Energy Economics and Policy
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Week - 03
Energy Demand - Part II
Lecture - 03
Demand Side Management - Energy Efficiency

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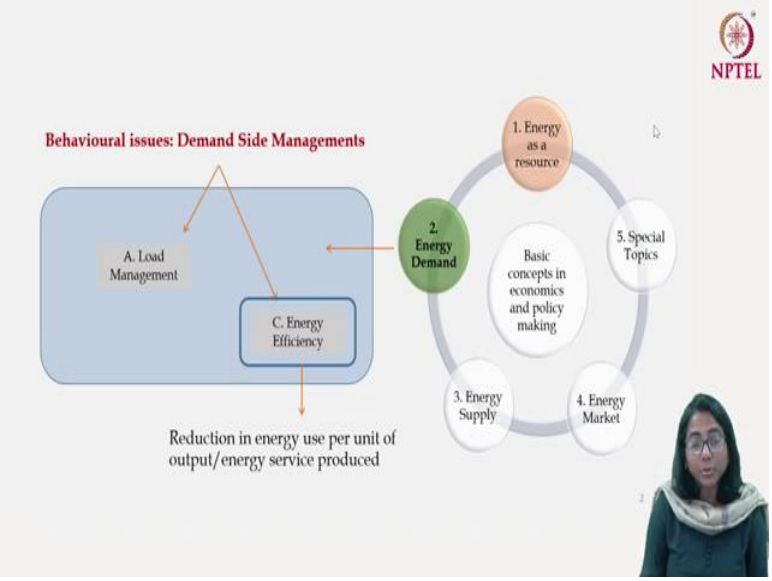

In this lecture, we are going to talk about Energy Efficiency and as you can recall, we are talking about energy demand under module 2. This is one of the behavioural aspects with regards to Demand Side Management. Let us understand what energy efficiency is?

In the previous week, we had a discussion on energy intensity which was the energy consumption divided by output produced. The concept of energy efficiency is just the opposite. If you have to consume more energy to produce the same amount of output, your energy efficiency will go down. However, if you can consume less energy to produce the same amount of output, then your energy efficiency will go up. It is a reciprocal concept of energy intensity. The reduction in energy use per unit of output or energy produced is called energy efficiency.

We are going to have a quick look at how energy efficiency plays a role in the whole policy discourse in India with respect to energy demand reduction or energy management.

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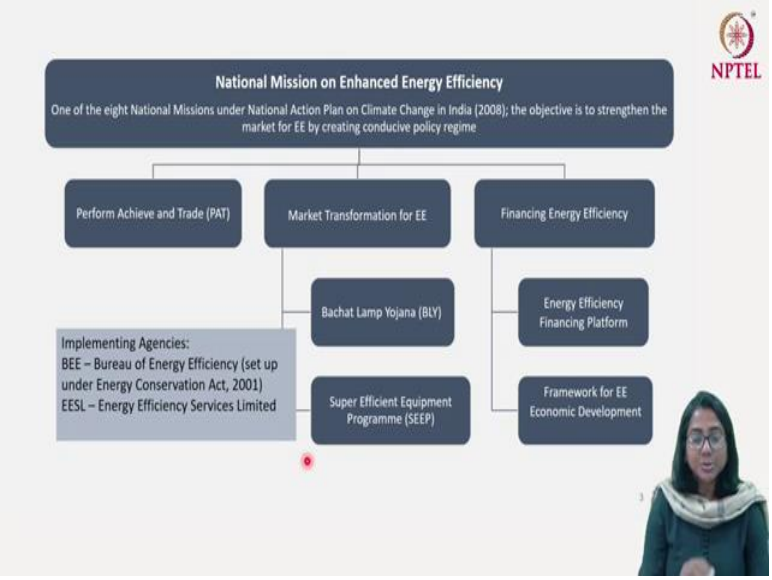

We will now discuss the National Mission on Enhanced Energy Efficiency. India took up the National Action Plan on Climate Change (NAPCC) in 2008 and under the NAPCC there are 8 national missions. One of them is the National Mission on Enhanced Energy Efficiency (NMEEE). What is the objective of adopting the NAPCC? In order to comply with the international effort to reduce the greenhouse gas emission, India agreed to put efforts in terms of reducing the emission intensity of our GDP. The total emission may not go down but the emission that is coming out of production per unit of GDP will come down. Enhanced energy efficiency was considered to be one of the main driving forces which can help the country in achieving a reduction in the emission intensity of GDP. This is one of the important and key components of NAPCC in India. The objective was not only to promote energy efficiency but also to come up with a market-based concept, to generate some kind of market incentive so that people take up measures which are energy efficient in nature.

