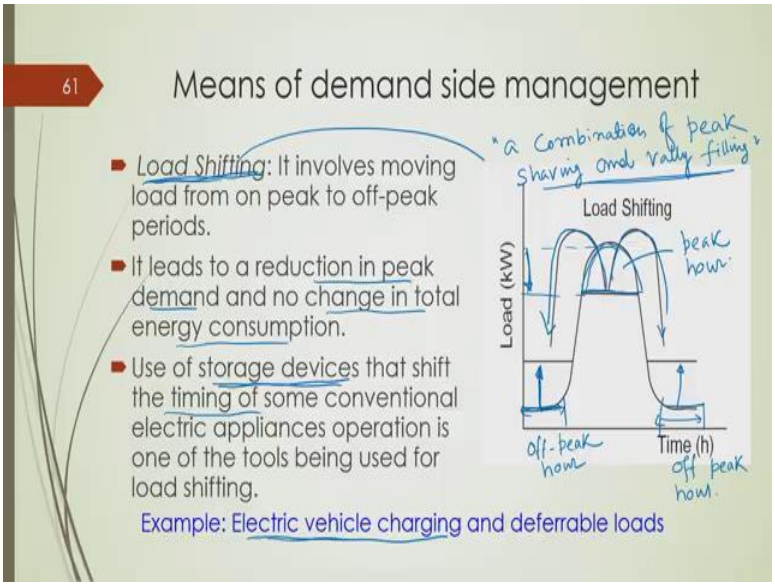

The next one is, off course, load shifting; load shifting. Here, there will be certain amount of loads which will be shifted from the peak demand to the off peak hour. So, these loads were initially at peak hour. So, this is peak hour and these are off peak hours. So, these are off peak hours. So, these are off peak hours ok.

Now, if you can shift, you are not basically denying; you are not asking here for this program not to operate this load, rather you are shifting the timing of this load demand from this peak hour to the off-peak hour ok and it will reduce your peak demand; but no change of the total energy ok.

So, there are two advantages for this type of program. One is peak demand will reduce from this value to that value, whereas this off peak hour demand will increase from that

value to that value ok. So, this program is basically a combination of you know peak shaving and valley filling.

So, this is a concept which can do this dual purpose. So, they can reduce this peak demand to that much they can increase this off peak demand to that much. So, you have both the purpose which will be fulfilled and how can you do that? So, use of storage device you know that can be that can shift some you know timing for this energy.

So, one of the such kind of things is electric vehicle charging. Again, you can instead of asking for charging in the peak hour you can shift it to the off peak hour. How can you make that? You can make some sort of incentive. So, that customers will be interested to this charging in the off peak hour rather than peak hour ok.

You can make different energy pricing in off-peak hour charging and peak hour charging and thereby you can motivate this customer to use their charger during off peak hour which will make this dual benefits, ok alright. Alternatively, you if you have some storage devices you can store this energy during off-peak hour by charging the store storage device and that energy you can utilize the during peak hour ok.

So, charging of storage device can be done in during off-peak hour and this storage device will act as a source of energy during peak demand. So, thereby it will fulfill the both the purposes.

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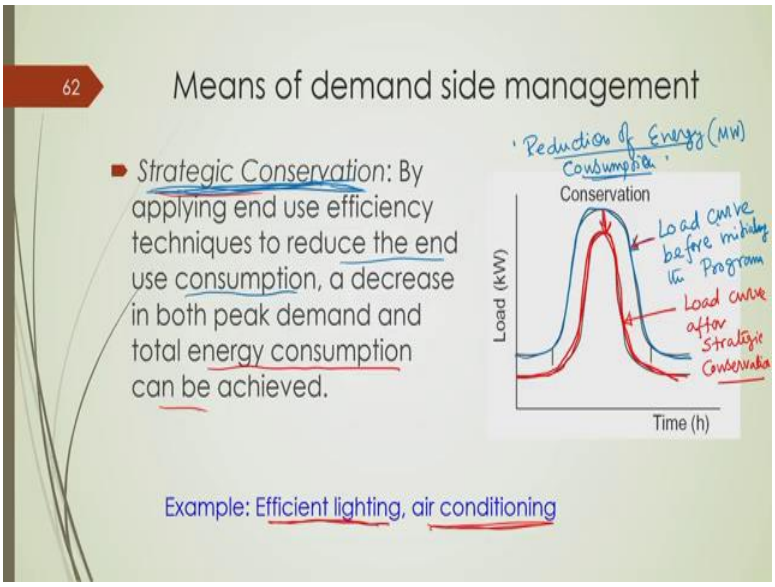

