Energy Resources, Economics and Environment
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Lecture 25
Revision Paper – Part 1

In this module we will look at the solutions of the revision paper, the second revision paper, I hope you been able to solve these, these are actually the questions are all related to whatever we have done in the course and so that we just go over it quickly.

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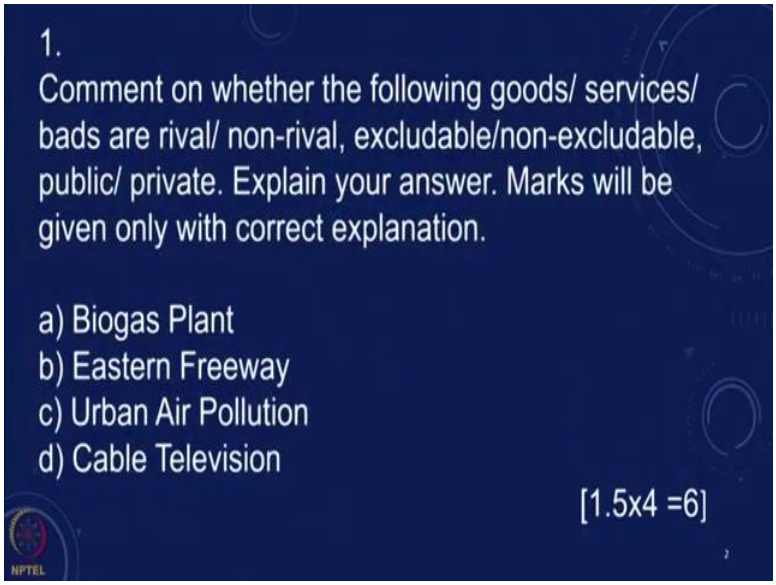

The first question is comment on whether the following good services bads are rival non-rival excludable, non-excludable, public, private explain your answer. And so, we will start with the first one biogas plant.

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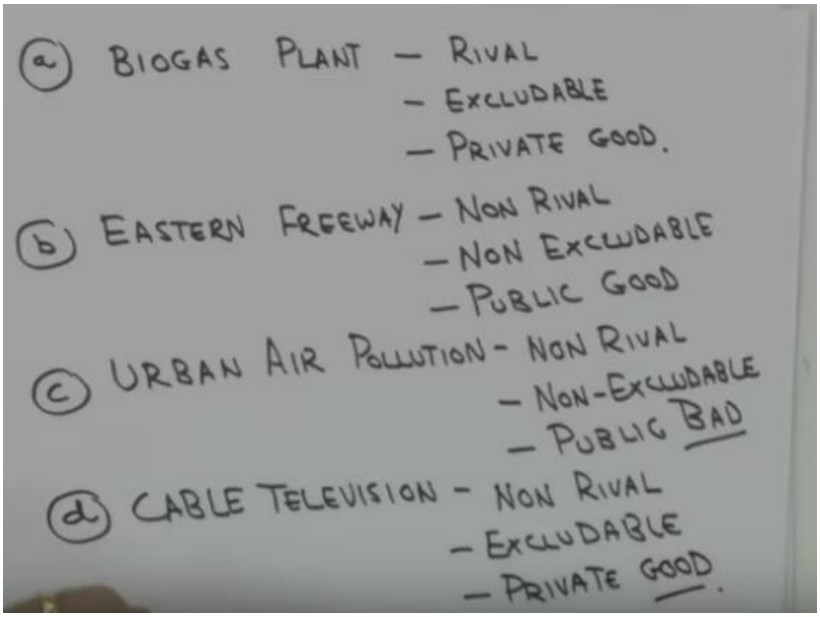

So, when you look at a biogas plant, a biogas plant is manufactured by a company it is supplied. It is sold at a price and if someone uses the plant, it will not be available to someone else. So basically, this is very clearly this is going to be rival as well as excludable, it is sold only once price has been paid. And so, this is very clearly this is a private good, now just look at the next one, the eastern freeway.

The Eastern freeway is a road in the city of Mumbai connecting the suburbs to the main hub, then going all the way up to CST and this is a this is a freeway there is no toll being charged. So, in a sense if now in this case in the case of road if there are if there are many cars coming on it there would be congestion. So, if we say that there is no congestion, then this can be this will be non-rival.

Someone using the freeway does not affect the ability of someone else to use the freeway. If you think of congestion, then it could be rival and since it is being made free, we are not. It is non-excludable and this can be treated as a public good. We could change the rules and if you have told then it is excludable, if we are looking at a congestion then it could also be rival, but in this case, we can consider it as a public good.