In NMEEE, there are three building blocks, although they mentioned four components. Two of the components are similar and that is why we can consider three building blocks. The first one is called Perform Achieve and Trade, the PAT scheme. This is the energy efficiency scheme which was taken up under this program for the energy intensive industries. We will have a detailed discussion on this in this lecture.

The next one is market transformation for energy efficiency. The whole concept was that energy efficiency should not only come as a mandate but it should tell people where the

financial gain lies. There has to be a market transformation and there has to be a financial mechanism. Under market transformation there are two prominent attempts that were taken, one is the Bachat Lamp Yojana where households were encouraged to use the CFL lamps in place of the incandescent bulbs and CFLs were provided at 15 rupees per CFL where the cost is almost equal to the incandescent bulb. The other was the super-efficient equipment program under this market transformation. The government identified that energy efficient equipment has a high initial cost. Although the running cost is much lower than the energy inefficient equipment, there is a first cost barrier.

These two programs were taken up to remove that first cost barrier. Energy efficient equipment was provided to the customer at the same cost as of the existing low energy efficient equipment. This removes the first cost barrier. However, it requires a lot of investment to supply all the households with the CFL or for example, if I want to supply all the agricultural farmers with energy efficient pumps, it actually is a matter of a lot of money.

Where does the government get this amount of money? There was some financial mechanism that was developed and it was said that the initial investment will be done by some energy service companies. How will they be repaid? Once the energy efficient equipment is installed, the customers will realize financial savings in terms of reduced electricity bills over a period of time. As a result, the customer will pay the energy service companies over a period of time out of these financial savings. The first cost barrier has been removed and the payment will be made over a period of time.

This was thought to promote the market transformation of energy efficiency and other than that there are certain other financial mechanisms which were developed. One was called the Energy Efficiency Financing Platform and the other is called the Framework for Energy Efficient Economic Development.

If you go to the document of the National Mission on Energy Enhanced Energy Efficiency, two programs that is Energy Efficiency Financing Platform (EEFP) and a framework for Energy Efficient Economic Development will appear as two different programs but their objectives are the same. They essentially try to come up with a certain MoU and understanding between the financial sector and the nodal agency in the government.

Who are the implementing agencies of the National Mission on Enhanced Energy Efficiency? This particularly falls under the Ministry of Power which came up with the Energy

Conservation Act in 2001 where a huge thrust was given on enhancing energy efficiency in India. Under this Act in the year 2002, the nodal body was set up which was called the Bureau of Energy Efficiency (BEE).

A lot of information about the energy efficiency policies in India is available on the website of the BEE, along with different thrust areas of the BEE at different levels. BEE has some areas related to building energy efficiency, industrial energy efficiency, residential, agricultural sector etc. and different market mechanisms. It is worth visiting the website of BEE to uncover the energy efficiency policies in India. The other one important and interesting is Energy Efficiency Services Limited (EESL). This is one of the energy services companies in India owned by the Ministry of Power, Government of India.

When we were talking about providing the farmers with the efficient pumps, then we talked that EESL is undertaking the initial investment and farmers are paying back to the EESL. This is the energy service company whose role has become very important in the context of promoting energy efficiency policies in India.

We are going to look at a couple of thrust areas of the Bureau of Energy Efficiency which have come up with very significant energy efficiency policies with some visible outcome. Firstly, we are going to look at in detail the policy called Perform Achieve and Trade in India.

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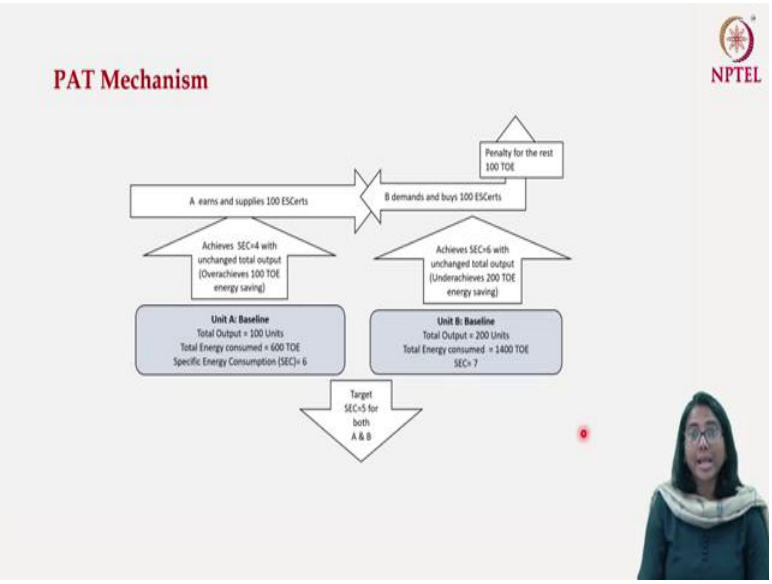

Let us first have a look at what is the mechanism of Perform Achieve and Trade. Consider two industrial units, unit A and unit B with their imaginary baseline scenario is shown above in figure.

