Introduction to Environmental Economics
Prof. Diptimayee Nayak
Department of Humanities and Social Sciences
Indian Institute of Technology, Roorkee

Lecture – 57
Environmental Regulation and Basic Regulatory Instruments – Market Based Instruments / Approaches – III

Hello friends, we are discussing with the Market Based Instruments for controlling the pollution level. So, today, we will be discussing the role of subsidies or how subsidy can be helpful in controlling the pollution level. So, we will be discussing the very definition of subsidy then we will be discussing what is the role of subsidies and how it is used as an incentive in controlling the pollutions.

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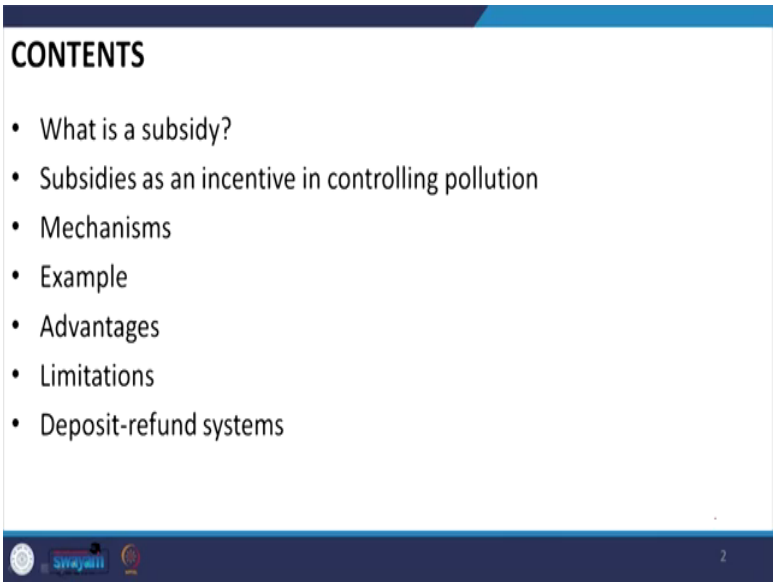

We will be discussing the mechanisms and details with suitable examples and then it will say followed by the advantages and limitations of this very instrument that is subsidy. And finally, we will be talking about a hybrid form of subsidy that is known as the deposit refund systems.

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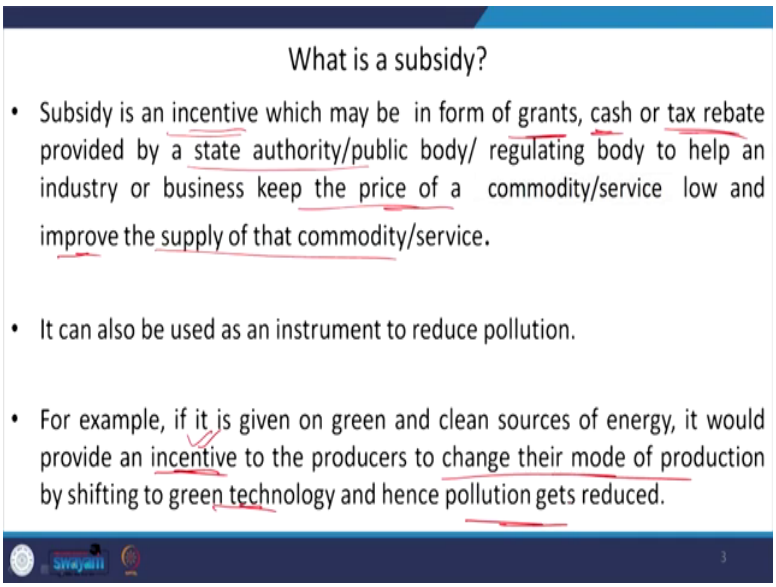

So, let us discuss with the first one that is subsidy. So, what is the meaning of subsidy? For a layman you are saying it is a kind of incentive of benefit that is given. And this generally this incentive is given in form of grants or cash or you can say the tax rebate if it is a case of the pollutions. And these subsidies are provided by a authority or a regulating body or a state body.