C) is urban air pollution, this is a big problem in most cities in the in India now. And if we look at this in a sense someone is breathing the polluted air does not affect someone else's ability to breathe that polluted air. So, essentially this is non-rival and generally this is also going to be

non-excludable. Of course, now people are putting air purifiers and looking at ways in which one can actually remove this so that could change, so this is what public bad.

And that is why, since it is a public bad, the normal rules of market are not very good at controlling this and then we need to have regulation, we need to have different kinds of methods. Now let us look at the last one, here this is cable television. In cable television, this is actually going to be non-rival. And in general, again, depending on the bandwidth there no congestion, you are watching cable television does not affect someone else's ability to watch it and you have these set top boxes.

So, only if you pay the charge you are going to be able to get the channel, so it is excludable and this is private good though it is non-rival. So, with this we look at it, so you can just summarize whatever we have done in the course related to private goods and public goods and these examples you illustrate this. So, let us move forward with the next part of the question 1e).

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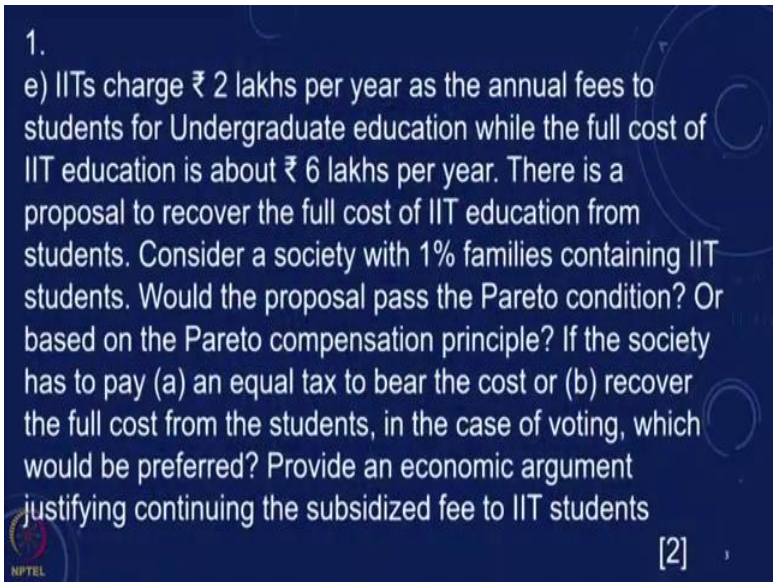

And this question says IITs charge 2 lakhs per year as annual fees to students for undergraduate education while the full cost of IIT education is about 6 lakhs per year. It may be a little more than that but for the point of view of this question we just put it as 6 lakhs per year. There is a proposal to recover the full costs of IIT education from the undergraduate students.

Consider a society with a 1 % families containing IIT students with the proposal pass the Pareto condition. So, the currently the students are paying 2 lakhs and the increase in fees would be 6 lakhs. So, if we look at a Pareto condition, the percentage of families, the families who are with

students, who are currently doing the education, they would not be there, they would not bear condition their utility would decrease because they would have to pay an additional amount.

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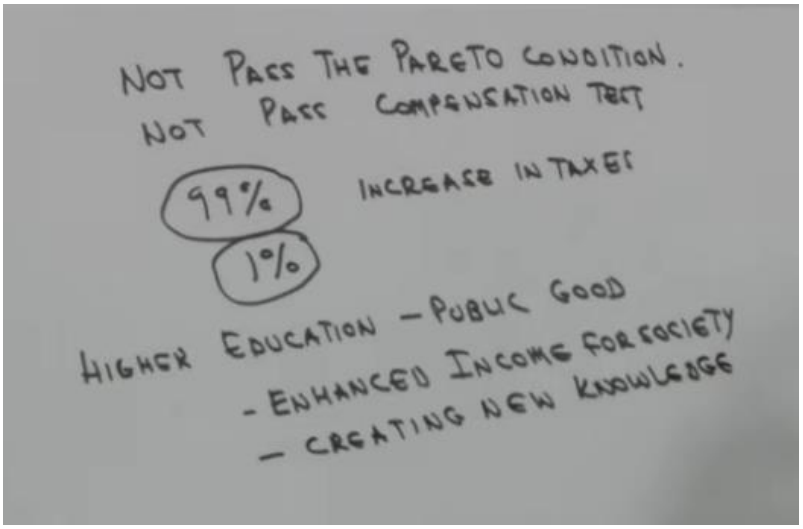

So, it will clearly not pass the Pareto condition. Others would not be affected but if we increase this, the existing students would their utility would decrease and hence that would not pass the Pareto conditions. Then the second thing is would it be based on the prior to compensation principles? Now, the compensation principle would not be, would not apply in this case, because possibly with this additional money which is coming in maybe the rest of the society will have to pay less.