Unit A is producing 100 units of output. You can think of both of them from the same industry or from different industries and both of them are producing steel. The total output is 100 units and total energy consumed is 600 tons of oil equivalent.

What is the Specific Energy Consumption? The Specific Energy Consumption is a measure of energy intensity. The Specific Energy Consumption is total energy consumption that is 600 divided by total output that is 100. The Specific Energy Consumption is 6.

In case of the industrial unit B, the baseline scenario is that it is a bigger plant and the output produced is 200 units. Total energy consumed is 1400 tons of oil equivalent and therefore, the Specific Energy Consumption is 1400 divided by 200 which is equal to 7.

When Perform Achieve and Trade was initiated, it identified most energy intensive industries in India and under these industries they surveyed all the units which were big enough and have high energy intensity. Finally, there were 428 industrial units, they carried out baseline study. They identified the Specific Energy Consumption, what could be the possible benchmark that each of these units can achieve? and where is the potential for energy efficiency? Each of the units under Perform Achieve and Trade in the first cycle received a threshold that they had to reach.

For example, the Bureau of Energy Efficiency after surveying both the units identified that both of them can improve their energy efficiency so for both of them the Specific Energy Consumption should become five. Unit A has to reduce its Specific Energy Consumption that is the energy intensity from 6 to 5 and unit B has to reduce it from 7 to 5. These were the targets set by the Bureau of Energy Efficiency for these two units.

When the National Mission on Energy Efficiency was planned and PAT was being designed, initially BEE thought that they would have one single benchmark, that is one single Specific Energy Consumption target for all the units under one particular industry. All the iron and steel industries will get one target, all the units under the paper industry will get one target, etc. That was the initial plan and it was planned that PAT will be launched in the year of 2010. However, when they started collecting the data and visiting different units, they found out that different

units under one particular industry are very different in nature. So, you cannot have the same Specific Energy Consumption target for all the units under iron and steel or for all the units under the cement industry.

The scope of energy efficiency varied from one unit to the other. They did a very rigorous job at that point of time. They delayed the implementation and collected detailed data from each of the units where PAT was supposed to be implemented. For each of the units they came up with a specific target.

Let us assume two such units out of 428 units where the first cycle of PAT was implemented and both of them received the target to reduce their Specific Energy Consumption, one from 6 to 5 and the other from 7 to 5. However, they do not have to reduce their total production because that will not help as we are talking about intensity.

Suppose some efforts are made by unit A. It not only achieves the target but rather over achieves the target. So, instead of achieving 5 Specific Energy Consumption, unit A achieves 4. It becomes more energy efficient than it was required to do. Now what happens? If the total output remains unchanged that is the 100 unit and now the Specific Energy Consumption is 4. The total requirement of energy of this particular unit is 400 tons of oil equivalent. The target was actually 500 ton of oil equivalent. It would have satisfied the Bureau of Energy Efficiency specified target had it reduced the energy consumption to 500 tons of oil equivalent. However, it has reduced further, so it has overachieved 100 tons of oil equivalent energy saving.

Let us next see what happens in case of unit B. Unit B invested less in enhanced energy efficiency and as a result instead of achieving Specific Energy Consumption of 5, it achieves only 6. Its Specific Energy Consumption is reduced from 7 to 6. It under-achieves 200 tons of energy saving because of a gap of one Specific Energy Consumption for 200 units. For each unit of production unit B is lagging behind by 1 ton of oil equivalent and for 200 units of production, unit B is lagging behind 200 tons of oil equivalent. Now, there is an opportunity to come up with the market. Unit A has over achieved and so has some energy efficiency which it can sell and unit B has underachieved. So, it wants to buy energy efficiency and this scope was exploited under the mechanism of PAT.

It said that the unit who has underachieved will be supplied with some energy saving certificates. ESCerts stands for Energy Savings Certificates, for each ton of oil equivalent, the government or the BEE will issue one energy certificate to this overachiever which can be sold

in the market. Because the savings is 100 ton of oil equivalent, Unit A gets 100 energy saving certificates.

What happens to the underachiever? The underachiever has two options; it can buy energy saving certificates from the unit who is selling the energy saving certificates or it can pay a penalty.

There are only two entities in the market. There is a supply of 100 energy savings certificates; however, there is a demand for 200 energy saving certificates. So, what unit B can do? It can buy 100 energy savings certificates from unit A and pay the penalty for the rest of the 100 units. But here the penalty structure should be designed carefully in such a way that per unit penalty that unit B has to pay should be higher than the price of ESCerts in the market. If the penalty is lower than the price of ESCert, then unit B will only pay the penalty and this market mechanism will not work and there will be excess supply of ESCerts in the market.

