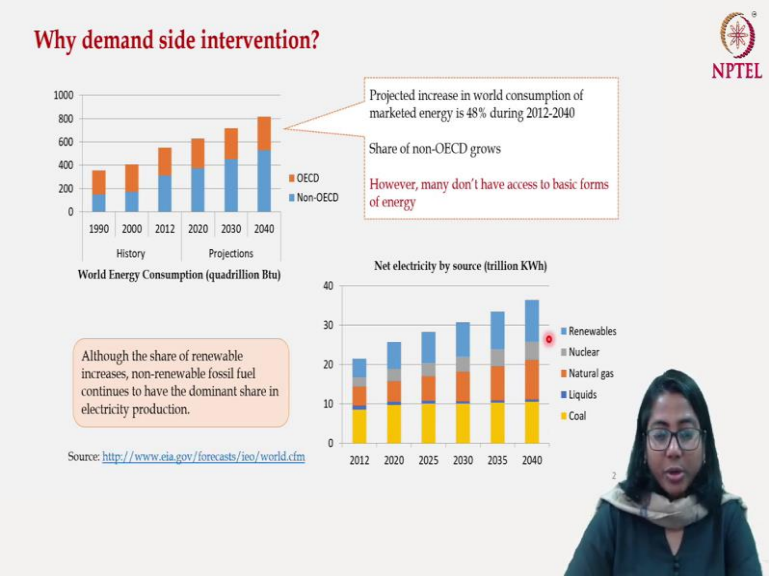
**Energy Economics and Policy**
**Prof. Shyamasree Dasgupta**
**Department of Humanities and Social Sciences**
**Indian Institute of Technology, Mandi**

**Week - 03**
**Energy Demand Part II**
**Lecture - 01**
**Demand Side Management**

Welcome to the 3rd week of the course Energy Economics and Policy, this week also we will continue discussing various topics on Energy Demand and in this lecture specifically, we are going to talk about Demand Side Management (DSM).

(Refer Slide Time: 00:15)




So, as the word suggests, 'demand side management' has to do with intervention through the demand side so that at the end there is a reduction in the energy demand. Now the question is: why is it so important to walk through the path of demand?

Why do we want to make an intervention through a reduction in demand or to make demand more efficient? The reasons are like this: if you look at the projected energy demand growth for the world, you will see that during 2012 - 2040, the predicted growth rate is about 48 percent. Now that you have already gone through the concept of growth, this is the total growth rate that is anticipated to happen between 2012 and 2040.

Now, where does the energy demand mostly come from? You can see that the energy demand is mostly going to come from the non-OECD countries because of an increase in their process of development, the rate of growth, and so on. So, energy demand is going to go up in the future.

However, one point of caution that I would like to make, although the energy demand is going to go up and the use of electricity and other energy is expected to increase in the future; however, till now we have a lot of households and a lot of geographical areas, that are yet to be covered by electrification or they do not yet have the access to the basic forms of energy.

So, increasing energy demand does not really mean that the distribution of the demand will be equitable. This is just a passing remark which is important to take a note of. The point is that the demand for energy is going to increase. Now, how are we going to support this increase in demand? The other projection by IEA, says that the electricity will be generated mainly by fossil fuels during the same period of time.

So, if you look at this graph you can see that the yellow part represents coal, then you have some oil and the blue part is natural gas. So, even during the period between 2012 and 2040, there is an increase in the production of electricity, although the share of renewables is going to increase but it's going to be mostly dominated by non-renewable fossil fuels.

The supply will increase maybe to commensurate with the demand. However, the problem is that most of the supply will come from fossil fuel sources. Therefore, there are are scopes to intervene either through the demand or through the supply side. However, if there is a reduction or management of demand that will reduce the pressure on the supply side of the energy sector. For more information on this, you can visit the website from IEA.

(Refer Slide Time: 03:19)


Next we move on to understand what is demand side management? When you want to manage the demand of various producers and consumers, what exactly do you do?

The demand side management of energy encompasses a series of systematic activities taken up by the power utilities and the government in order to change the amount, intensity and the timing of energy use in a very sustainable manner. The definition takes into account two entities: one is the power utilities and the other is the government.