But then there is no way in which they can compensate or provide the 1 % of students with the difference in this amount. So, it will not pass a compensation principle either, not pass the compensation test. Now suppose the next part of the question is, if the society has to pay an equal tax to bear the cost or recover the full costs from the students.

So, these are the two options, so clearly 99 % of the population would not want to even though the amount would be less, they would not want then increase in the taxes for education. The 1 % would of course say that an equal tax can bear the cost. So, from a voting point of view, the solution will be get an option where an equal tax to bear the cost will lose and the full cost would be borne from the students because it is only 1 %.

Now the last part of the question is, provide an economic argument justifying continuing the subsidized fee. So, if we look at higher education, typically as a public good and if we look at the products of that education resulting in an enhanced income for society, and every graduate

from the IITs based on the income that they are going to earn over the, over their lifetime and their career and the taxes that they pay to the government.

So, from an economic viewpoint, the enhanced ability to earn will compensate for the subsidized fee. The second thing is that in general, we can, they will all be also thinking in terms of creating new knowledge and providing an opportunity for all, so that means every individual has this opportunity and depending on their abilities, they can get through this and then they can upgrade their abilities and then they can contribute to society.

And in many cases, the graduates would actually also create employment and create. This, of course, is a debatable issue, but in many cases, you will see that a lot of literature talks about higher education actually being a public good, and this is something which benefits society in the long run. So, the other option, of course, is to provide loans but depending on the average income and taking a large amount of loan for education becomes a barrier for several families and this has an equity impact, let us move ahead to the second question.

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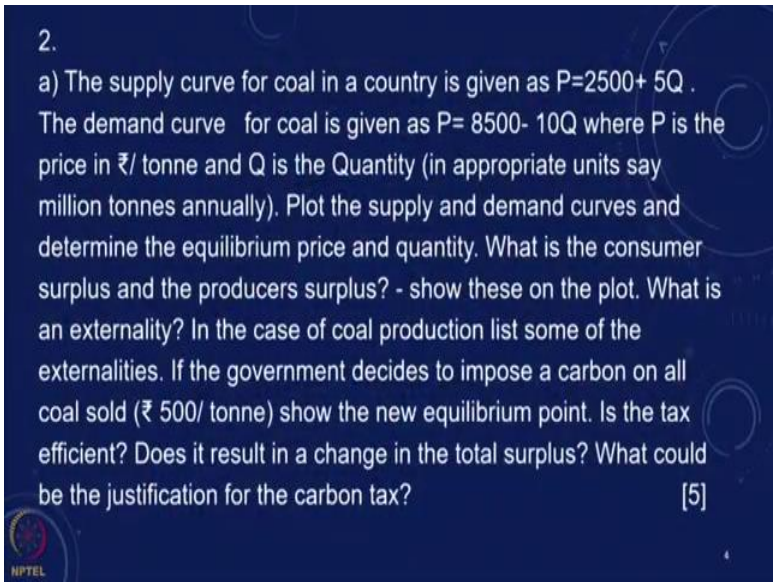

The second question is a standard supply demand curve which we had also solved it in the when we had done that module. If you look at this, this is a supply curve for coal in a country is given as P is equal to 2500 plus 5Q, demand curve is given as 8500 minus 10Q where P is the price in rupees per tonne. Q is the quantity in appropriate units in million tons annually. Plot the supply and demand curves, determine the equilibrium price and quantity, what is the consumer surplus and producer surplus, show these on the plot.

What is an externality in the case of coal production, list some of the externalities if the government decides to impose a carbon tax on all the coal sold, that means 500 rupees per tonne of coal, show the new equilibrium point? Is the tax efficient, does it result in a change in the total surplus? What could be the justification for the carbon tax?

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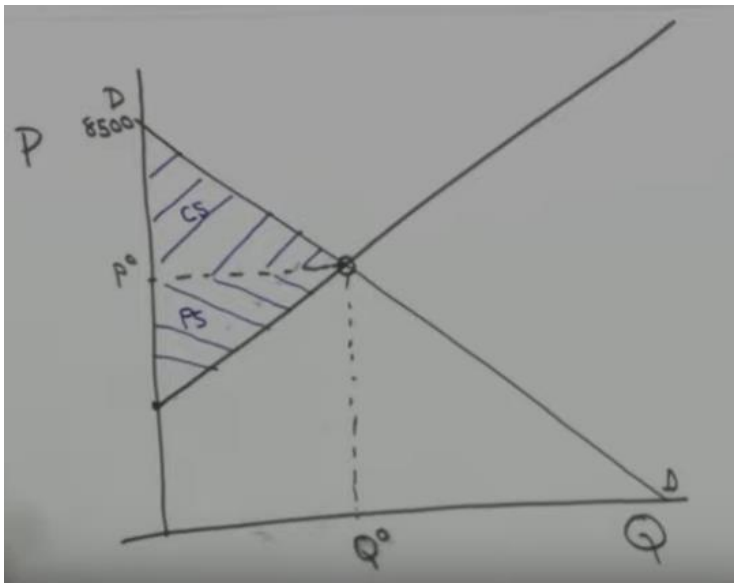

