Energy Economics and Policy
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Week – 06
Energy Market
Lecture – 03
Energy Market: Market Failure and Monopoly

Welcome to the third lecture of the 6th week. In this lecture we are going to discuss monopoly and see whether that is a more suitable form of market structure to understand the markets in energy. We have already discussed perfect competition, we tried to understand the theory behind it and also tried to understand what are the situations or what are the characteristics of the energy projects or energy market that makes it deviate from the perfectly competitive market structure.

And towards the end we discussed whether it means that lumpiness of investment and high fixed cost are indicative of the fact that monopoly is a better market form within which the energy market can be analysed. Initially, we will have a discussion about the theoretical understanding of what monopoly actually means.

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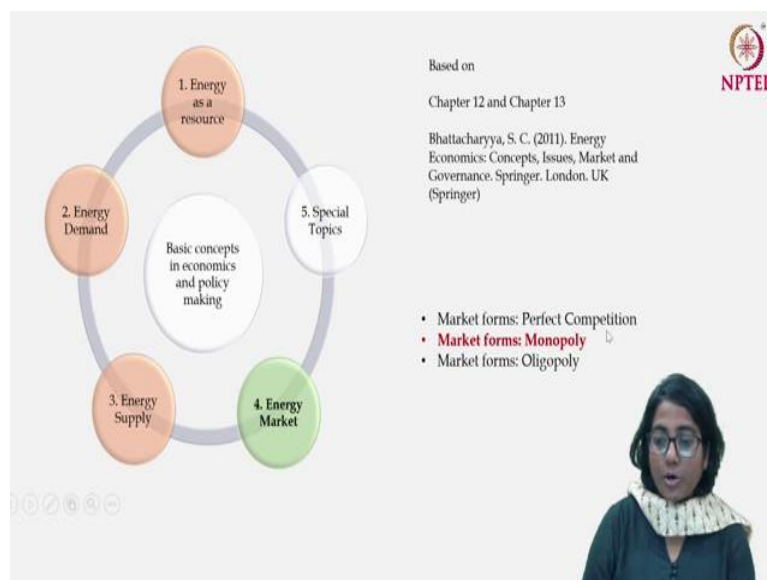
This is the structure that we have been following. For this as well you can consider chapter 12 and 13 from the same book referred. We discussed perfect competition and here we are going to discuss monopoly.

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Various Market Forms

- Perfect Competition – Many buyers and many sellers
- **Monopoly – Many buyer and one seller: The seller has control over price – the seller is price maker while the buyer is price taker.**
- Oligopoly – Many buyers and few sellers

What is the crucial feature of monopoly and how does it deviate strongly from perfect competition? We discussed that in case of monopoly there are many buyers however, there will be one single seller in the market. If there is one single seller in the market and there are multiple buyers then the seller who is the individual seller has some dominance in the market. It enjoys some market power. It can extract a higher price from the consumer but that is not an indiscriminately higher price. There is a limit to it and there is a theory behind how much higher price the monopoly can extract as compared to the perfectly competitive market.

Features of Monopoly

- In USA on an average the variable cost of making a medium pizza is 1-2$ and the price is ~7$.

- During Oil Embargo, in 1973, the price of oil had risen from US$2 per barrel to nearly $12 globally by OPEC.

- True for any copyright item.

- So, clearly, these producers are charging P>MC

- Does it violate profit maximizing condition? – Actually not!

- Note that Coal India till Feb 2018, Indian Railways are also sole suppliers

What are the features of monopoly? Let us start with a couple of examples. Let us think about the pizza. In the US on an average the variable cost of making one medium size pizza is 1-2 dollars and the price of the pizza is 7 dollars. The variable cost of producing one medium pizza is the marginal cost of producing one pizza. The cost of pizza includes the cost of flour, cheese, cost of other ingredients, payment to the labour, electricity bill that is being paid to run the facility and so on.

This cost does not include the cost of an oven for example or the other facilities that are installed in the whole infrastructure. The cost incurred at the beginning of the production will be the fixed cost and will not be incorporated in the marginal cost or in the average variable cost. If you look at the average variable cost or if you look at the marginal cost, the marginal cost is relatively smaller.

If under a perfectly competitive market the producer has to equate the market price with the marginal cost then the cost of pizza would have been 1-2 dollars however it is 7 dollars. The pizza company will not go out of the business even if they start charging 10 dollars because there are very limited options in front of you. The number of producers or sellers of pizza are very limited in the market.

This kind of behaviour cannot be expected from a vegetable vendor who is running a shop in a market. In the market there are some 10-12 vegetable vendors and they cannot charge more

than the other because they know that the entire customer base will shift to the other supplier and that was one of the characteristics of the perfectly competitive market.

The price charged by the monopolist is actually higher than the marginal cost. This is the first point of departure from the perfectly competitive market outcome. However, in future we will see that this does not mean that the monopolist is not actually maximizing profit.

Let us take the second example whereby in 1973 the first oil crisis took place and the price of oil rose from an average 2 dollar per barrel to 12 dollar per barrel, globally. That was the average global increase in the price of oil. The question is how did that happen? Was it the case that suddenly there was change in the cost of production or was there a sudden increase in the marginal cost of production? The answer was no. The price rise was triggered by a certain geopolitical situation whereby the major supplier of the oil in the world made a cartel and they made a decision to act together and reduce the supply of oil to a particular part of the world.

In the perfectly competitive market structure, the producers are not equating the price with the marginal cost of production. Then if the marginal cost doesn't change the price is not going to change at all and in the very first place, they would not have any power to change the price because the perfectly competitive markets are price takers. But clearly in case of oil what you can observe is that there are not many sellers of oil whereas there are n number of buyers of oil that is there are limited number of suppliers and many buyers in the market.

When we actually look at the practical examples with respect to monopoly, we will understand that monopoly is actually a theoretical extreme that we discussed with one seller and multiple number of buyers. In reality there are a limited number of sellers and multiple number of buyers. We call this market structure oligopoly.

However, it is very important to understand the features of monopoly because that actually deviates from the feature of oligopoly. Sometimes even though there are some limited number of firms in the market, they follow the behaviour of monopolistic firms rather than the oligopolistic firms. Suppose you want to buy some kind of software. The price that is charged is not really the marginal cost of supplying the software. Now, the marginal cost of supplying a software is very limited, it will be the cost of a pen drive or cost of a CD or sometimes it's just shared over the link. Giving the access to a particular software to one more individual doesn't actually provoke a lot of costs. The marginal cost is not high but since there is a

copyright the producer or the supplier can deviate from this price being equal to marginal cost kind of equilibrium.