Now, there is another form of you know energy management system which is called or demand side management which is called strategic conservation, ok. By doing so you can reduce the energy consumption ok; reduce the energy consumption. So, this is a way of reduction of energy consumption; energy you can write it in terms of megawatt ok.

So, this is the process of reduction of the energy ok; directly you can ask customer to make some changes so that overall load curve which was previously that this one, so, this was probably the load curve before you initiate this program; so, load curve before you know initiating this program and this is the load curve after initiating this program.

So, this is load curve after strategic conservation ok. So, this was your previous load curve and this load curve you are basically shaved; you can basically make the shape of the load curve same, but you reduce the load demand at each and every time not only during peak hour, but also in the off peak hour, so that this original load curve is shifted to this much ok.

And, this will reduce significant amount of energy ok. How can you do that? You know that lighting load is something which is changed; see in fact, drastically during last 10 – 15 years ok. So, what was that lighting load 15 – 20 years back? It is completely changed. That sort of light does not exist nowadays ok. Previously we have, we used incandescent lamp for domestic lighting ok.

And, nowadays everywhere you can see LED ok which is much energy efficient ok. If incandescent lamp consumes 100 watt, your one LED of let us say 15 – 20 watt can give you similar type of lighting in a similar or better lighting ok. So, lighting load is something which you can do; we can replace by efficient you know lighting system and thereby you can have this program strategic conservation.

Similarly, air conditioning also are changing. In fact, refrigeration also they are more and more energy efficient now-a-days ok. So, these are the appliances which will make your strategic conservation successful ok.

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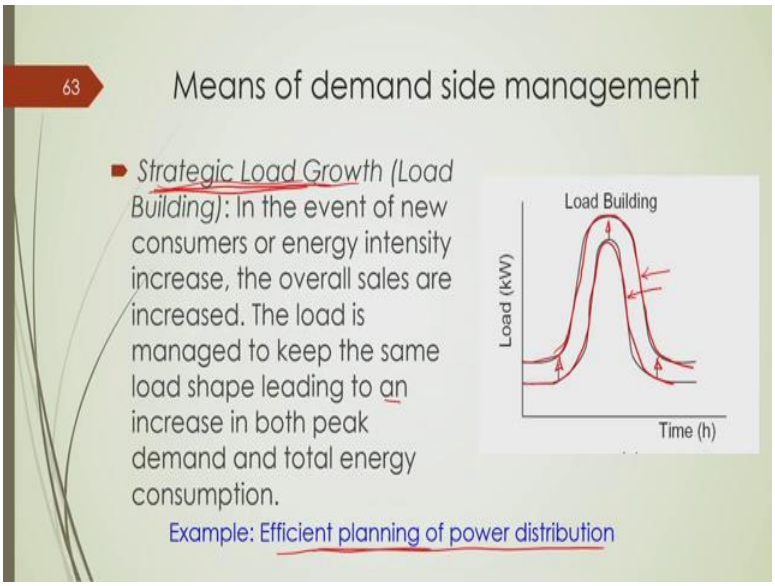

This is a different kind of demand side management program which is called strategic load growth. In that load growth load, as you know it will grow over the year and accordingly we have to set up all our infrastructures, so that our infrastructure for electrical utility point of view can meet that load demand.