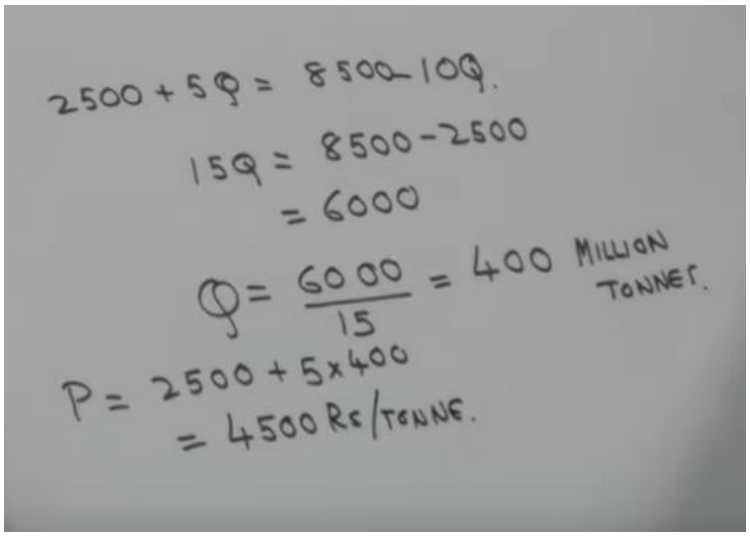

So, let us start with the first thing is that let us draw the quantity on the x axis and price on the y axis. And if we look at this, and the sub demand curve will be given as let us take this is the D, this is 8500 minus 10Q and so this is 8500 and the supply curve is, so let us say somewhere here 2500 plus 5Q. This is the point of intersection., this is the equilibrium quantity, equilibrium price.

And these points, this is the consumer surplus because this is the price paid is P 0 but at 0 quantity the demand we are willing to pay so much, so this is the consumer surplus and this one is the producer surplus., this is consumer surplus, producer surplus, this is the total surplus, so this is what we have done.

We can calculate this let us just calculate from the equation. Let us put down 2500 plus 5Q is equal to 8500 minus 10Q. So, we get 15Q is equal to 6000 by 15, 400 units, let us say million tons. What is the price, price is going to be 2500 plus 5 into 400 and this comes to 4500 rupees per ton?

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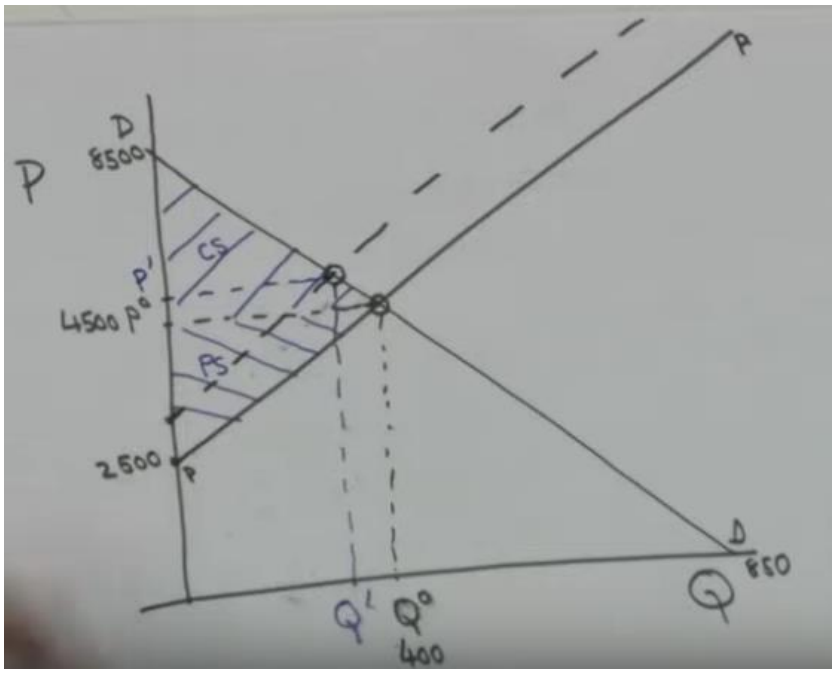

So, we can go back to this and write down, this is 4500, this one is 400. Yeah, this is 850. Okay, so now we have done this, show these on the plot, what is an externality? An externality is basically something which come influences the utility of a consumer or the production function of a producer without its own permission. So, in the case of coal production, what are the externalities that we have?