If there are a limited number of producers, they have some kind of a power so that they charge the price which is higher than the marginal cost whereas we have seen that in case of perfectly competitive market structure the maximization of profit takes place if price is equated to marginal cost. Is it the case that the monopolists are actually deviating from the profit maximization by charging a price which is higher than the marginal cost? The answer is no and, we will explore why it is happening.

One more interesting observation is that it seems that monopolists are the limited number of producers in the market, therefore they have certain market power and as a result they exert that market power in order to extract the price which is higher than the marginal cost. However, monopoly can also become a form of public ownership. When the government owns something that is a public monopoly and in case of public monopoly it may not be the case that the government is charging the price which is higher than the marginal cost. In this kind of situation, the government knows that if it is given in the private hands then there will be only one or limited number of producers and suppliers in the market and therefore, they will exercise their power to increase the price over and above marginal cost.

Since, they do not want the private entities, they try to be the sole operator in the market as has happened in case of Coal India. Coal India was a totally a public enterprise till February 2018 and after that it was privatised. Indian Railways is another very important example where we see public monopoly. State is the only producer and supplier of the railway services in India. However, if you look at the airline services, there are multiple suppliers including state being one of the suppliers and you will see that the economics of the railways is very different from the economics of air lines.

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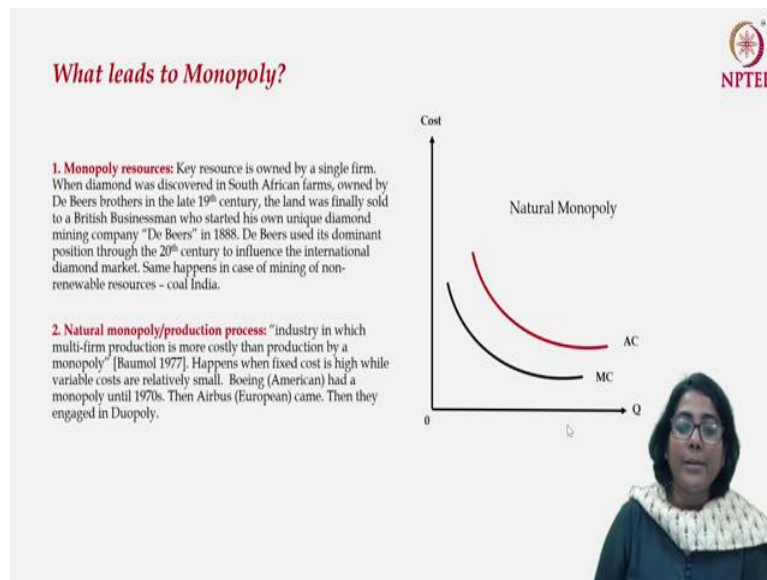
We understand the monopolist is going to deviate from the marginal cost and charge a price which is higher than marginal cost. But the more interesting and fundamental question is what leads to monopoly? What are the circumstances that actually lead to a monopoly kind of situation?

Two reasons are mentioned here, one is the monopoly of resources and the second is the case of a natural monopoly. Basically, if you have monopoly over resources that too may lead to a case of natural monopoly. To explain the monopoly of resources let us take a very interesting example which is although unrelated with energy. This is a very interesting example to understand the monopolistic behaviour of the diamond industry.

Diamond was first introduced in the late 19th century by the Dutch brothers who are the De Beers Brothers and who owned some firms in South Africa. The firms were owned by these brothers and they actually discovered some diamond in their field. Once it was discovered people came to know that some very important and precious things have been discovered in this field and therefore, everybody wanted to buy that land.

The land which was initially owned by the De Beers brothers was bought and sold and changed hands for a number of times. The British government at that point of time got involved to have access to that land and finally, a British businessman bought this piece of land and they started a mining company of diamond called De Beers in 1888.

This sole piece of land and some peripheral land in that part of the world had the initial resource to start the business and in no other part of the world diamond was discovered. So, when the De Beers was formed in 1888 this British businessman was the only one who had access to the resource. In this way if only one person or one company has access to resources then the monopoly automatically comes and this monopoly of De Beers in the business of diamond actually continued for a long period of time, after even the late 20th century. It was abolished because there were certain allegations against monopoly and then the business strategy changed and now, we also get diamonds in some other parts of the world.

Same kind of thing happens in the mining of non-renewable resources for example, Coal India where we said that this is a public enterprise. Mining is a very cost intensive affair, not everybody can invest in mining, not everybody can invest in the oil field, it is an investment sensitive affair and it has other characteristics as well, as asset specificity which we have discussed.

If the business falls then the asset that you have purchased is not going to be used in some other way. There are a lot of risks that you have to take. There are not many people or there are not many business houses that can take this kind of risk. If that is the case then at the very initial stage, we have a limited number of willing producers who are entering into the market and therefore, in future only some of them will sustain. Those who succeed they will sustain and at the end of the day we actually stay back with a very limited number of successful suppliers who have discovered the resources and who can economically extract the natural resources.

This again leads to a monopoly. If the government wants to restrict the entry of the private enterprise in this kind of action then the government can go for public ownership. There is another reason why public ownership is actually important in this kind of energy resources. The reason is that, given the asset specificity, high investment at the beginning, huge gestation period, low rate of return at the initial phase; all these things discourage people from investing in energy projects.

In order to make it up, the government sometimes comes forward and takes the responsibility to invest in energy related projects and therefore we see the production of electricity by government owned enterprises, still dominating in India and may be the reason is because it is a very high-risk investment. Although, nowadays the situation has changed and there is a lot of deregularization, we see a lot of private entities coming along and supplying them in the

power sector as well. There is an opening up of coal mines as well, so things are changing in different directions nowadays.

The second thing is a little more theoretical although the genesis is very practical, a quote from Baumol's writing in 1977, he says that, in an industry in which multi firm production is more costly than production by a monopoly, there you have a natural monopoly. This happens when fixed cost is very-very high. The average fixed cost curve looked like a rectangular hyperbola; it was declining throughout. The average variable cost was initially declining and then it looked like a 'U' shaped curve and then it went up.