Now, the question is how this load is growing? Again, that is also not in hand of this utility ok. So, this is based upon their customers and the new customers which will come in picture in future and new sort of appliances also ok and their usage, their timing, etc. So, but if you make a strategic load curve so that strategic load growth so that your overall this load curve which was previously that much is shifted according to what you what you want.

It is shifted to in this upwards so that you know the new load curve it is e the same shape, same shape and also the same kind of load factor, ok. So, what was the load factor is here and what was the load factor there are almost same; only thing is that this load is increased.

So, if you can make your strategic load growth like this then you will be able to somewhere you know a planned way of increasing your infrastructure, so that this will be capable to meet your future load curve, ok.

And, this program you can do by efficient planning operations for power distribution systems including this customers' load demand ok and also you can make your network expansion in such a way that load demand will be as per your desirable values.

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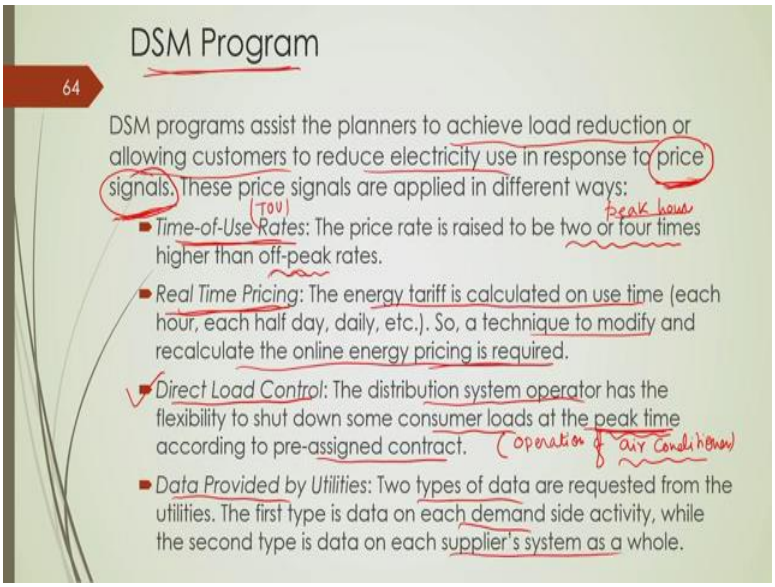

Now, these are the previously whatever I discussed they are the part of your DSM programs ok and these DSM programs will assist the planner to achieve load reduction or allowing customers to reduce their electricity use, ok. And, one of the aspects by which you know you can make your demand side management program (DSM program) successful is by devising a proper pricing energy pricing signal ok.

Now, as I said this how the customers will use their load, and what sort of appliances when they will use, – these are not in the hand of the electric utility. But, you can devise a pricing signal so that you can motivate this customer indirectly to reduce their consumption during peak or in order you can encourage the consumption during off-peak or shift by shifting this load all these programs can be successful with a proper energy pricing signals.

And, there are many types of energy pricing possible; one is called time of use rate TOU ok which is you know you can make this energy pricing during peak hour. So, peak hour pricing can be 2 to 4 times than the off peak hour. So, this will be the peak hour pricing or peak demand pricing can be much higher than off peak hour.

Then, automatically the customer will be diverting or, will be started diverting some of their load from this off-peak hour to the peak hour ok. Real time pricing is another approach, ok. So, in this approach, the energy tariff is calculated on the use time that when you are using ok, so, a technique to modify and recalculate the online energy pricing ok.

So, here the pricing will be time dependent ok. So, whenever you are using that particular appliance accordingly at what time you are using based upon that your energy pricing will be decided. Similarly, direct load control is another approach I was talking about; if this distribution system operator, they if they have direct access to the consumer load and they can regulate it during peak time for example, this you know the operation of operation of air conditioner.

So, you can regulate the operation of air conditioner particularly during peak time, so that you know you can reduce the load in significant amount, but this need some pre assigned contract to the customers and also this needs some changes of the infrastructure because at the present infrastructure utility does not have any access to the control of any sort of appliance of a customer.