Who are the power utilities? They are the producer and the distributor of power and the government is the one who is formulating the policy and sending the mandates. It also talks about three components of demand side management: the amount of energy that is being consumed, the intensity of energy and the timing of energy use.

These are the three main components that are managed under the demand side management. Sometimes we feel that it is only the reduction of energy demand, which is the motto of demand side management but it is not so. Demand side management is a broader concept as compared to demand reduction, it is more about management in a sustainable manner and it should not be such that the reduction of energy demand is done in a manner that growth of the country or the development process of the country is hampered. For example, in India we cannot say that we want to reduce the consumption of electricity in the household sector, where the

consumption is already very low. There are a number of households who do not have access to electricity and for them probably reducing electricity is not a demand side management in India.

Here is an example that can bring out the difference between the reduction in energy demand and energy management. So, here I quote Jimmy Carter, who in 1977 being the president of the United States of America made this comment. Note the timing of the comment, It was 1977. This is the post oil price shock period when the oil price shot up and the US was going through a crisis situation with a shortage of oil supply.

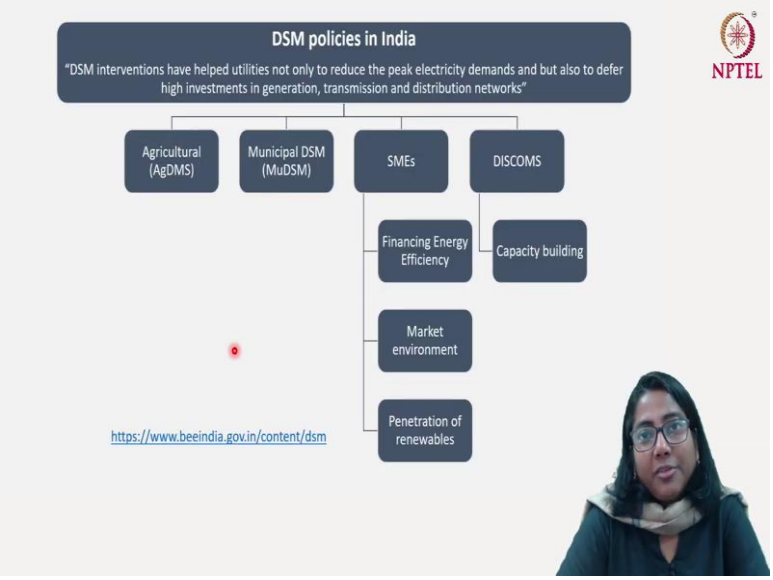
The statement made was: “All of us must learn to waste less energy simply by keeping our thermostats for instance at 65-degree Fahrenheit in daytime and 55-degree Fahrenheit at night and we could save half the current shortage of natural gas”.

Here he is trying to say that, in the colder parts of the USA if they reduce the indoor temperature, it is going to reduce the load on the electricity production. The interesting fact is that two things need to be taken care of here, but if we think whether this actually talks about the demand side management or not?. The answer is probably the No, reason being that, if a particular section of people is used to a lifestyle of staying in a warmer house, then suddenly reducing the indoor temperature will affect their lifestyle. This is one factor because 55-degree Fahrenheit is almost 10-11 degree Celsius, which at night is pretty cold inside. The other factor is that, the electricity is produced to necessarily support the peak load.

If you reduce the electricity consumption during night or at some other point of time of the day where you do not have a peak load, then it may not lead to the use of gas for the electricity production. Therefore, before saying whether this is a demand side management policy or not, one needs to understand what is the load curve of this particular area? The point being that demand side management is a much broader concept as compared to only demand reduction.

When demand side management started a few decades back, it was more like a government mandate. It came from the government as a mandate and there were not many business model ideas for its implementation. Later, it was realized that if an incentive-based mechanism and a sustainable business model wasn’t created, then it will be difficult to sustain any demand side management. It is so because as a consumer or as a producer if one does not see any incentive then he is not encouraged to go for the demand side management. Thereby, meaning that being guided only by mandates is a little bit tricky and there comes the role of economics.