In this kind of mechanism, it is very important to identify the target, that is 5 to come up with the appropriate benchmarking and appropriate target. If the target is not set appropriately there is a possibility that there will be over supply of ESCerts in the market or there will be excess demand of ESCerts in the market. If that is the case then the excess supply of ESCert will lead to their price crash. As it's a market mechanism, the demand and supply will interact and reveal the market price. Hence, the government said that there is no floor price and there is no ceiling price; let the demand and supply interact and reveal the price.

Now if that is the situation and the target is not very stringent, then most of the people will overachieve and if everybody overachieves, there will be over-supply of ESCerts in the market and the price will crash. However, if you make the target too stringent and nobody overachieves everybody under-achieves, then there will be a large number of buyers. However, the supply will be limited and this excess demand will shoot up the price of ESCert.

We find that the literature on European Union Emission Trading System (EUETS) is very similar to PAT. Here it's about buying and selling of Energy Savings Certificates, there it is buying and selling of Carbon Saving Certificates. There the target that they made was so less stringent that everybody overachieved it and everybody wanted to sell their carbon certificate. Therefore, in the first phase of EUETS, the price crashed, the whole market and the mechanism crashed. This was one of the criticisms about the first cycle of EUETS and it gives a nice comparison with this situation.

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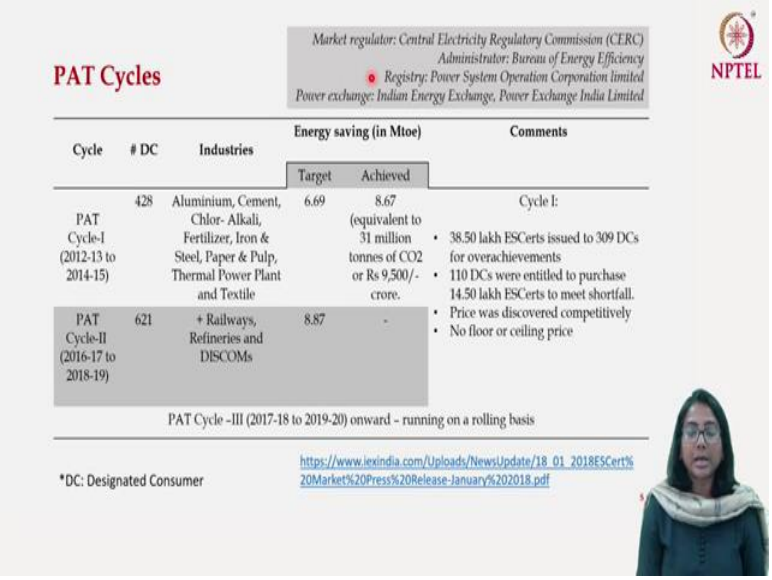

The first cycle of the PAT was introduced during the period 2012-13 to 2014-15. Over a period of 3 years, 428 designated consumers were identified, one industrial unit was considered as one designated consumer. There were 428 designated consumers who were identified to be highly energy intensive in nature. Data were collected from all of these 428 designated consumers and the benchmark was created. Each of these designated consumers got their own targets to achieve. There was no blanket target for any of the industries, each of these 428 received their own targets to achieve.

Who are the industries which were the part of the first cycle of PAT? These are the most energy intensive industries aluminium, cement, chlor-alkali, fertilizer, iron and steel, pulp and paper, thermal power plants and textile.

In our discussion on reduction in energy efficiency, the six charts were shown in the industries where the energy intensity has been declining, these are the industries that we were talking about. These are the most energy intensive industries in India and consume most of the energy that is produced in the country.

The total energy saving that was targeted was 6.69 Mtoe and more than this was achieved, that 8.67 Mtoe. Most of the industrial units overachieved the target.

If you think about the avoided energy use of this particular amount, it was equivalent to avoiding emission of 31 million tons of carbon dioxide and a monetary value that is equivalent

to 9500 rupees crores. There is a huge saving which took place but it again takes us to the discussion, do we really want all the units to over achieve? How did buying and selling of ESCert went on after overachievement took place? When we discuss that the buying and selling of ESCerts we see that the overachievement was quite okay in terms of the fact that the price of ESCerts never crashed. But one has to be very careful to understand, what is the supply and demand of ESCerts in this context?

So, let us see what happened in cycle 1, this is perhaps the most important part because here we will discuss the market mechanism. As seen, the target was overachieved so some of the units got the energy saving certificates. The data shows that there were 309 designated consumers who overachieved out of 428 DCs and 38.5 lakh ESCerts were issued. 110 DCs were actually underachievers and they had to buy from these 309 DCs. They had to buy 14.5 lakh of ESCerts in order to meet the short fall.