And obviously, this kind of incentives are given in order to help the particular industry or businessman who are doing some externalities or who are producing some kind of externalities. And this will be helping them to keep the price of this commodity or services

whatever they are producing at a low level and the second thing is that it can improve the supply of that commodity or the service in question.

And, moreover, when you are talking about the reduction of pollutions then, this subsidy can also be an instrument in incentivizing the polluting industry or polluting firm to reduce the pollution level. We can take an example, suppose say, we are talking about the difference between the green and clean sources of energy and; obviously, we are emphasizing the green sources of energy nowadays.

And that is why in order to promote more green sources of energy production. We need to actually provide some kind of incentive to those producers who are producing these green energies. And again, if you are providing this incentives then; obviously, it will be it will be used as a kind of incentive for changing the very behavior and the mode of the production and that is why it is likely that the conventional producers they can be shifted to the green technologies and hence we can control the pollution level.

So, that is how in a layman sense the what is subsidy and what is the role of subsidy in promoting the promoting improved quality. So, after understanding this let us understand what is the mechanisms of the sub subsidy. How this subsidy is working in improving the products and services and giving a kind of societal desirable output and price level.

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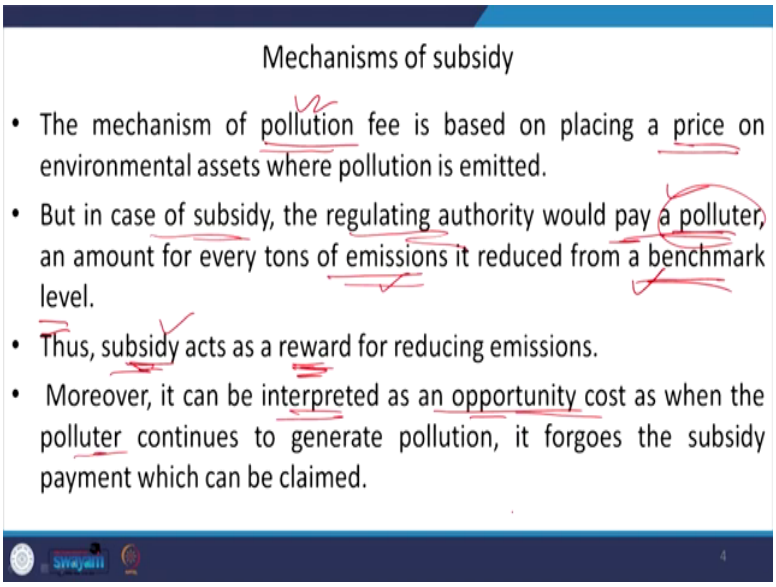

So, here so, far this mechanism is concerned we are here focusing on the pollution fee right. We are comparing with the pollution fee then we will be talking with about the subsidy. So, if we are talking about this pollution fee or sometimes a special case Pigovian fee then this mechanisms of this pollution fee is based on the logic that to put a price on the environmental assets right. Why because, pollution is emitted and the damage is done in the environmental asset itself.

But, in case of the second asset second instrument that is subsidy the mechanisms is here different. In the first case; we are taxing on the on the environmental assets were pollution is emitted right. And this price is to be paid by the polluter agency itself, but in case of the subsidy this is not happening the mechanisms would be different here. So, what is the difference?.

Here the regulating authority or the public authority who is in charge of controlling or monitoring the pollutions. So, they are going to pay a kind of incentive maybe grant or grant or a cash or some tax rebate right. And they are going to pay to this polluting industry or polluting firm. Why? Because, when these pollution this polluting firms are polluting industries they are trying to reduce the emissions level or pollution levels for its units of emission levels it is reduced, they are these eh agencies or this regulating bodies that they are providing kind of incentives to these polluting industries.