As long the average productivity of variable input increases, average variable cost declines, as soon the average productivity of the variable input starts declining variable cost will start increasing. The average cost curve was the vertical integration of the average fixed cost curve and average variable cost curve. Up to the point at which the average variable cost curve was declining; average cost curve will decline because up to that point both average variable cost as well as average fixed cost is declining. After that, for a while the average cost curve will decline because the influence of declining average fixed cost curve is more. After that the average cost curve is rising because the influence of rising average variable cost was greater on average cost. That is why we got a kind of structure of average variable cost and average cost and average fixed cost.

The problem is that if you have an investment where the average fixed cost is very high and variable cost is quite low, in that case the entire cost structure is dominated by the average fixed cost. If there is a dominance of average fixed cost, the shape of the average cost curve was determined through the interaction between the shape of average fixed cost and average variable cost that is average variable cost is too insignificant as compared to the average fixed cost, then the pattern of average fixed cost will guide the pattern of average cost curve.

In those industries where the fixed cost itself is too high because the average fixed cost is totally falling, the average cost will also keep on falling, it will never rise. This is the case of a natural monopoly where the average cost curve is always declining.

Theoretically it is always true that if average declines then the marginal has to be below the average. Let us take an example from a cricket match. Suppose India has a falling run rate, India is batting and it has a falling run rate. After 10 overs India has scored 60 runs, 6 is the run rate. The average score, analogy of average cost is 6. We are saying that the average cost

is declining. The average run scored by India has to decline, it has to decline from 6 to say less than 6. In order to make the average less than 6, in the 11th over India has to score 5 runs. The marginal is less than the existing average. This is always true; this is the universal relationship between the average and marginal. If average falls then the marginal will always lie below the average.

In this kind of a situation where the industry has a very huge fixed cost, given is how the marginal cost and average cost curve look like. Both of them are falling however, the marginal cost is always lower than the average cost. This is a case of natural monopoly. It is called natural monopoly because if you look at the curves, as you keep on increasing the production the cost will decline forever. There is no incentive to stop production, where as a new entrant, a new firm will have to start from a high price. As you keep on increasing production, the cost falls. As the new entrant will start from a higher price he will stand nowhere in competition with respect to the existing firm. Therefore, everybody other than the existing firm will be driven out of the market from the competition as a supplier. This is generally called the natural monopoly.

There are multiple examples of natural monopoly, one close example is in the US till 1970 there was only one company who produced the aircrafts and that was Boeing. Boeing had the monopoly in the production of aircraft until 1970. Until the 1970's we have to make a huge investment in order to be able to manufacture the aircraft, once you make that investment the variable cost is insignificant as compared to that. After 1970 it changed as we have Airbus as well. They have engaged in more of an oligopolistic or duopolistic setup but that's different. What we try to imply at this point is that if we look at the characteristics of monopoly, we will see that there is a close match between the characteristics that we have been discussing with the energy projects because energy projects have sole access to resources, have very high initial investment, relatively low variable cost as compared to the fixed cost and so on. It gives us a glimpse that probably monopolistic market structure may be able to capture the energy market. However, the mathematics of monopolistic market structure is a little complicated as compared to the perfectly competitive market structure. We will go slowly and we will try to understand where does the equilibrium take place?

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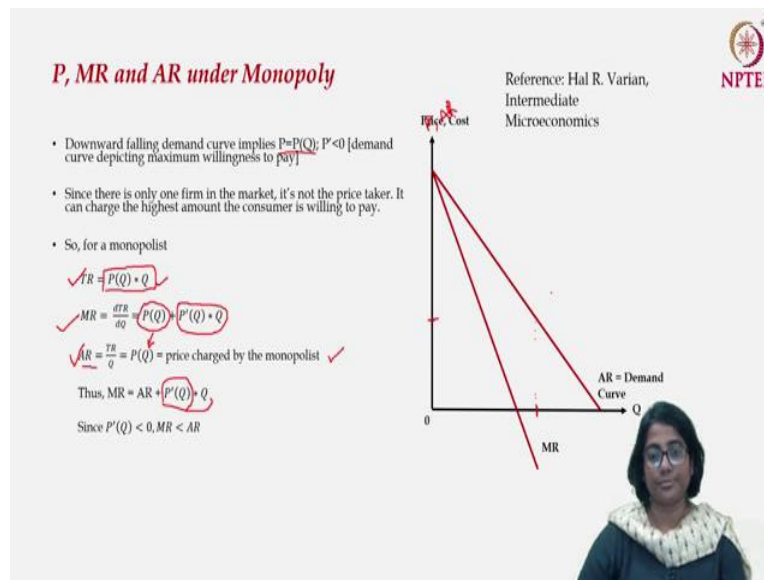
If you want to explore some of the basic economics books in order to understand this kind of market structures, one very good book that we always refer to is the Intermediate Microeconomics by Hal Varian.

Let us look at the equilibrium that we have under monopoly, how is there a deviation from the equilibrium that we had already obtained in the context of perfectly competitive market structure. We start with the downward falling demand curve in case of the monopoly. Similar to the perfect competition, there is a downward falling demand curve and this demand curve is represented as $P = P(Q)$

We plot P and we are also plotting cost here. If you look at this demand curve, this is the market demand curve. This is the demand curve that the monopolist is facing. This demand curve is denoted by $P = P(Q)$.

$P = P(Q)$, $\acute{P}<0$, as Q increases P falls, this is true because this is a negatively sloped curve. The demand curve actually captures the willingness to pay the consumer. This is how we have not so far interpreted the demand curve but this is one of the very crucial interpretations of the demand curve.

Why does the demand curve capture the maximum willingness to pay of a consumer? At any point on the demand curve we can say that if given is the quantity demanded, what is the maximum price that one is willing to pay? If the following is the demand curve, the consumer

will say I am willing to pay this much amount of price at maximum. If you charge me a price which is more than this, then I am not going to buy your product. As the demand curve also represents the maximum willingness to pay of the consumer however, we will realise that the price that was charged in the competitive market was actually not the highest willingness to pay of a consumer and was actually lower than the highest willingness to pay of a consumer.

If you ask the consumer to pay at a given price for this much quantity, the consumer will probably agree and that is what the demand curve says. Since there is only one firm in the market it's not the price taker, it has some monopoly power, it has some market power and therefore, it can change the highest amount. It can change the price from the competitive outcome and the highest amount of money that the consumer is willing to pay for a particular level of output.

How does mathematics go for the monopolists? The monopolist will also try to maximize the profit and it will always be at the heart of any producer be it a perfectly competitive market, be a monopolistic market. The profit is always equal to $TR - TC$.