Well, we have the in the mining, there would be a lot of dust and there would be a lot of land modification. And in the case of there would be also pollution in terms of the both air quality as well as water. And so, these are the kind of things and then the use of coal, when we look at it will have carbon dioxide and we have new emissions.

So, these are some of the externalities and if the government decides to impose a carbon tax on all the coal sold, incidentally there is already a carbon cess today and it is probably around 400 rupees per ton. So, we have said here, suppose there is a carbon tax of 500 rupees per ton, how would the equilibrium change and is the tax efficient.

So, what this would mean is that if you look at the supply curve, for every time we are adding another 500 So, this will now start from 3000 and we would have it as something which would be, should be parallel to this So, now this will be the new point new point is Q dash and P dash. We can calculate this let us calculated by looking at how much will this be.

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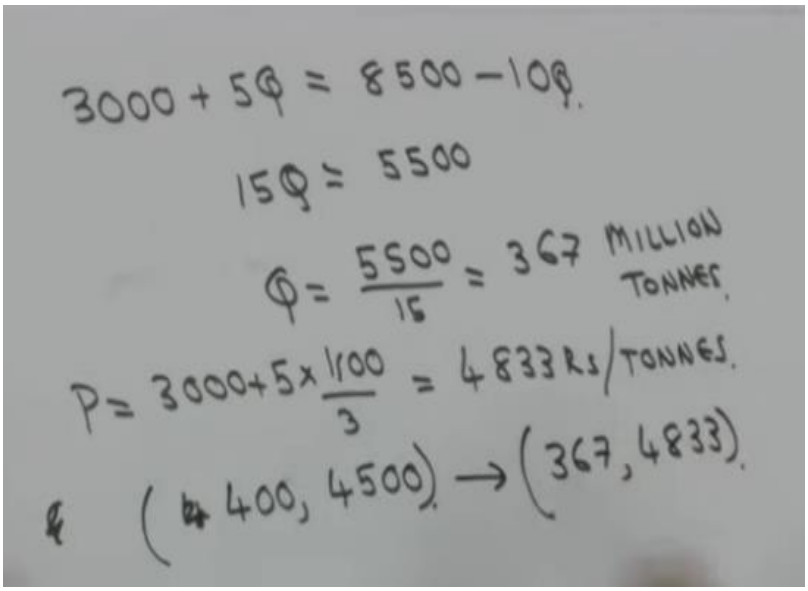

We can, 3000 plus 5Q is 8500 minus 10Q, so 15Q is 5500, Q is 5500 by 15, 367 million tons. What has happened is, we have now the equilibrium point has shifted and we are now reusing less amount of coal and the price now is 3000 plus 5 into 2100 by 3, which comes out to be 4833 rupees per ton. So, now we have shifted from the earlier case where we had the price of the initial equilibrium point was 4000 sorry 400 million tons and 4500, and this has shifted to 367 million tons and 4833.

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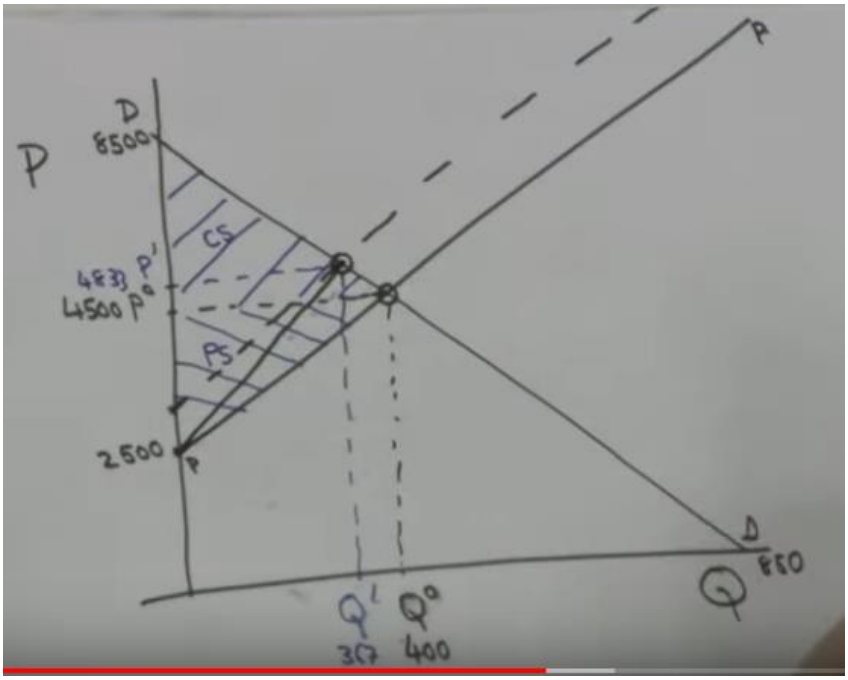

So, if we go back to the figure that we had, this is 367, this is 4833. Now, if you look at the total surplus, you will see that the total surplus has decreased. So, the tax of course, is not efficient from that point because the total surplus has decreased from an economic viewpoint.