But, obviously; for that region, we need to see the benchmark of the level of pollutions. So, before doing this exercise, we need to actually the polluting authority, sorry, the regulating authority is going to see and set what is the benchmark level of emissions at that current time.

So, based on these taking this as a base and base mark or a benchmark; we eh need to also reduce the emissions level and the greater the emission level it is reduced by the firm itself then the incentives will be more and more. So, in this context, this subsidy is acting as a reward for the polluting agencies because if they are reducing this emissions then; obviously, they will be getting a kind of revenue in form of subsidy right.

So, in this context we can say, this reward or this subsidy getting subsidy or providing subsidy to the polluting industries can be interpreted as an opportunity cost. Why opportunity cost? Because, if the industries polluting industries if they are not going to reduce the pollutions then; obviously, they need to pay the tax for it. And if they are reducing the pollution then; obviously, they will be getting a kind of reward that is subsidy.

So, this subsidy can be interpreted as the opportunity cost when the when this particular polluting industries it is generating the pollutions and forgoing the subsidy payments.

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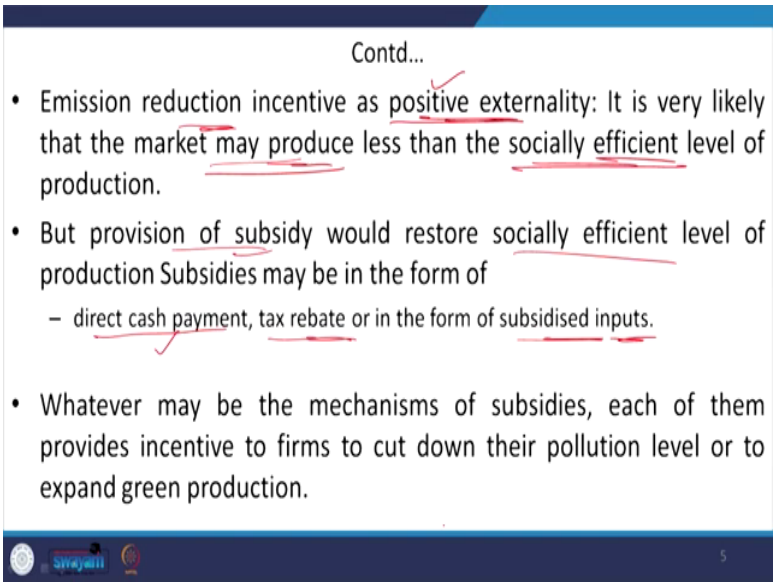

And moreover, this emission reduction; it is also acting as an incentives right in case of the positive externalities. So, we talked about two types of externalities; one is negative externalities. In negative externalities, we are saying this tax is suitable major taxing just like a pollution tax, but in case of this positive externalities; this subsidy can be useful as an instrument for controlling the pollutions.

So, so that is why you can say these in case of this emission reductions this externality is acting as a positive instrument for controlling the externality itself. And in this case, in case of this positive externality, what happens? It is very likely that the market will be producing less than the socially efficient level of production right. But in case of positive externality it is just the a reverse one. They are the more production will happen in comparison to the socially efficient level of productions right.

So, in case of positive externalities; where the actual level of production is less than the socially efficient level of production. Some kind of intervention from the government is required and it is in terms of the any kind of subsidy. So, so providing a subsidy in this case, it will be trying to restore the point or condition of social efficient level of productions and this social level of socially efficient level of production can be restored by the provision of any kind of subsidy like your direct cash payment to the polluting agencies or you can say getting the tax rebate or in form of the subsidized inputs.

And therefore, whatever may be the mechanisms of these subsidies. Maybe it is the direct cash payment or it is the tax rebate or it is the subsidized input. Each of these instruments they are providing incentive to the firms to reduce their level of pollutions right, and that is why they can actually adopt for green production or greener sources of energies in this example.