In a sense it's good that we have overachieved, saved a lot of money and saved a lot of carbon dioxide emission as well but it is clearly evident that the supply exceeds the demand. The realized price of ESCert in the market was a bit lower. Had these two things been closed, it would have been a bit higher. Hence, one has to be careful when setting up the target.

The other thing is that since the supply exceeds the demand, there should be a banking option with the ESCerts. For instance, you can keep the ESCerts in a bank and you should be able to sell it during the next period. This kind of mechanism should be there.

As I already mentioned that price was discovered completely in a competitive manner, there was no floor or ceiling price that was set by the government. You can further explore how the price was discovered in the market, on the website of IEX India. It states how the bidding went on? What is the total volume of sale? and how the price actually moved?. This transaction is for the first cycle of PAT.

The second cycle of PAT was implemented from 2016-17 to 2018-19 for another 3 years. Some more DCs were added under the second cycle of PAT, there were all together 621 designated consumers. Other than these 8 industries, 3 more industries were added; railways, refineries and the DISCOMs that is the power distribution companies. In the second cycle, the target was to achieve 8.87 million ton of oil equivalent of energy savings. The data on how much we have achieved is yet to come because it has just ended.

What we can see from the first cycle of PAT as an experiment is that it was quite successful because the market mechanism could be incorporated. Some of the industries say, an energy efficiency policy is not needed to be in place because energy itself is so expensive that the industries have their own interest in order to reduce their energy intensity. They will anyways work towards energy efficiency.

These studies could be interesting to see, if you remove policies like PAT, will the industries achieve the same result, what is the additionality given by PAT? So, these are the questions which are interesting to ask and in my opinion market mechanism can't be introduced if each of the industries individually practice energy efficiency measures.

After 2018-19, the PAT cycle III, IV and the forthcoming one is V will be introduced on rolling basis and every year some new DCs will be added and every year some new targets will be given. This was more like an experimental phase and now we have entered into the phase where every year a new cycle of PAT will come. When you see this kind of a mechanism in place the immediate question is who are the people who are organizing this whole mechanism, who are the stakeholders?

Let us have a quick look at the stakeholders for PAT. The Central Electricity Regulatory Commission is the market regulator for PAT, the whole scheme comes under the Ministry of Power and is administered by the Bureau of Energy Efficiency. This is the nodal agency for any energy efficiency program in India and it falls under the Ministry of Power.

The registry that does the registration of the companies who want to buy or sell ESCerts was the Power System Operation Corporation Limited, POSCO for this program. The ESCert were being bought and sold in two power exchanges in India; one is the IEX and other is Power Exchange India Limited (PXIL). These are the two designated power exchange companies who conducted the buying and selling of ESCerts under PAT.

One note of caution is that when you look at these different numbers, they may vary from one document to another a little. I am not in a position to give you the explanation why the number varies but even if you extract the documents from the BEE website, in two different documents you may find two different numbers but they are pretty much close.

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After the industrial energy efficiency which seems to be quite effective in India, we come to the next flagship program by the Bureau of Energy Efficiency, the Standards & Labelling. A statement on Standards & Labelling from the BEE website itself, "A key objective of this scheme is to provide the consumer an informed choice about the energy saving and thereby the cost saving potential of the relevant marketed product". Let us focus on the part, 'informed choice'. Often consumers do not make a choice based on all the information as it is not available to them. When we were talking about load management, we said that it's good to have a dynamic price where you have higher price during the peak period and lower price during the off-peak period but it's not just having the dynamic pricing, it is also about communicating the information to the consumers, so that they can make informed decision. Here also they refer to the consumer taking some informed decision about energy saving and thereby cost saving potential of relevant marketed products.

The scheme targets display of energy performance levels on high-energy end-use equipment and appliances and lays down minimum energy performance standards. More details about it can be found on the website of BEE.

Let us have a quick look at what we understand by Standard & Labelling and its importance in helping the consumer to make an informed choice.

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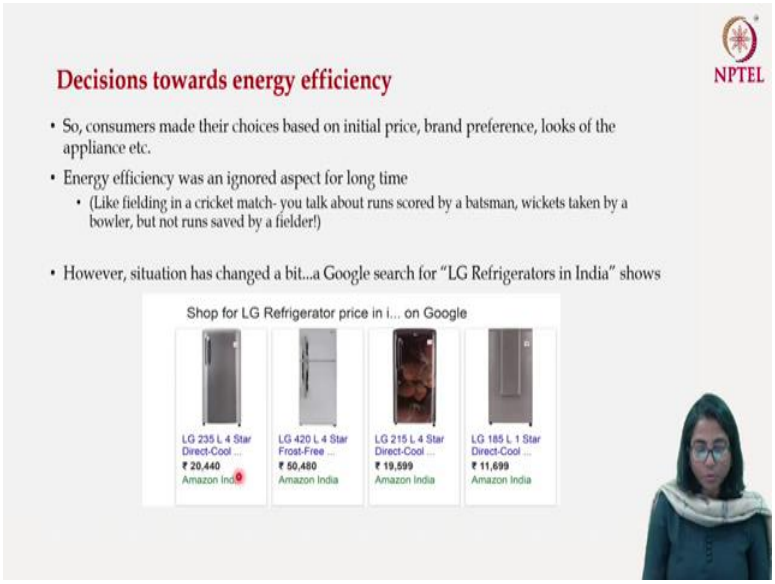