However, the justification is that if we look at the cost of carbon and the social cost of carbon and incorporate that, then you will find that overall there is a benefit because we are reducing the CO_2 and then the benefit to society offsets the loss which is there for the consumers and the producers.

And so, the justification for the carbon tax is that we would like to see that we use, we reduce the total CO_2 emissions, and then we are trying to give a disincentive for using coal which has a high carbon content. So, this is, this was the calculation for the second problem. And now let us move on to the next problem.

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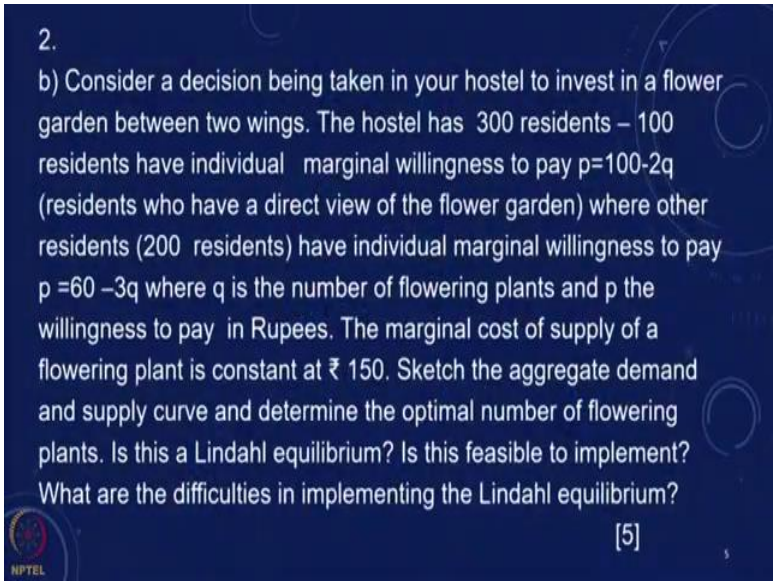

So, the here we are looking at, consider a decision being taken in your hostel so that we can invest in a flower garden between two wings. Now, the way this works says that the hostel has a large number of 300 residents, out of which 100 residents are willing to pay a little more, they have a marginal willingness to pay P is equal 200 minus 2Q because they can have a direct view of the garden.

While the other residents can if they are passing by will see it but they do not have it from their room. So, the 200 residents have a marginal willingness to pay which is less, 60 minus 3Q, where Q is the number of flowering plants and P is the willingness to pay in rupees, marginal costs of supply of a flowering plant is constant at ₹150, so at ₹150 you can buy one plant and then put it in the garden.

So, the question is how many plants should be put in the garden, so we want to sketch the aggregate demand and supply curves and determine the optimal number of flowering plants. And then we the question further asked is this a Lindahl equilibrium, is this feasible to implement, what are the difficulties in implementing the Lindahl equilibrium?

So, now, this is a public good and the supply though is something where there is a price for the supply, but the good of having a garden is something which is non-excludable and it is a private good, but the question is how much of that public good should we be providing.

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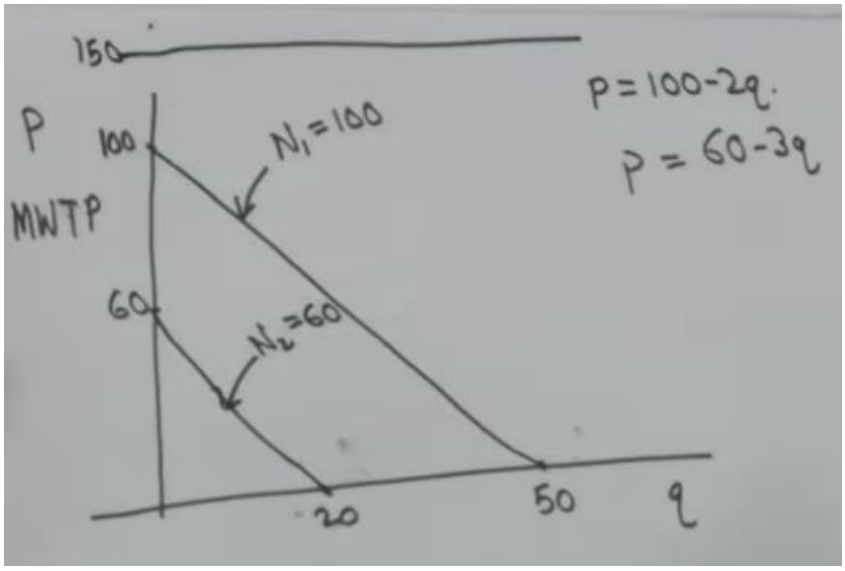

And when we look at this, if we try to sketch this, if we look at the marginal willingness to pay and P and the quantity Q, you will see that individual, the individuals who are, have a direct view of the garden have a marginal willingness to pay, P is 100 minus 2Q. So, this will go on to when it becomes 0 beyond so that will be 50, so we can just join this. This is the individual demand curve and there are 100 such individuals.