What is total revenue of a monopolist? For the monopolist the $TR = P(Q) * Q$ but the monopolists can actually extract the highest willingness to pay of a consumer as such P is not fixed for the monopolist. For a monopolist unlike the perfectly competitive market this $P = P(Q)$, as Q changes the monopolist can charge different amounts of price from the consumers, it's not fixed by the market. Monopoly has this power and this is the total revenue of the monopolist.

If this is the total revenue, then you see what is the marginal revenue and what is the average revenue? The average revenue (AR) is $\frac{TR}{Q}$, this is equal to $P(Q)$. If we plot average revenue along with P, we will see that $AR = P(Q)$ actually denotes the average revenue curve and $P = P(Q)$ was denoting my demand curve.

So, essentially the average revenue curve and the demand curve are the same, there is no difference. The line that has been drawn represents both the average revenue curve as well as the demand curve and this is the price charged by the monopolist.

Let us now come back to the marginal revenue part. For marginal revenue what we have to do we have to take $\frac{\partial TR}{\partial Q}$. Although the monopolist can choose or influence the price because price

is a function of quantity, the choice variable in front of the monopolist is also initially the quantity. Once the quantity is decided based on the demand curve it can charge the price but initially it's going to determine, what is the quantity that is going to be produced?

If we take the MR that is $\frac{\partial TR}{\partial Q}$, we get $P(Q) + \acute{P}(Q) * Q$. There are two components in total revenue function $P(Q)$ and Q. When we take total derivative, in the first place we keep $P(Q)$ constant and we take the derivative of Q with respect to Q. So, that is giving me this term. In the multiplicative rule we keep Q constant and take the derivative of $P(Q)$ with respect to Q. That is giving $\acute{P}(Q)$. With the second term in the multiplicative form we get $\acute{P}(Q) * Q$.

The marginal revenue has two components $P(Q)$ and the other component is $\acute{P}(Q) * Q$. This $P(Q)$ is also the average revenue. If we replace the average revenue by $P(Q)$ we get $MR = AR + \acute{P}(Q) * Q$. This is the relationship between the marginal revenue and average revenue.

In case of a perfectly competitive market we saw that the $MR = AR = P$ and everything was being determined from the outside of the market. Here we see that there is a departure or there is a difference between the marginal revenue and the average revenue. Whether the marginal revenue is higher than the average revenue or the average revenue is higher than the marginal revenue, that is the question.

That is actually determined by the sign of $\acute{P}(Q)$. $\acute{P}(Q)$ is the derivative of this in the equation of this line with respect to Q. This is basically telling me the slope of the demand curve or the slope of the average revenue curve.

We see that the slope of the demand curve is negative. The demand curve is falling. So, MR is equal to AR minus some positive number. We can say, plus some negative number or minus some positive number, so we need to add something to MR in order to get the average revenue. So, marginal revenue is actually lower than average revenue.

In this diagram if we draw the marginal revenue curve, the average revenue is different from the marginal revenue curve and this is how we draw the marginal revenue curve. Theoretically, we can prove that curves may start from the same point and the marginal revenue curve has half the slope of the average revenue curve and it just falls half way below the average revenue curve but we are not going into those kinds of details here.

The only point that we want to make here is that in case of a monopoly, unlike perfectly competitive market structure the demand curve is not the marginal revenue curve. The demand curve is not the marginal revenue curve and demand curve is not also the average revenue curve. The equality between the price, marginal revenue and average revenue needs to be relooked in case of the monopoly.

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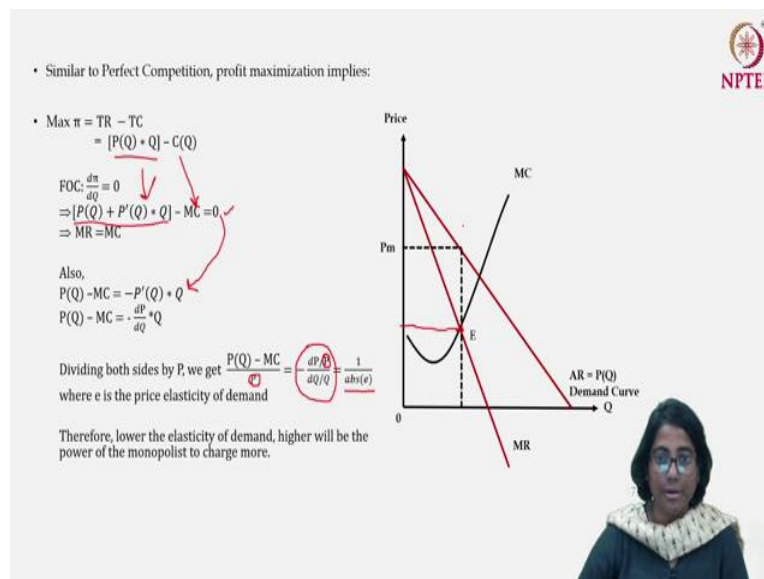
Similar to perfect competition the profit maximization for monopolist also would imply maximization of profit which is $TR - TC$. The only difference is that the price is defined in a different way, instead of writing $P * Q$ for TR we write $P(Q) * Q$ because the monopolist has the power to change the price.

What does the first order condition say? The first order condition says that we have to put $\frac{\partial \pi}{\partial Q} = 0$ because Q is the choice variable. From this term $P(Q) * Q$, I get this particular expression, how it is obtained is explained in the previous slide. Then we take the derivative of $C(Q)$ with respect to Q and we get the marginal cost. For profit maximization the monopolist has to equate the marginal revenue with marginal cost.

This was the same in the case of perfect competition as well, however the marginal revenue is now being defined in a different manner. This component, $\acute{P}(Q) * Q$ was not there in the marginal revenue that we calculated for the perfectly competitive market. For perfect competition $MR = P$ because that was determined by the market.

We see how the equilibrium looks like in a diagram and there is a small twist here. This is the demand curve and average revenue which is equal to $P(Q)$. The marginal revenue is actually lower than the average revenue curve and this is how we have depicted the marginal revenue curve and then we have imposed the marginal cost curve. In order to achieve the profit maximization, the equilibrium takes place at the point where the marginal cost intersects the marginal revenue curve.