How is the decision towards energy efficiency taken? This is very interesting because as a consumer when I go and buy, for example, a refrigerator, what do I look at? I go to the shop and ask what is the price of the refrigerator? I might have some brand preference, maybe brand A over brand B. So, I stick to one brand and look for a particular colour that I want to use.

But it is not very common that a customer walks down in a shop and asks what is the energy consumption of this particular refrigerator, that is usually not the first question that you ask. We can say that energy efficiency is now not so much an ignored aspect as it used to be in decision making of a consumer. The consumer would consider certain clues but not go by energy efficiency.

A good example is to compare energy efficiency with a cricket match where a very good fielder saves a lot of runs. But in the result of a cricket match, you will only talk about how many runs are scored by the batsman or how many wickets are taken by the bowlers; you never discuss how many runs are saved by the fielders. This is somewhat like energy efficiency is that ignored aspect of energy consumption. However, things have changed a little bit.

For example, a google search for LG refrigerators in India throws up the following results. These are the different LG refrigerators that you can see and along with the capacity of the refrigerator you are also getting different ratings for different refrigerators. The search result gives the star rating as the second most important information. When a consumer is looking at it of course, you are looking at the size, price, brand, first cost but also you are bound to look

at these terms called 4-star and 1-star. It gives the consumer information about the energy intensity. The energy that is consumed by these refrigerators and which amongst them is more efficient.

A comparison can be drawn between two refrigerators, a 185-litre refrigerator and a 215-litre refrigerator. As this is 1-star, the price is much lower. If the information on star rating was not given to the customer then she would have thought this as a much cheaper option and good to buy. The moment the ratings come into the picture one is bound to think that the price may be less but the spending will be more in terms of electricity bill. By mentioning the star or the label you are forcing the consumer to base her decision on some information about energy efficiency.

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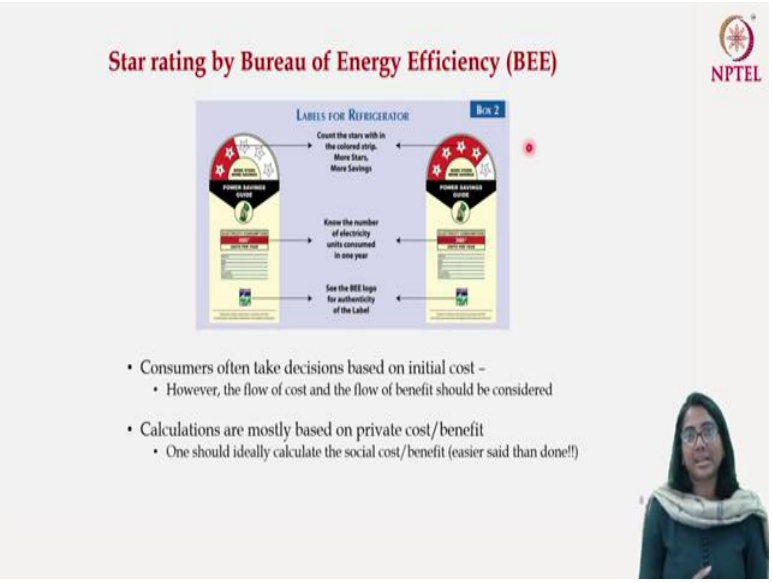

This is how the stars or the labels provided by BEE look like. If you look at the labels for the refrigerator, there are 5 stars. The more the number of stars is covered by the red area, higher will be the energy efficiency of that particular equipment. So, now other than the capacity, the first cost, the look, the colour, the brand; how many stars are covered by red will also guide your decision making.

As compared to 15 years ago, now-a-days if you go to a shop to buy a refrigerator, at least few customers will be seen talking about the star rating. They are saying that I want to buy a 4-star or 5-star refrigerator and tell me the options within that and do not want to buy one which is 1-star.

The star and labelling program give the information to the consumer which is very important. Without this information you can't optimize. Now the consumers along with initial costs are also taking into the consideration the flow of expenditure that they will have on the electricity consumption.