For the other set those who are not having a direct view of the, it will start from 60, P is equal to 60 minus 3Q, so, it will go on till 20. And here N2 is equal to 60. The demand, the supply the curve will be shown clearly as a straight line at 150.

Now, here what happens is that we aggregate based on the number of for the plants which are there, at any value of Q, we can find out how much people are willing to pay from these two curves. So, when it is between 0 and 20, you will have sorry the N2 is equal to 200. So, these 200 people will be willing to pay from here and 100 people So, we can take any point here and just take the values which will be here and multiply so we will get.

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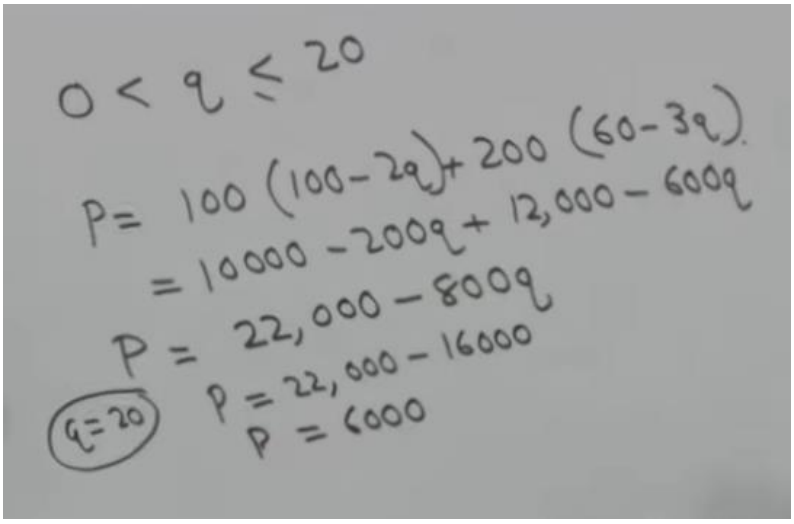

If it is it, if 0 let us just write this as 0 less than Q less than equal to 20, what will happen is the total willingness to pay aggregate demand curve P will be 100 into 100 minus 2 Q plus 200 into 60 minus 3 Q. So, this is 1000 10000 minus 200 Q plus 12,000 minus 600 Q equal to 22000 minus 800 Q. So, if we look at this, this is the total amount that we are willing to pay, this is going on from, so it will start from 22000 and then come down when Q is equal to 20. This will be P will be 22000 minus 16000, so this is going to be 6000.

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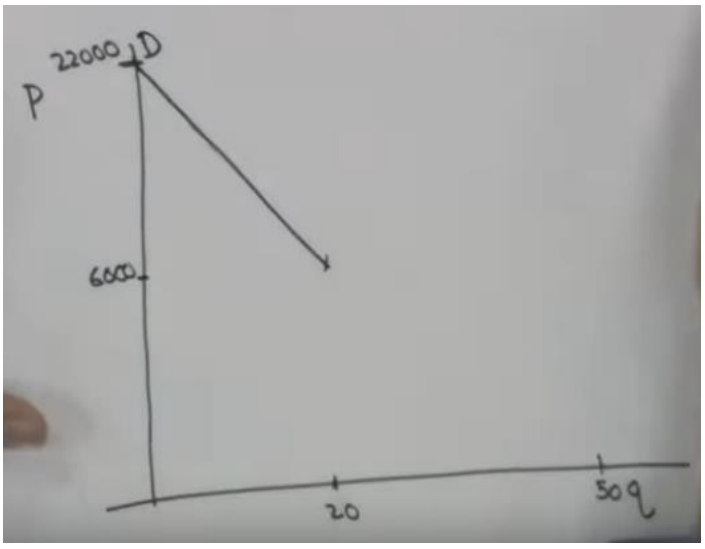

So, wha.t will happen here is that when we do this curve, the aggregate curve P, it starts from 22,000 and then we go to when we take 20 and let us take 50. In the case of this, 22 then 6 let us say 6000, this is the aggregate demand curve.