Now, also these utilities, they need to provide two types of data ok; one is the demand data, another is the generation-supply data ok and then accordingly this you know pricing signals can be decided.

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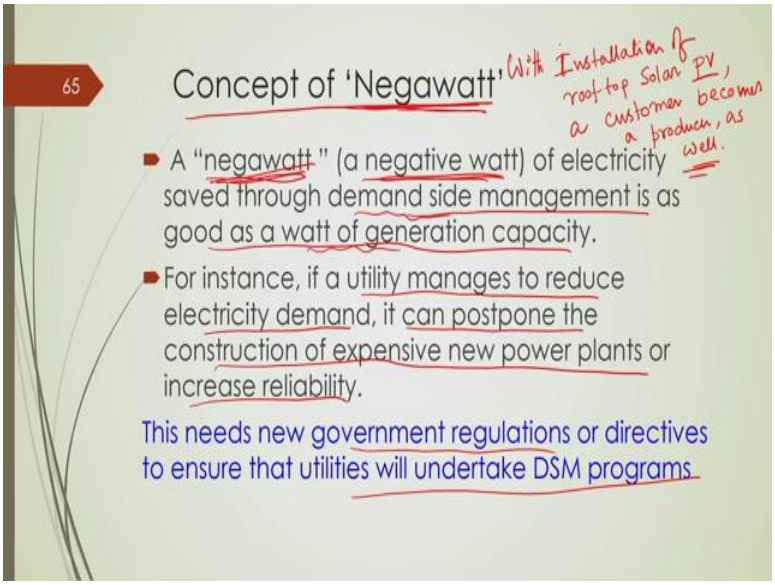

Another concept is negawatt, ok. So, you might be observed this thing in some of the textbook. What is that concept? This concept is basically when you have a negative demand? when you have a negative demand and you know customers they might have negative demand. Negative demand means they are basically as if they are providing some generation back to the utility ok.

And, how it is possible? if a customer has a proper generation infrastructure and this is possible. How it is possible? You know that if you have a rooftop solar PV, then you know a customer can also be a energy producer. So, with the installation of installation of rooftop solar PV a customer with the installation of rooftop solar PV, a customer becomes a producer as well ok.

And, thereby it can you know have a capacity to sell the energy to the utility. So, negawatt is basically a negative watt of electricity shaped through demand side management is a good as a watt of generation capacity ok. For instance, if a utility manages to reduce electricity demand it can postpone the construction of expensive new power plants or increase reliability, ok.

So, negawatt is basically a concept that you are basically with that any sort of demand side management you are providing a negative watt ok. It means that it is as good as a watt of generation capacity. It is as good as a watt of generation capacity ok. Now, how can we do that? We have already discussed all these things in previous few slides that how can one customer can be participated in demand side management ok.

So, this needs new government regulations or directives and also the utilities need to undertake the DSM program. It is as good as one shaving of one unit of energies as good as you are having one unit of generation, ok.

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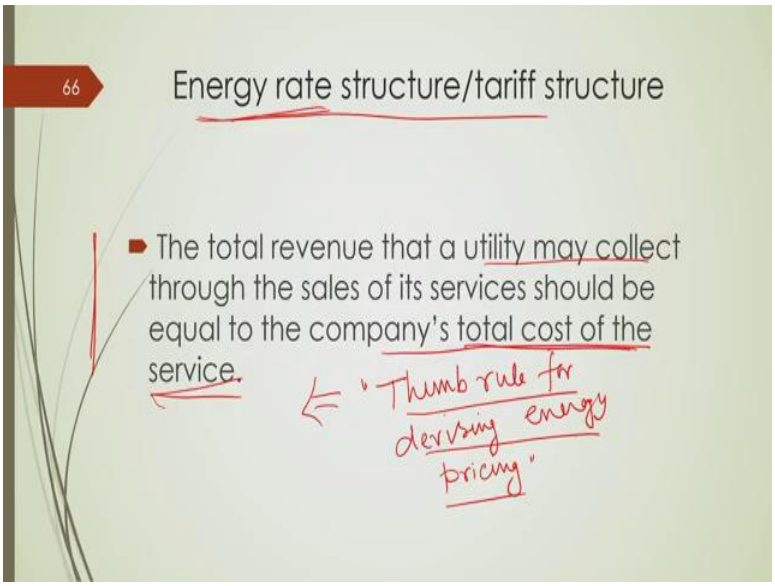