(Refer Slide Time: 08:35)




Further in this lecture we are going to briefly discuss few important demand side management policies taken up in India. It will give us a broader picture regarding understanding of demand side management policies. In India on the website of the Bureau of Energy Efficiency (BEE) under the Ministry of Power, you can get a lot of resources and a real understanding of the policies related energy domain in India. BEE has a dedicated page on demand side policies in India and it is quoted from this website, 'The demand side management interventions have helped utilities not only to reduce the peak electricity demand but also to defer high investments in generation, transmission and distribution networks.' This is essentially what we have discussed in the first slide, that if the increase in demand can be curtailed then there will be less pressure on the electricity production sector. It is not only about reducing the peak load but also avoiding the capacity addition to the power generation sector. The investment that is needed for capacity addition in the power generation sector is actually huge. It has implications both for saving fuel as well as saving the fund that is needed for the investment.

There are four focus areas in the demand side management policies by BEE in India. The first one is the agricultural sector, AgDSM, discussed further in details. The second one is the municipal demand side management, yet to be implemented but the groundwork and studies have been done. AgDSMs is mainly for the agricultural sector in rural area and municipal DSM is mostly for the urban area. Other than these, the other two focus areas are, demand side management in small and medium scale industries and demand side management in the DISCOMS.

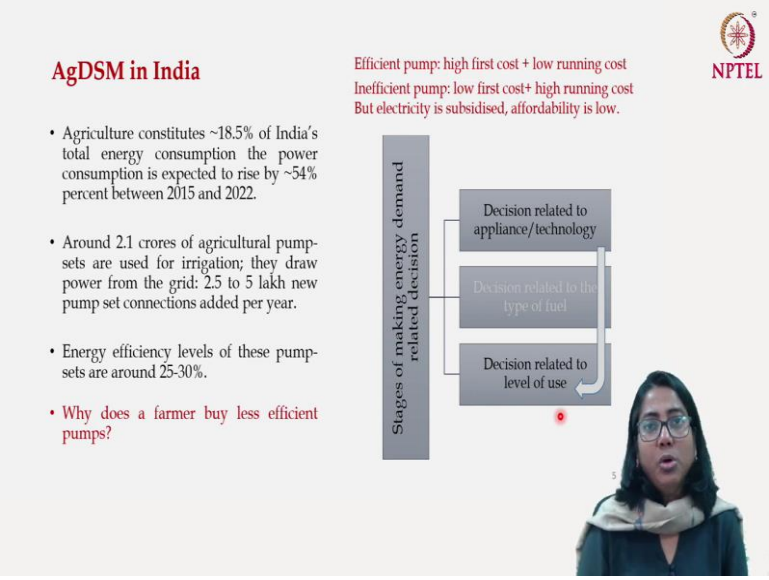
The small and medium enterprises in India face a lot of inefficiency due to shortage of fund, advisory etc. BEE has identified three ways to penetrate the demand side management in the small and medium enterprises.

The first way is financing energy efficiency because the equipment that is required to promote energy efficiency is costly. You can recall the discussion we had last week on the substitution between capital and energy. If you want to go for energy efficient equipment then your capital will go up, capital investment will go up whereas your energy demand is going to come back. This investment in energy efficient equipment is a one-time investment but a lot of funds is needed for this. The short and medium enterprises often face a scarcity of funds to promote the energy efficiency in their practice. Thus, this is one channel of intervention. The second way is to give them a proper market environment where they can understand the incentives that can be generated from the implementation of DSM policies. The third way is the penetration of renewable energy in order to make the situation conducive for small and medium enterprises to shift towards electricity generation by renewable sources. This is fuel shift, a substitution of one fuel by the other. It may be not exactly the fuel shift as you are using electricity, though you are substituting the source of the electricity generation.

The final focus area of BEE is the demand side management in DISCOMS. These DISCOMS are the distribution companies for the power sector. In this case the demand side management comes in the form of capacity building.

Now, we are going to look in more details the most important demand side management policy in context of India, that is the agricultural demand side management policy.

(Refer Slide Time: 13:03)




We will have a look at the situation in the agricultural sector and why it is so important to talk about the demand side management in the agricultural sector?