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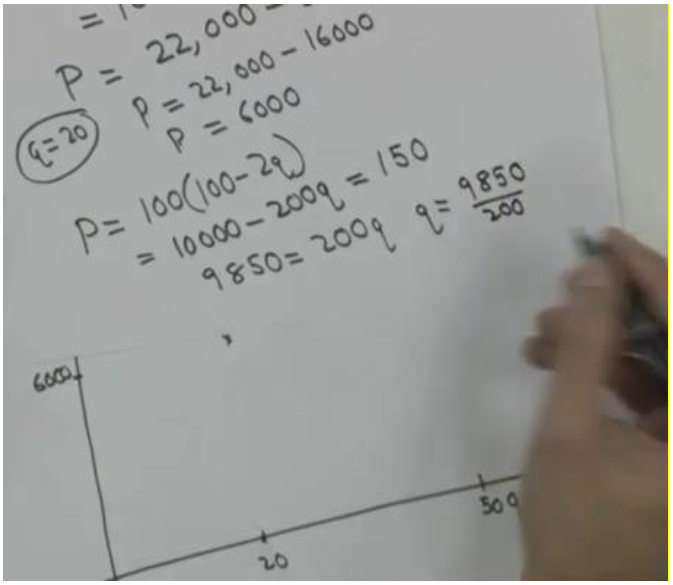

From here onwards from 20 to the next point it is only going to be equal to P is equal to 100 into 100 minus 2Q because all those the remaining the this set of individuals are not willing to pay anything beyond 20, it is only going to be this. So, when we look at this, this is going to be equal to 10000 minus 200. Now, if the supply price here is 150, so if we put this as 150 then this is going to be equal to 9850 is equal to 200Q, Q is 9850 by 200 So, we round it off to the smallest whole number, it comes to about 49.

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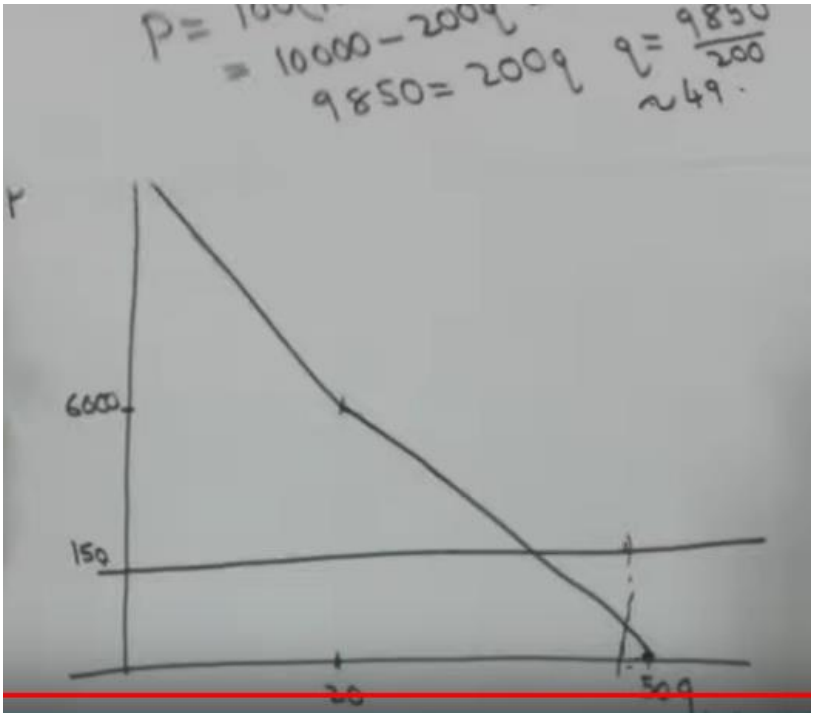

So, this we have a line here, which is the demand curve which is 150. And this is actually intersect, it will intersect almost at this point. So, this is if you draw it proportionately, you will find that this is the value which we stay. So, this is now the question which has been asked is, is this a Lindahl equilibrium?

Yes, it is a Lindahl equilibrium because we are asking individuals, what is their willingness to pay and then we are aggregating that is this feasible to implement, it is difficult to implement, one is because there is it is difficult to get the demand curves of the individuals, stated demand curves accurately. There is an incentive to understand the willingness to pay because you enjoy the quality, but you will pay based on your based on the marginal willingness to pay, so others may be getting a better share.

So, basically, the issue is the difficulties in implementing the Lindahl equilibrium is the ability to assess the individual demand curves and point that there is an incentive for individuals to understate their willingness to pay so, that actually end up not paying this. But it theoretically Lindahl equilibrium is an interesting concept. And there is this whole issue in terms of when we try to price a public good or a public bad, these are the kind of problems. So, this is what we have solved in this question.