Now, we will discuss this energy rate structure or tariff structure. A total revenue that a utility may collect through the scales of service should be equal to the company's total cost of the service. So, this is how this energy rate. This is the thumb rule for devising these energy pricings. So, this is basically thumb rule for devising energy pricing ok. So, this is thumb rule for devising energy pricing.

And, a utility may collect this price, based upon that how much cost it requires to provide that particular service because in fact, this electricity business also a profit making business. So, you as an electrical utility, you should devise a pricing strategy so that it can get the amount of money they are investing back ok.

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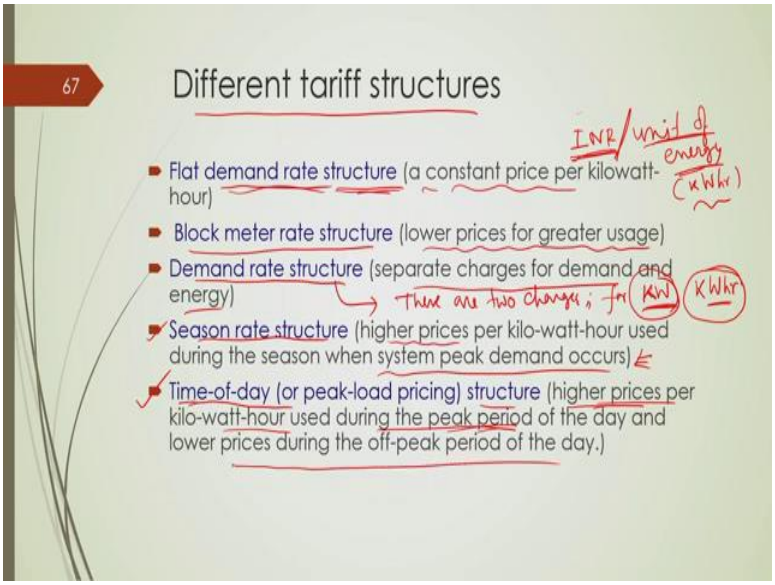

Now, there are different types of tariff structure – one is called flat demand rate structure or constant pricing per kilowatt hour. This means that irrespective of you know your energy consumption, the pricing will be fixed. So, this will be that much of rupees INR per that much of unit of energy.

Now, by the way this unit of energy we make means that 1 kilowatt hour of energy ok. Now, based upon this, you know flat demand rate structure, we have a fixed INR or energy pricing in Indian rupees based upon a per unit energy consumption. Similarly, block meter rate structure, in this structure, lowest prices would be for greater usage ok. So, for industries and bulk customers this pricing will be lower, so that we can encourage their consumption ok.

For demand rate structure, separate charges for demand and energy. Basically, in this structure there are two pricings. There are two pricing; there are two charges. One is for kilowatt consumption another for kilowatt hour consumption ok. So, based upon your connected load or connect your demand, your one pricing will be that much of prices per kilowatt and based upon your net energy consumption; another part would be that much of you know price per kilowatt hour consumption ok.

Also, there is one season rate structure here; higher prices per kilowatt hour used during the season when system peak demand occurs. So, based upon seasonal changes pricing will be decided and finally, this time-of-the day tariff structure is higher; this prices per kilowatt hour used during peak period of the day and this will be higher you know; that

means, during peak demand prices will be higher and off-peak demand prices will be lower ok, so, which I was also talking about in a couple of minutes before.