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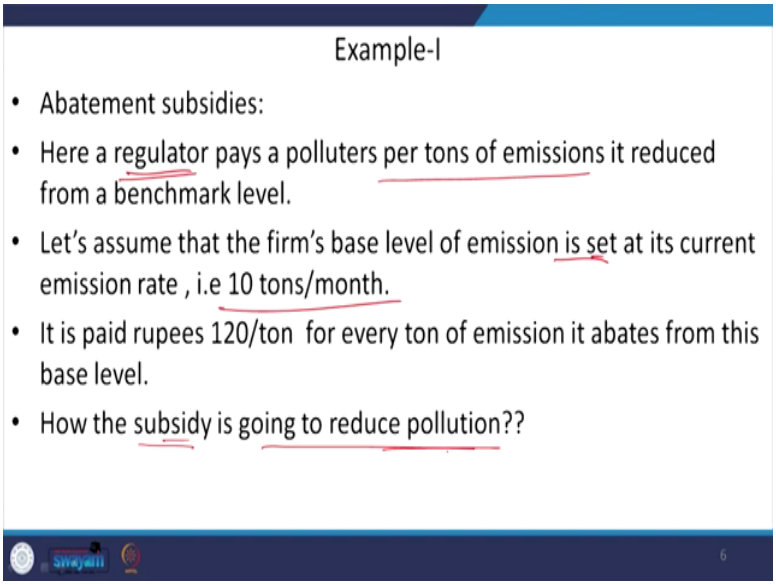

So, based on this subsidy context that we are saying it is eh acting as an incentives right to control the production pollution level. We can have two examples in this context. The first example we are talking about the abatement subsidies. So, what is abatement subsidies? That means; when the firm is reducing the level of emissions I am getting some subsidy that is provided by the government or regulating agencies right.

So, what is the conditions here, the condition is that the regulator here, the regulating authority or regulator here. It is paying the polluter right per ton of emissions that the industry or the firm is reducing from its benchmark level. So, in this context, let us assume that the firms current level or benchmark level of emissions is set right.

And that is 10 tons of emission per month. So, for every month it is producing the firm is producing 10 tons of emissions and we are taking the data of the current month right. And the firm is asked that if you are going to reduce the emission level every month then for every minute of reduction in emissions you will be you will be getting 120 rupees as incentives or are as rewards right.

So, if the if the firm is reducing from 10 tons of emissions to 9 tons then; obviously, the firm is going to get 120 rupees per ton per month right, but the thing is that the question is how these subsidy is going to reduce the pollutions right that we need to explain.

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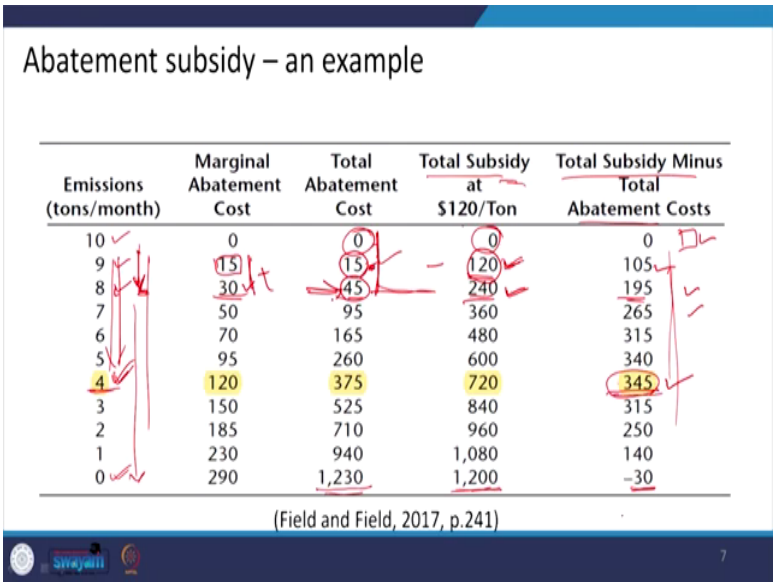

So, we can take an example numerical examples. So, let us say, we talked about that the firm is a now, set it is has set its benchmark level of pollution that is 10 tons of emissions per month right. So, that means; if the firm is going to produce the same level of emissions that is ten tons in the next month then it has not abated anything it has not reduced any pollution level that is why the total abatement cost would be 0 for the firm.