Few facts, the agricultural sector in India constitutes almost 18.5 percent of total energy consumption. The power consumption in this particular sector is expected to grow at 54 percent during the period 2015 to 2022 (By mistake has been mentioned as 2020 in the video lecture). This 54 percent rate of growth is not the annual rate of growth, this is the total growth that is expected to occur between 2015 and 2022. You can recall the concept of total growth rate that had been discussed earlier in this course.

Where does this demand come from in the agricultural sector? This demand mostly comes from the use of pumps for irrigation. Agricultural pump is the main source of energy demand in the agricultural sector. There are around 2.1 crores agricultural pump sets that are used for irrigation in India. All of them are connected to the grid and are drawing power from it. Every year almost 2.5 to 5 lakhs of new pumps are being added to the system but the problem is that all these pumps are less energy efficient. The energy efficiency level of these pumps hover around between, 25 to 30 percent but not more than that. The agricultural sector uses a lot of pump sets for irrigation; however, these pump sets are not energy efficient and therefore use a lot of energy to produce the same amount of output.

This takes you back to the concept of energy intensity. The energy intensity for irrigation in the agricultural through the use of these pump sets is very-very high in India.

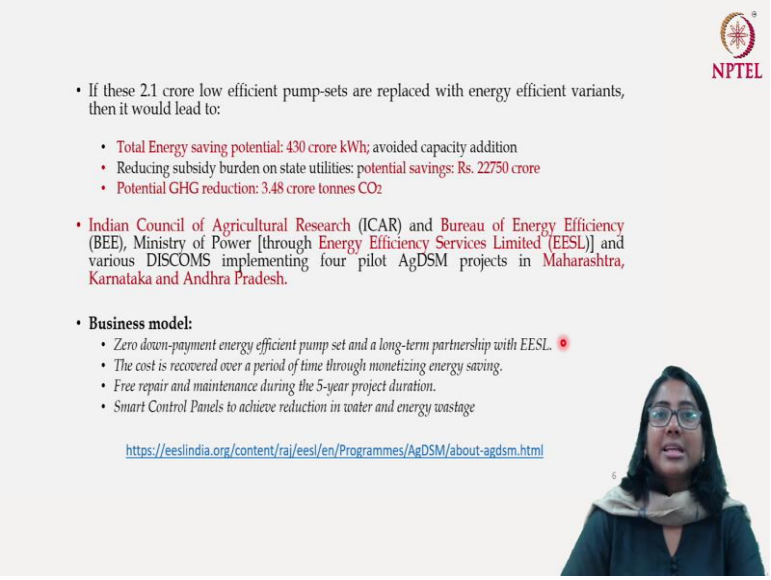
The question arises: Why does a farmer buy the less energy efficient pump sets? We go back to the formulation in the last week about the different components that the consumer takes into account when deciding about the use of energy. We are not discussing about the type of fuel because all the pumps are using electricity. We are going to show here that the decision related to the appliance or the technology that the agricultural sector is going to opt for, is related to the decision of level of energy that they are going to use.

Why is it so? Because if a farmer has to buy the efficient pump then the first cost is going to be high, as these five-star pumps are more expensive as compared to the pumps that they buy now. However, if they buy the efficient pumps then the running cost will be low because less power is drawn to run the pump. This is one scenario.

The second scenario describes what is actually happening. If they buy the inefficient pump then the first cost is going to be low because the price of these pumps is low. However, since more power is drawn from the grid, running cost is going to be high and hence the electricity bill will be high.

So, the difference between the use of efficient pump and inefficient pump comes in the form of a trade-off between the first cost and the running cost. This is what makes the whole situation interesting. Now, who pays the first cost? Both the running cost and the first cost is paid by the farmer. When the farmer is paying the first cost, it is going from his or her own pocket but the running cost for the agricultural sector is highly subsidized, specifically for the energy. One does not care much if running cost goes up a bit, because running cost is quite low given the subsidized electricity. So, even if it goes up a little, it doesn't really pinch farmer's pocket. This is one aspect. The other aspect is that the affordability of the farmers in India is pretty low. Due to low affordability, the farmers tend to buy the inefficient pump as the initial cost is low; however, they are able to bear a little bit higher running cost as it is not much high because the electricity is totally subsidized for agriculture in India. This takes into account a situation where the farmers prefer purchasing the inefficient pump sets. If a policy intervention or the demand side management is desired, the first thing that has to be done is replacement of these pump sets by the efficient pumps sets. This is the policy intervention that comes in the form of demand side management in the agricultural sector in India.