In case of perfect competition, P was intersecting the MC. P was MR and we were taking the intersection of MC with MR there as well. Here point E is telling us how much a monopolist should produce. The monopolist should produce a given amount of output. Let us call it Q_m, so Q_m is the output that the monopolist should produce given the profit maximization.

What should be the price that the monopolist will charge? We have already discussed that if you look at the demand curve, for any particular quantity the consumer is actually willing to pay up to a given price. At point E, the monopolist will determine how much quantity is needed to be produced and it will continue up to the AR curve to determine what is the price to be charged. The quantity is determined by the intersection of MC and MR. Once we decide the quantity, we put that quantity in the function of the demand curve and then determine the price that the monopolist would charge. This is the difference between the monopolist and the competitive firm.

Also, one more thing you can observe from this particular equation is that, if $\acute{P}(Q) * Q$ is taken to the right-hand side than we are left with $P(Q) - MC = \acute{P}(Q) * Q$. This is derived from this particular equation. If we write it in this way and then also what I can write $P(Q) - MC = -\frac{\partial P}{\partial Q} * Q$.

If I divide both the sides by P, the left-hand side becomes $(P(Q) - MC)/P$. The right-hand side will then become $-\frac{\partial P/P}{\partial Q/Q}$. This Q is actually going up and we are adding the divided by P. Each side is being divided by P, rest of the things remaining unchanged. This expression is in fact the reciprocal of this expression $-\frac{\partial Q/Q}{\partial P/P}$ which is the elasticity of demand i.e. change in percentage demand with one percent change in price.

This $(P(Q) - MC)/P$ is $\frac{1}{|E|}$ because the demand curve is negative $\frac{\partial P/P}{\partial Q/Q}$, this itself is going to have a negative value. Since we are adding one minus sign here therefore, we are saying that this is the absolute value of the elasticity.

The interesting thing is that if the price elasticity of demand is low, then this $\frac{1}{|E|}$, right-hand side is going to be high. If this is high, it means that the gap between price and marginal cost will be higher. Lower the value of elasticity, higher will be the gap between price and marginal cost.

The lower the elasticity, the monopolist will be in a better position to charge higher prices from the consumer. This is quite logical in the sense, think about the product which has less elasticity. Low elasticity of demand means even if the price rises you do not change demand that much. These are necessary goods or may not have a substitute of those commodities. These are the commodities for which the demand doesn't change much whenever the price is changing. The consumer doesn't have much flexibility on their part.

And in that case the monopolists have a market power to charge a price which is much higher than the marginal cost. This is what we have written therefore, the lower the elasticity of demand, higher will be the power of the monopolist to charge more. The gap between marginal cost and average revenue curve will be higher if the elasticity is higher.

However, what is most important here is to observe that E gives the equilibrium where the marginal cost is equal to marginal revenue. The output is being determined however, to understand what the price is going to be, you have to go up to the demand curve which is the average revenue curve and from there you actually decide the price for a monopolistic firm.
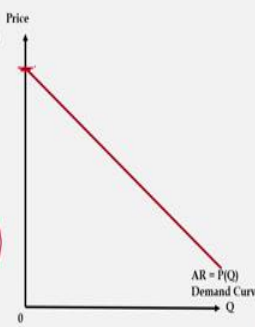
Let us do a quick exercise which may make our understanding a bit clear. Suppose the demand function is given by $Q = 120 - 3P$. This is how the demand function is given. We have also discussed that the demand function itself is the average revenue curve. The cost function is given by $C(Q) = 108 + 2Q^2$. The objective is to find out the price and quantity solution for both the monopolist as well as the perfectly competitive market and we will understand where the difference lies. We start with the monopolist, for the monopolist the demand curve is $Q = 120 - 3P$. If this is the demand curve, we can write it in an inverse way because we are saying that the price is a function of quantity, we are trying to express price as a function of quantity. Just by changing the signs we can write $3P = 120 - Q$ and therefore, $P = \frac{120 - Q}{3}$.

This gives us $P = 40 - Q/3$ and this is the equation for this particular line. This is the average revenue and also represents the maximum willingness to pay of the consumer. The amount that the consumer is willing to pay at max for any quantity is reflected in this demand curve. The monopolist will charge the price along with this line.

We have to see where the profit maximization leads us? Profit is again $TR - TC$. $TR = P * Q$ but this P is a function of Q itself. We plug this value of P from here in order to derive the TR. The TR is $(\frac{120 - Q}{3}) * Q$ is the TR that the monopolist is earning.
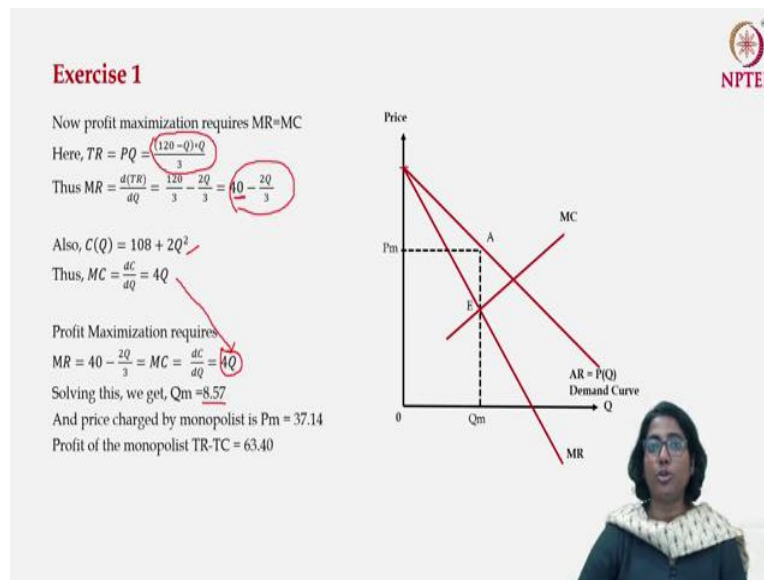
If this is the $TR = (\frac{120-Q}{3}) * Q$ in order to get the marginal revenue we take the derivative of total revenue with respect to Q.

The first term is $\frac{120Q}{3}$ and the second term is $\frac{Q^2}{3}$. If you take the derivative of $\frac{120Q}{3}$ in terms of Q you are left with $\frac{120}{3}$ itself. If you are taking the derivative of the second term $\frac{Q^2}{3}$, we get $\frac{2Q}{3}$.

The marginal revenue will be $40 - 2Q/3$. The equation for the average revenue curve this is $40 - Q/3$. 40 is the intercept term and slope is $-\frac{1}{3}$.