There is another thing when the calculations are mostly carried out by us for buying an electrical appliance or equipment, in terms of private cost. We see how much money I am going to spend from my own pocket. I do not see that if I spend more money from my own pocket, then it will lead to lowering of energy use and therefore lowering of emission.

Now, this lowering of energy use or lowering of emission, these are associated social benefits which may not reflect in private benefit. There has to be a mechanism which transforms this social benefit and reflects into the private benefit of the customer who is buying this electrical appliance. So, when you are promoting energy efficiency as a policy measure, then these are the things one has to be very careful about.

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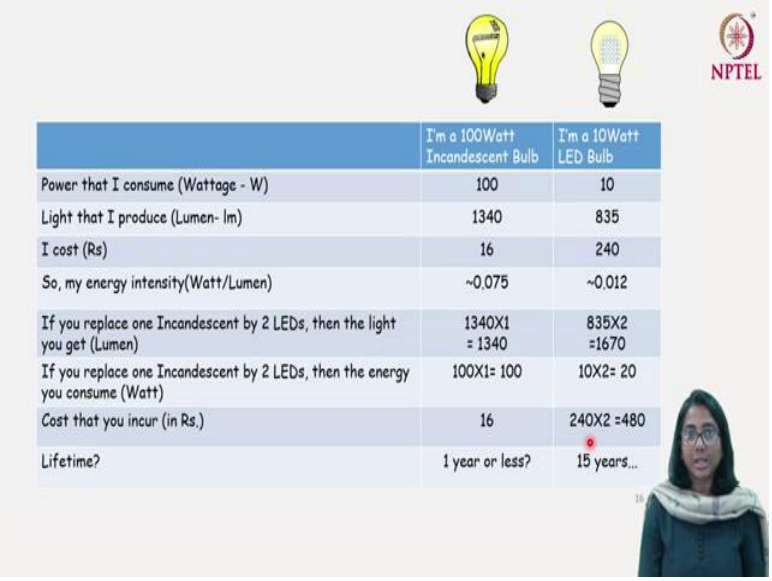

We take a very simple example to show how the mind of a consumer works. So, here I have taken the example of two bulbs; one is the 100-Watt incandescent bulb and the other one is a 10-Watt LED bulb.

What are the different characteristics of these two bulbs? The power that these two bulbs consume is 100 Watt and 10 Watt. The next one is the light that they produce. The amount of

energy consumption is the amount of energy service that they are producing. You may recall the discussion that we had in the initial lecture on energy demand, we said that it's tricky how you choose the energy using appliances, you choose the energy type and then you choose the level of energy use. Here we are talking about use of the particular appliance.

The light that is the energy service which is produced by these two equipment are as follows. A 100-Watt incandescent bulb will produce 1340 lumen that is the brightness of the light; however, a 10-Watt LED bulb will produce only 835 lumens so you cannot replace one incandescent bulb by one LED bulb, you need at least two10-Watt LED bulbs to replace 100 Watt incandescent. How much do they cost? If I buy one each then one incandescent cost 16 rupees whereas one LED costs 240 rupees.

So, there is a huge initial cost barrier. If you go to the market, the shopkeeper gives you two options; one is 16 rupees and another is 240 rupees. It’s very difficult to make a choice in favour of 240 rupees and also, 240 rupees is not enough to meet the lighting demand of 1340 lumen. This is only for 835 and you have to pay double that is 480 rupees.

What is their energy intensity? The energy intensity of the incandescent is approximately 0.075 whereas the energy intensity of the LED bulb is 0.012. The energy intensity of this LED bulb is much-much low. This will be reflected in your electricity bill; however, the initial cost is going to be very high. If you replace one incandescent by two LEDs, then the energy that you consume here is 100 Watt whereas in case of LEDs, it's only 20 Watt.

The regular energy consumption will be low but the first cost barrier exists. What is the cost that you incur? If you buy one incandescent, you pay 16 rupees to get the same amount of energy service. If you buy two LED bulbs, you have to spend 480 rupees. The difference between 16 rupees and 480 rupees is 30 times higher.

Now comes the most important point that the consumer often overlooks, the lifetime of the two bulbs. An incandescent bulb can be used maybe for 1 year whereas if you buy one LED it is going to last at least for 15 years. If you think about 16 rupees as an investment, you are making this investment for 1 year. Every year you have a recurring investment whereas, if you invest 480 rupees once, then this investment is for 15 years. Now you can go back to the concept of growth rate that we had been discussing.

Had you kept this money in the bank, the rate of interest in the bank being 5 percent, then both 16 rupees each year and 480 rupees for 15 years, it could have grown at 5 percent average annual rate of growth. Then what is the actual cost of these two equipment is very important to understand.