(Refer Slide Time: 18:09)




Now, the question arises that if I want to replace all 2.1 crore inefficient pump sets by the efficient pump sets, it will involve a huge cost but what benefit will I get out of it? The benefits are as follows: Firstly, if 2.1 crore low efficient pumps are replaced by energy efficient variant then energy saving can be achieved. The total energy saving potential of this particular act will be 430 crore of kiloWatt hour. If this much energy is saved then we can avoid a lot of capacity utilization in the power sector.

Secondly, as we know the electricity is highly subsidized for agriculture in India. If the electricity power consumption comes down then the government will need to pay lesser amount of subsidy. The subsidy burden on state utilities will come down to a great extent which is of the amount 22,750 crores of rupees. This is a huge amount of money that is saved apart from electricity saving.

The other important thing is this power is mostly coming from coal in India thus creating emission of a lot of greenhouse gases. So, the potential greenhouse gas emission reduction by replacing 2.1 crores of inefficient pumps will be 3.48 crore tonnes of $CO_2$.

The saving potentials are huge but as a student of economics one should understand that the kind of savings that we are generating are avoided social costs whereas the price that the farmer has to pay from the pocket in order to buy the energy efficient pumps is a private cost. There is a distinction between the private cost and the social cost because the farmers are not always

aware of the benefits or the gains that they are going to derive out of this social cost savings. This is one point to keep in mind that gives you the scope of research in this area.

What did the government do in agriculture sector? The Indian Council of Agricultural Research (ICAR), the BEE acted through Energy Efficiency Service Limited (EESL). EESL is the biggest energy service company in the world and is government subsidiary in India. They implemented the agricultural DSM projects in different districts of 3 states in India; Maharashtra, Karnataka and Andhra Pradesh and this was considered to be a big success.

One way is that the government can mandate the policies, they can just say that the farmers have to buy the energy efficient pumps. But then the farmers do not really see the incentive and there are leakages in the policies. Here they have incorporated a business model in the, and this is how the whole thing will be conducted in a financially viable manner.

The following is the business model; BEE along with EESL, implemented the project. EESL will fund the energy efficient five-star rated, energy efficient pumps. The entire initial investment came from EESL. They procured all energy efficient pumps and provided them to the agricultural sector farmers. Initially, the farmers had to pay nothing so there was zero down-payment. One of the barriers to adoption of energy efficient technology is the high first cost. Thus, they eliminated this component of high first cost as there was zero down payment and the farmers were getting these pump sets.

In addition, EESL also entered into a long-term partnership with the farmers. EESL will be available to provide the advice to the farmers anytime it is required. This is another very important point when we are talking about the social embedding of a technology. A technology many a times is imposed on a community and the community doesn't know how to use it and where there is need for any repair, they don't know whom to approach. These problems were solved by long term partnership of EESL with the farmers.