If you look at the marginal revenue curve, the slope remains 40, this again justifies why the marginal revenue curve will also start from this point and if you look at the slope of the marginal revenue curve and if you take the negative away, it's double the slope of the average revenue curve.

We are getting $2Q/3$. That again justifies why your marginal revenue curve should start from the same point as average revenue and the slope lies just half way below the average revenue curve. This is a typical construction of the average revenue and the marginal revenue curve.

We have got our average revenue curve, marginal revenue curve and we know the total revenue. We have to understand, what is the structure of the marginal cost curve?

The cost curve is given by $108 + 2Q^2$. If this is the cost curve then in order to get the marginal cost, we have to take a derivative of this cost curve with respect to Q. We get $4Q$. The marginal cost is basically a straight line originating from this point 0. Let us add the marginal cost curve, by construction it seems that marginal cost curve will not reach 0 but ideally it should have been so. The slope should have been such that it starts from 0.

In order to go for profit maximization, we have to equate the marginal revenue with marginal cost. If we equate MR with MC, we have to equate $40 - 2Q/3 = 4Q$. If this equation is satisfied then I have to solve $40 - 2Q/3 = 4Q$ and it gives the solution at particular point E.

This is where the marginal cost and marginal revenue intersects and this is where we get the solution for Q which is 8.57. If we equate marginal cost with marginal revenue once again, we get the quantity that the monopolist is going to supply in the market, so 8.57 is the quantity. The question is what is the price that the monopolist is going to charge? In order to do that we need to pick the output 8.57, put it in the average revenue curve and understand what the price is. The average revenue curve was actually $40 - Q/3$. We put $Q = 8.57$ in $40 - Q/3$ to get the price and that will give a price which is $P_m = 37.14$. This is the value we get for the equilibrium price and this equilibrium price $P_m = 37.14$. The profit that the monopolist is earning can be easily calculated, this is the $TR - TC = 63.40$.

This is how we calculate the equilibrium of a monopolist. We equate marginal cost to marginal revenue in order to obtain the quantity. However, equating these two does not give the solution for the price, for that you have to pick the quantity, put it in the average revenue curve and then decide what is the P_m; what is the price that the monopolists are charging.
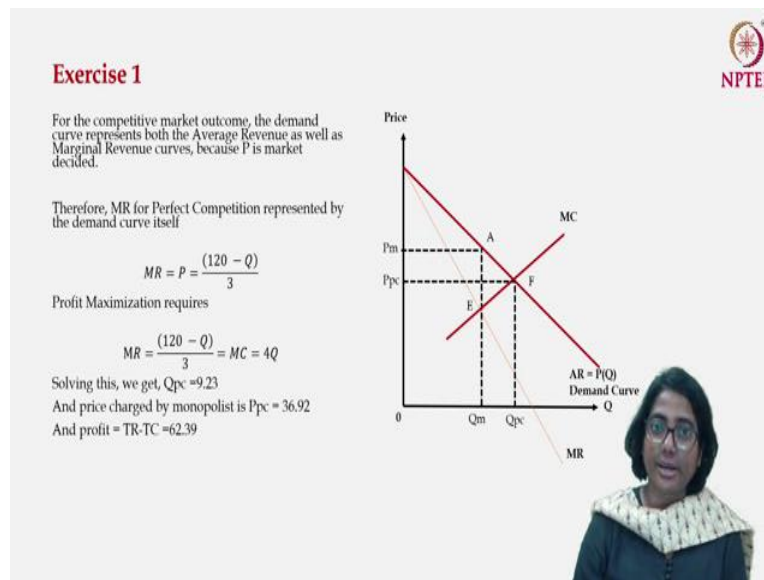
Let us see what happens in case of the perfectly competitive market outcome. We have made this MR line thinner because for the perfectly competitive market, average revenue itself is the marginal revenue. In case of perfectly competitive market, $MR = P = \frac{120-Q}{3}$, this is again given because P is given and we know this is the marginal revenue. The average revenue curve itself is the marginal revenue curve. Profit maximization requires equating this marginal revenue with marginal cost which is equal to $4Q$.

If you equate $\frac{120-Q}{3}$ with $4Q$, the solution is at 9.23. Instead of talking about point E, we are talking about point F, where the marginal cost curve actually intersects the marginal revenue curve for the perfectly competitive market which is also the average revenue curve for the perfectly competitive market. The equilibrium for perfect competition is obtained at point F. This is the quantity that the perfectly competitive market will produce.
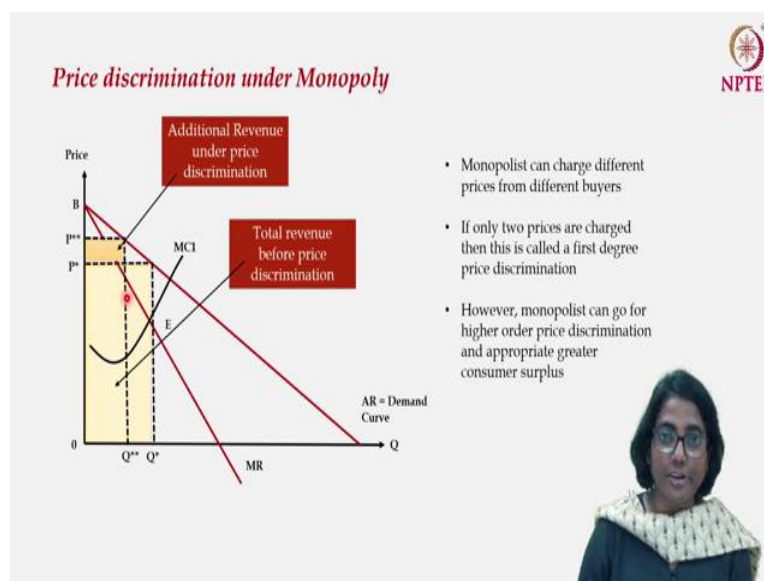
This perfectly competitive market has no way to manipulate the price, it will actually charge the price where the market outcome is determined and we can take this value 9.23 put it here, $120 - \frac{9.23}{3} = 36.92$. We can also calculate the profit as $TR - TC$. If we compare the equilibrium on market outcome under monopolist as compared to perfect competition, we see that under perfectly competitive market structure one tends to produce and supply more and charge less amount of money.