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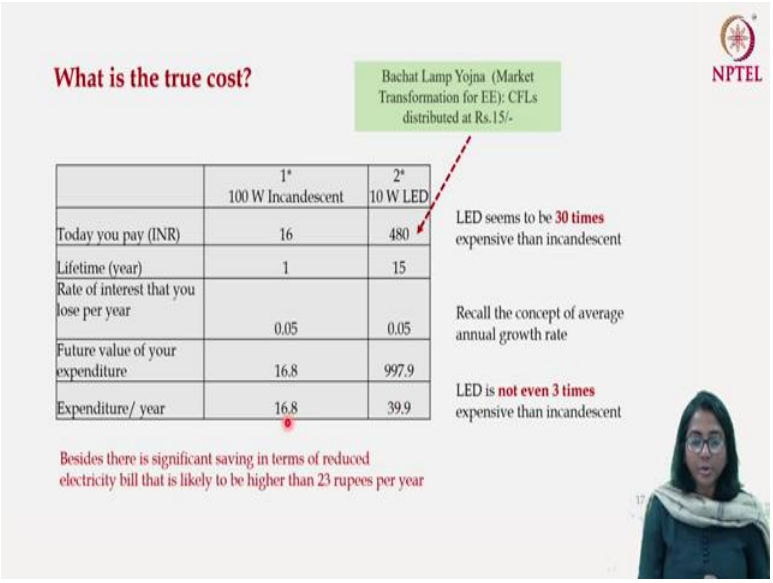

If you are buying one 100-Watt incandescent, today you are paying 16 rupees. If you are buying two LEDs, then you are paying 480 rupees. In a way if you compare these two figures, you will see that LED is 30 times more expensive as compared to incandescent. This is the first thing that comes to mind of a customer however as an economist, we think a bit carefully. We say,16 rupees are for 1 year whereas 480 rupees is for 15 year.

What is the alternative use of 16 rupees and 480 rupees? If I do not buy the incandescent or if I do not buy the LED, I put this money in the bank and my money will grow at an average annual growth rate of 5 percent. So, 16 rupees after 1 year will become 16.8 rupees as it has grown at 5 percent rate.

However, if I keep 480 rupees for 15 years in the bank, this will become 997 almost 1000 rupees. So, for 16 rupees not invested every year the loss is 16.8 rupees and for 480 rupees the loss is 1000 rupees for 15 years.

If I divide this 1000 rupees by 15 years, this is my loss per year. The amount that you are losing if you are spending your money on one incandescent is 16.8 and you are losing 39 or almost

40 rupees if you are buying two LEDs. This is not exactly 30 times higher; this is not even 3 times higher. If you compare the cost in this way it is not even three times higher than what you are spending per year but we do not take these things into consideration and are carried away by the barrier of first cost.

Now, what can one do? Here comes the role of policies like Bachat Lamp Yojana. This is something that we had been discussing before, as one of the policies that was adopted for market transformation, for energy efficiency, so CFL was distributed at 15 rupees.

When the customer is going to the market, she doesn't see the difference in the first cost between the CFL and the incandescent. However, if you are distributing CFL at 15 rupees, then somebody is investing in that. The money is going from somebody's pocket, maybe the government. But, how do you pay back the government? You pay the government back as by using the CFLs, you are saving money in terms of reduced electricity bills. Over a period of time, you pay back that money to the government. Again, it is the same mechanism of removing the first cost barrier and distributing the payment over a period of time. This is where policies like Bachat Lamp Yojana come handy.

You can go through the exercise and recall the concept of average annual growth rate and see how you come up to figures of 16.8 and 40 where you see that the LED is not at all 30 times expensive as compared to incandescent. It's not even 3 times expensive as compared to incandescent; however, the story doesn't end there because this is only about the initial cost.

So, in case of initial cost, this is a 23 rupees difference. These two things, it has a 23 rupees difference. But over a period of 15 years, per year, you will be able to save more than 23 rupees in terms of electricity bill.

If you think about the present value of investment in the type of equipment and if you also take into account the flow of expenditure that you are saving, probably you will see at the end of the day, LED is much less expensive as compared to the incandescent. The social benefits that are being generated have not been included. Also, there will be less imports, reduction of carbon etc. If you make all calculations, there is a possibility that LEDs are less expensive as compared to incandescent.

Here comes the role of information, the customer has to understand, what are the nuances of this information? If you don't provide the customer with all this information, then it's very difficult to make a choice.

Again, the problem is when you are going to the market to buy some equipment, you do not sit with the data and do these kinds of calculations. All these calculations, they can be converted to a star rating. The star rating is telling you the energy efficiency. It is giving you a lead, you can avoid calculation and yet focus on energy efficiency.

So, we are going to stop here.

We have discussed two main pillars of demand side management; one is load management and other is the energy efficiency.

In the next lecture we are going to look at a very interesting behavioural response which is called rebound effect which comes as a result of energy efficiency.