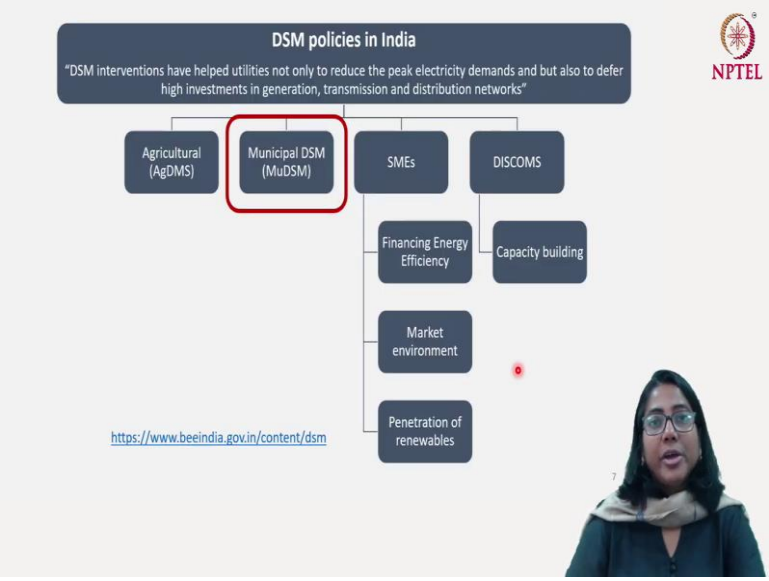
Now the question is will this model be an economically viable model? EESL had to bear the entire investment cost that is a very high. The EESL said okay we are giving you the pumps at a zero down payment but as you start using the pump you will realize that there will be energy saving. Energy saving means you are going to save money per month as your total energy consumption and electricity bill will be reduced for your agricultural use because of use of efficient pumps. So, every month you are actually saving some amount of money in terms of this reduced energy consumption. There is some avoided expenditure on the electricity bill and

if you save this amount of money, you can pay it to EESL to recover the cost of the pump and the duration of this payment could be made on some agreement based on mutual convenience. For example, over a 2 or 3- or 5-year period of time the farmers are going to repay the first cost of the pump to the EESL. This is how they removed the first cost barrier; they made the business model viable and they created an environment where there can be interaction between EESL and the farmers.

Besides that, there are some other technological interventions as well. EESL also promoted the smart control panels in order to achieve the reduction in water and energy wastage as due to these inefficient pumps there was huge water wastage as well.

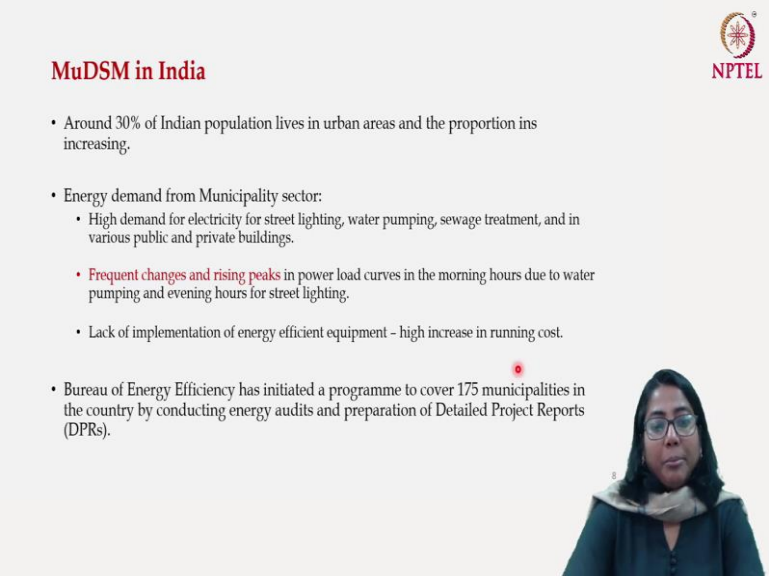
These are the interventions that took the form of the demand side management policies in the context of the agricultural sector in India and this is one of the very efficient policies that we see in the whole paradigm. Next, we are going to have a little bit of understanding on what is municipal demand side management.

(Refer Slide Time: 24:51)




As you can see in the agricultural sector the program is well planned, the DSM in municipality sector is yet to be implemented but the background work is done. It gives us understanding of a different context and different concept.

(Refer Slide Time: 25:15)




Before we go to that, few facts about the municipality sector and why is it so important? At this point of time almost 30 percent of Indian population lives in the urban areas and this percentage will increase as we move on to the path of development trajectory because there will be lots of migration from the rural sector to urban sector. So, the load on the urban sector is going to increase.

What is the difference between the energy demand in the urban sector and in the rural sector? In the urban sector, there is a lot of energy demand or a lot of demand for electricity for public requirements. Electricity supply is not only needed for the households but also for street lighting, for water pumping, for sewage treatment and so on. There are various public buildings, so the public infrastructure requires a lot of electricity in the municipal or the urban bodies.