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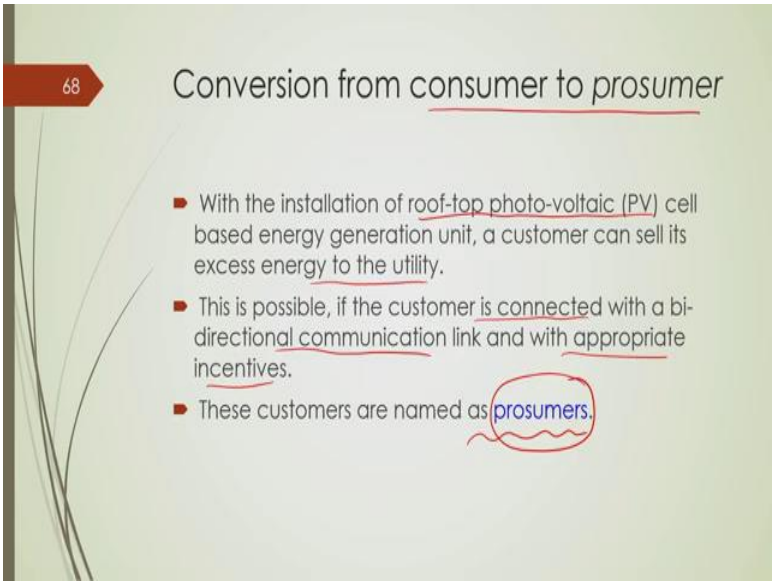

Now, which I was telling in that particular concept that consumer to prosumer; it means that with having this rooftop photovoltaic cell installed, a customer can sell excess energy to the utility ok. So, it means that you are not only shaving this energy, but also you are basically producing the energy as well.

And, this is possible if customer is connected with proper communication link and appropriate incentives ok; then only the customers will be interested to install their you know rooftop PV on their top of the house and they can participate in selling this energy.

These customers are called prosumers; prosumers means their electricity producer, as well ok; for those customers who will consume as well as produce called prosumer ok.

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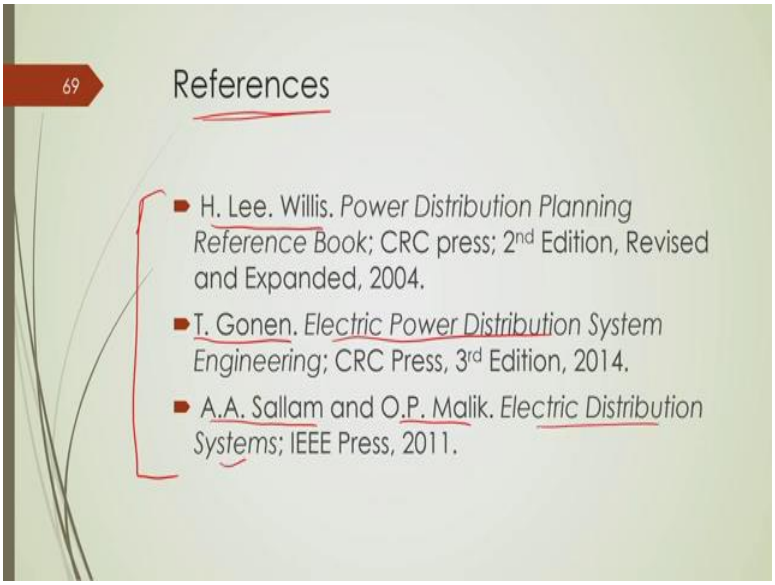

So, we come to the end of this part of this lecture and for this lecture I preferred for these three books. One is this H Lee Willis book; then Turan Gonen's book Electric Power Distribution System and also Sallam and O. P. Malik's book on Electric Distribution System. So, I sincerely acknowledge that many of the concepts which I discussed in this module 1, are taken from these three books ok.

Thank you finally, for attending this module 1.