The price is lower and the quantity produced and supplied is higher in case of a perfectly competitive market structure. However, if you compare the total profit that is earned, the profit earned by the monopolist is higher as compared to the perfectly competitive outcome. These are the differences between the monopolist and the perfectly competitive outcome.

Why is it so important to understand these distinctions in the context of understanding the energy market? The problem lies in the fact that if you talk about energy market and if you can establish that energy market resembles monopolistic market structure more as compared to the the perfectly competitive market structure then you will see that the producers of the energy they will tend to supply less in the market, create some sort of an artificial scarcity in the market and will be able to charge a higher price.

Energy is a component of day to day life, it is required for everyday life, it is required for all kinds of activities, it ensures the security of the energy. If the market structure resembles the monopolistic market structure and there is a tendency of reduction in energy supply and a higher price, there is a scope for the government to intervene and correct this kind of market outcomes. The correction of this market outcome in the context of the energy market is very crucial. In the previous lecture we were talking about the regulation, how price correction takes place in case of electricity. This is where the government and regulation comes into place.

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There are two corollaries which are very important to discuss that unlike perfectly competitive market structure it is not mandatory for the monopolists to charge the same price to everybody.

They can charge two different prices to two different people depending on how much they are willing to pay. This is the typical monopolistic outcome that we can see here.

We show that the marginal cost intersects with the marginal revenue at point E therefore, the monopolists produces at Q^* and the price charged is actually P^*. What does the monopolist think? We said that demand curve, which is the average revenue curve represents the highest amount of money that an individual is willing to pay for a specific quantity. The monopolist is producing and supplying Q^* amount of product in the market and charging P^* amount of money. Q^* means we are producing and supplying in the market OQ^* amount of product. There are people who are willing to pay higher than P^*.

Instead of charging P^*, even if monopolists charge higher, they will buy this product. The monopolist can make two price slabs, one P^{**} and the other is P^*. It is actually dividing the entire output that he is supplying in the market in two parts.

OQ^{**} amount of output will be supplied in the market at the price P^{**}. All the people who are willing to pay more than P^{**} they will buy OQ^{**} amount of product in the market. However, for the rest of the people that is for this Q^* amount of product, the price that is set is at P^*. The monopolist depends on the information how much the consumer is willing to pay, the monopolist knows the demand curve and can charge differential prices from different consumers. This is called the price discrimination under monopoly.

Again, the energy market resembles the structure of monopoly. It is possible that different categories of people, different categories of income groups are charged differently for the same energy output. The profit of the monopolist changes when the price discrimination takes place. The cost remains unchanged, there is no change in the cost if you are charging two different prices from two different communities or from two different groups of consumers.

In the first case, if there is no price discrimination what is the total revenue? The total revenue that the monopolist will earn under no price discrimination is captured by the yellow block. The moment this monopolist has gone for price discrimination in addition to the given area it will also earn the revenue which is equivalent to other area.

The revenue of the monopolist will actually increase if there is price discrimination. This also means that it is not necessary to charge two prices, one can charge multiple prices. As we

increase the number of slabs it is possible for the monopolist to increase the total revenue and therefore total profit.

But there is a problem with regard to that, if we go to economic theory, we will see that this is the extraction of consumer surplus. The monopolist is being benefited however; the benefit is being reduced on the part of the consumer. The consumer benefit or the consumer's surplus is being transferred to the producer surplus. This is not always economically efficient and always argued in favour of.

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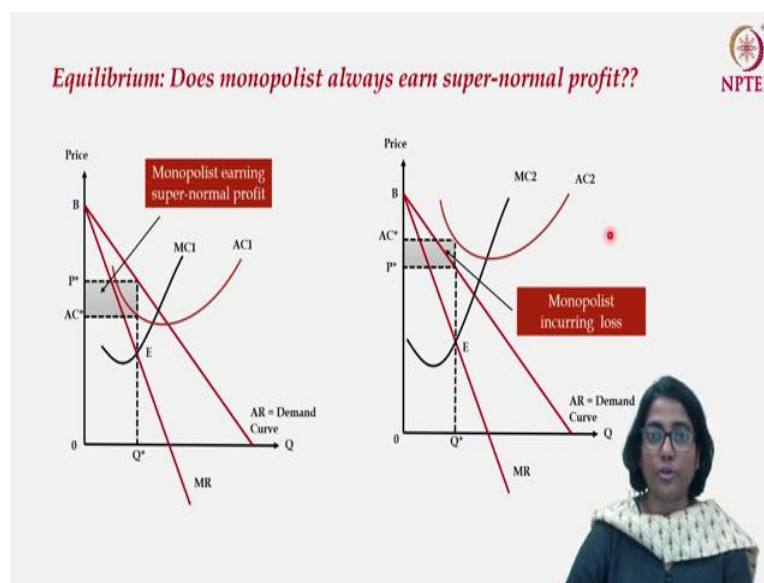
The last point that we have to make in the context of monopolists is, it is not always the case that the monopolist will earn a supernormal profit although, they can charge a price which is higher than the marginal cost. In the first scenario we have the equilibrium and quantity supplied by the monopolist, we have P^* and therefore and the average cost curve which is relatively low. If the average cost curve is low then the total cost of production will be captured by this area, $AC^* * Q^*$, is the total cost of your production. The total revenue will be $P^* - Q^*$.

It means, this particular monopolistic firm earns a supernormal profit because the price exceeds the average cost. However, that may not always be the case. There can be a situation where the average cost is so high that the monopolist, even after charging higher than the marginal revenue, will be unable to recover the cost of production. Here the monopolist is doing the same, producing at Q^* charging a price P^* however, the average cost is very high. As compared

to AC_1, AC_2 is much higher and therefore, the price is lower than the average cost. If the price is lower than the average cost then this is the loss that the monopolist is actually incurring.

This is a classic kind of situation where we see the role of the government. If there are energy projects and usually the energy projects will show a very high average cost and if that is the case there is a high possibility that there will be a loss in spite of being the monopolist. In that case the government comes forward and takes up the energy project, this is one line of intervention from the government.

We have already discussed that given the nature of the investment in the energy project, there is a tendency of achieving a natural monopoly because the fixed cost is too high, variable cost is relatively much less as compared to the fixed cost and so on.