Therefore, as the urban population grows, the electricity demand is going to increase manifold. The urban bodies or the municipality corporations are not well equipped or well-funded in order to promote the energy efficient policies, energy efficient equipment in order to undertake these kinds of activities. This is number one point.

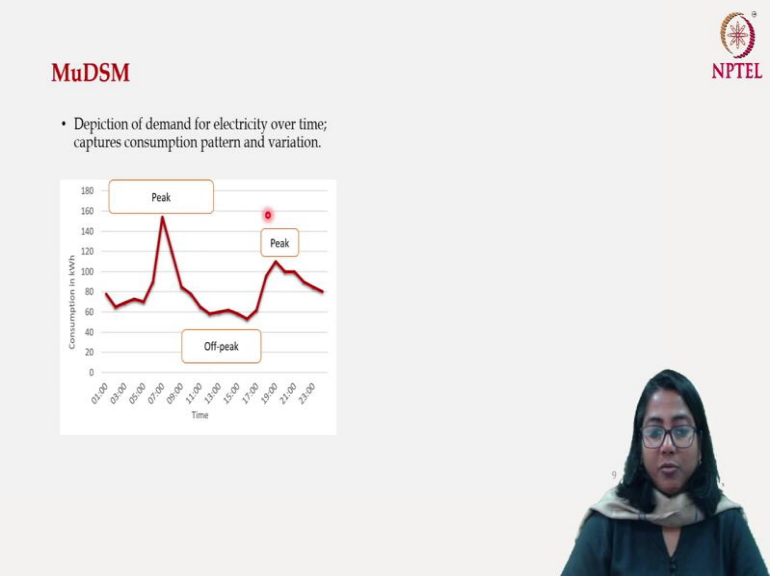
The second characteristic of municipal energy demand or specifically the municipal electricity demand is as follows. There are frequent changes in the peaks. What is a peak load? Peak load is the load where the electricity demand or the electricity use is highest in a particular household or in a particular locality. We will just have a look in a while but if there is a frequently changing

load curve then you really don't know, what is the exact amount of electricity that will be required?

The other thing is that, if there is a difference between the electricity demand between the peak load and off-peak load period, then there will be a huge wastage of electricity that is being produced. What did the Bureau of Energy Efficiency do? They initiated a program to cover 175 municipality corporations in the country by conducting the energy audit and preparing the detailed project report.

In order to implement any demand side management policy, it is important to understand the pattern of the load curve, only then an efficient policy can be introduced. So, before we come to the end of this lecture, we will have a quick discussion on load curves which will tell you what is meant by frequent changes and rising peak in power load.

(Refer Slide Time: 28:05)




A load curve is a description of demand for electricity over time and it captures the consumption pattern and variation. If you have a look at this particular load curve, what does it show? It shows that there are different points of time, say from 1 a.m. to 12 at midnight and this is how the electricity demand looks like and this is a typical kind of load curve for any urban area. You can see that there is more or less off-peak period where the energy demand is low. After this more or less off-peak period, then there is a sudden peak. In this sudden peak period, the energy demand or energy consumption goes up then again it declines, comes to the off-peak period and again it increases in the evening during the peak period.

There can be various explanations, one explanation could be that during the morning a lot of energy is needed to pump the water to supply to the urban households. Whereas in the evening you can see this peak maybe caused by the increase in street lighting and there are the off-peak periods. Now, it is important to understand the load curve of a particular area or of a particular household because when the electricity is produced, the amount of electricity that needs to be produced should be enough to enable this particular locality to consume peak period equivalent of electricity. Throughout the day peak period equivalent of electricity will be produced. So, if there is a big difference between peak period and off-peak period, during the off-peak period a lot of electricity will be generated, will be supplied but will not be used. So, that is a huge amount of waste of resource.

So, when we are talking about municipal demand side management and if the load curve looks like this, another possible strategy could be to reduce the difference of electricity consumption between the peak period and the off-peak period. This strategy is called load management.

So, in the next lecture we will see what are the different policies that come under Demand Side Management and we will discuss in detail two such policies, one is load management and the other is energy efficiency. So, we stop here for this lecture, we will see you in the next lecture.

Thank you.