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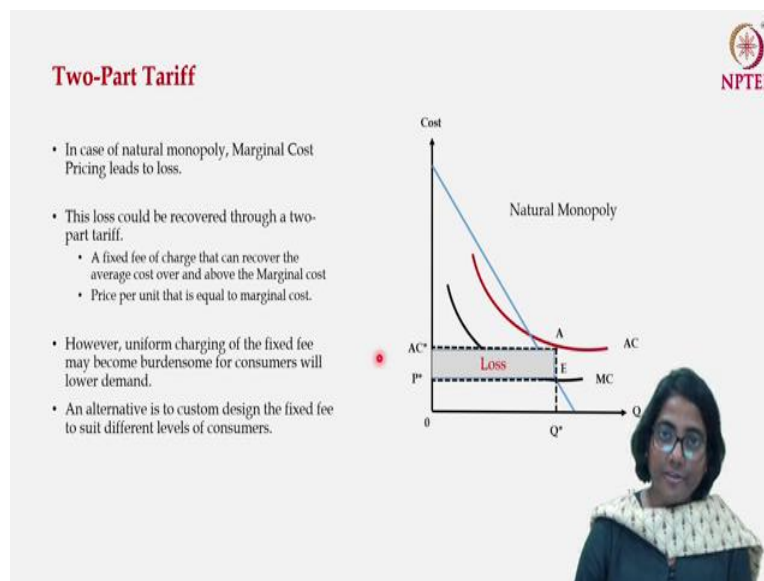
If that is the case, is marginal cost pricing really helpful, will that really be the optimal solution or not? The answer is no. If there is a natural monopoly, the marginal cost pricing does not lead to efficiency, the monopolist will actually incur some cost if there is marginal cost pricing. In case of natural monopoly, the average fixed cost was so high that the average cost keeps on declining and the marginal cost is lower than the average cost.

If this is the situation and if this is the demand curve and if we want to go by the marginal cost pricing then the equilibrium will be at E. We decide that the equilibrium is at E where the marginal revenue curve actually intersects the marginal cost curve and then we say that the

production should be at Q^*. But the problem is if the production is at Q^* the marginal cost is falling below your average cost.

This actually means that if the price that is charged is P^* from the natural monopolist, then average cost is exceeding P^* and therefore, you are incurring a loss. In case of natural monopoly, the marginal cost pricing will always trigger a loss for the monopolists and the monopolist will not be able to sustain. In that case the question becomes where does the remedy lies? The remedy lies in the two-part tariff, this is a common tariff structure in case of energy especially in case of electricity supply. The two-part tariff says that the tariff will have two parts; one is the marginal cost pricing. We recover the marginal cost that is one part and there will be a second part added to the tariff which will gradually recover the average cost over the marginal cost.

The P^* will be charged and we will charge something more than P^*, such that loss is also recovered overtime. This is called the two-part tariff and actually we all are very familiar with two-part tariffs. However, the question that remains is, we understand that there is a loss here but how are you going to distribute the burden of this loss to the consumer. Are we going to charge everybody the same amount of money as some additional amount added to P^* or are we going to distribute it in a different manner?

This is a major question in case of burden sharing. In case of electricity, if everybody has to pay a certain fixed cost than for some people, who are low end consumers of electricity, using only a few units of electricity, it will be too burdensome. The alternative that is suggested is to custom design the fixed P, we can charge everybody the marginal cost but the fixed P should be custom designed.
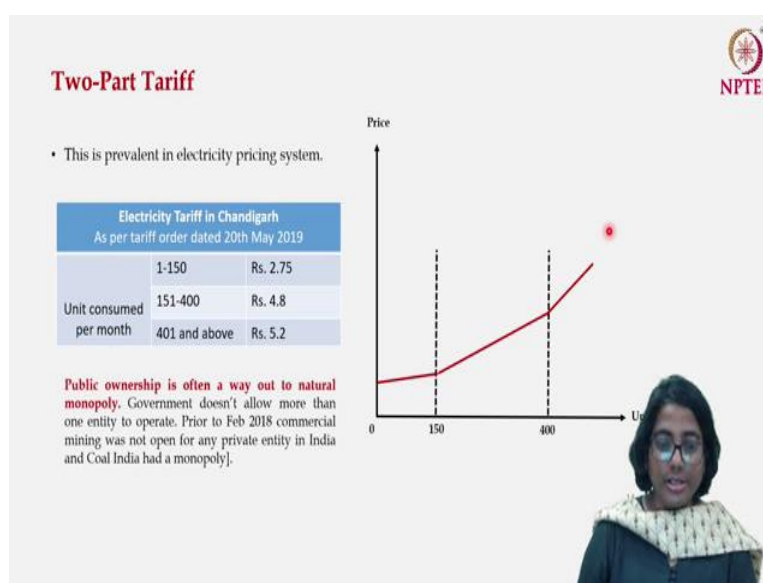
In India we do it in this way. We have taken the electricity tariff in Chandigarh. There are slabs given here, if electricity consumption is from 1-150 then per unit price is 2.75 rupees, if it is between 151-400 the rupees per unit is 4.8 and if it is above 400 units per month then you pay 5.2 rupees per unit. If you look at the marginal cost of production, in the previous case of natural monopoly we will see that the marginal cost of production is actually falling.

There is no justification if you base pricing on the marginal cost and to charge more at the higher slabs. But this is happening because we are trying to distribute the loss in the form of a fixed charge which is being collected from the consumers and this gives this kind of a tariff structure. The other thing is that when there is a natural monopoly and we try to work out a tariff structure which is not a typical $P = MC$ tariff structure, we really don't know how the private entities are going to work.

Especially in the 80's and early 90's there was a lot of public ownership that went around in the context of the energy industry. Energy industry was highly public investment heavy and there was a lot of public investment that was going on, so the government could control the tariff structure.

However, if you look at this two-part tariff, one part is to recover the marginal cost and the other part to recover the loss and this is how the tariff structure looks like. These are the thresholds 150 and 400. Up to 150 given is the tariff that can be charged and then the tariff

goes up. In order to make it look continuous it is kept but ideally it should be sort of a step kind of diagram.

We are going to close our discussion here by saying that, what we have observed so far is that the nature of the energy market is more closely associated with the structure of a monopolist which actually restricts the outcome of the market. It reduces the outcome of the market and tends to charge a higher price and we have also seen that in case of natural monopoly there will not be a scope where the price equal to marginal cost pricing can be applied and new innovative price mechanisms are applied in those kinds of situations.

In future lectures we will also talk about the oil market and we will see how the oligopolistic market actually is at the core of the world oil market.

Thank you.