So, when the when there is no reduction in the emissions then what will happen? Then obviously, the firm will not get any kind any amount of subsidy. So, that is why we are saying; the total subsidy for the tenth 10 tons of emissions is 0 right. So, what is the total one? The grand total is calculated. So, the total subsidy minus the total abatement costs.

So, here we are finding this the numbers in this column. So, this is the total subsidy again 0 and total abatement cost is 0, so; obviously, it is 0. But in the next month of a say, the firm has

reduced it is emission level to by one unit that is right now it is producing nine units. So, its marginal abatement costs for reducing this one unit of emissions let us say it is 15 rupees right.

So, what is the total abatement? Obviously, here for the first minute the marginal is equivalent to the total. So, it is also 15 minutes, sorry 15 rupees. So, what is the subsidy that the firm will be getting by reducing one unit of its emissions. So, that is it is from it is that the regulating authority eh it would be paying 120 rupees for everyday reduction in the emissions.

So, that is why it will be getting 120 rupees. So, now, we will be saying what is the what is the total revenues that the firm is getting. The grand total revenue the firm is getting is this is 120 rupees that is total subsidy and how the firm is eh is investing the 15 rupees for abating or reducing one unit of emissions.

So, now the total revenues, it will be getting is 120 minus this 15 rupees is 105 right. So, likewise suppose say, if the firm can reduce its emission level from 10 to let us say 8, then similarly, we are saying for reducing the emissions by 2 units that is up to 8 unit. So, what is the marginal abatement cost here for reducing the third unit? So, this is 30.

So, what is the total abatement costs? So, it will be totally the summation of this. So, it is 45 now right. This is 30 plus 15 is 45. So, 45 is 45 rupees is the total abatement cost for reducing the third unit of emissions. And when it is reducing 3 units of emissions then; obviously, it will be getting the eh the subsidy amount of 3 multiplied by 1. So, so it is 2 units now. It has been reduced by 2 units. So, this total subsidy will be 120 rupees per unit and how many units it has reduced, 9 and 8 2. So, it is 2.

So, for this it is 120 in to 2is 240 rupees. So, the total subsidy, the firm is going to get is two forty rupees. So, likewise we need to see that what is the grand total of revenues the firm is going to get. So, what is the amount here? So, here will be saying the total subsidy is 240 and what is the total abatement cost for reducing this two units? This is 45.

So, 240 minus 45 is 195 and likewise you can calculate for if the firm is going to reduce its pollution to 0 from tenth 10 tons per month to 0 ton per month if it is so. Then the firm is

obviously, going to invest and spend and its abatement cost for making this emissions to 0 is 1 2 3 0 right. So, the what is the total subsidy it will finding 120 for tenth it is 120 multiplied 10. So, it is 1200 right. So, what is the total revenue?

So, it will be 1200 minus 12 30 equal to minus 30 here right. So, so likewise you can say see that whether it is wiser on the part of the polluting industry or firm to continue to reduce its emission level and get the subsidy or not. So, to what extent the firm can continue reducing its emissions level and it will be getting the subsidy and generating the review revenue you can check it from these grand total revenue that is that the firm is getting.

So, this column you can check, total subsidy minus the total abatement cost. So, here you need to see that firms firm will be trying to maximize these numbers right. So, at which level of emissions this number is maximized so; obviously, it is 345. So that means, corresponding to the fourth.

So, if the firm is going to produce 4 units, 4 tons of emissions per month, then its grand total of revenues will be maximized. So, that means; the firm will be considering to reduce this much of emissions and will be will be considering to generate 4 tons of emissions per month and by doing so, it will be maximizing the total revenue from abatement cost and the subsidy as well.

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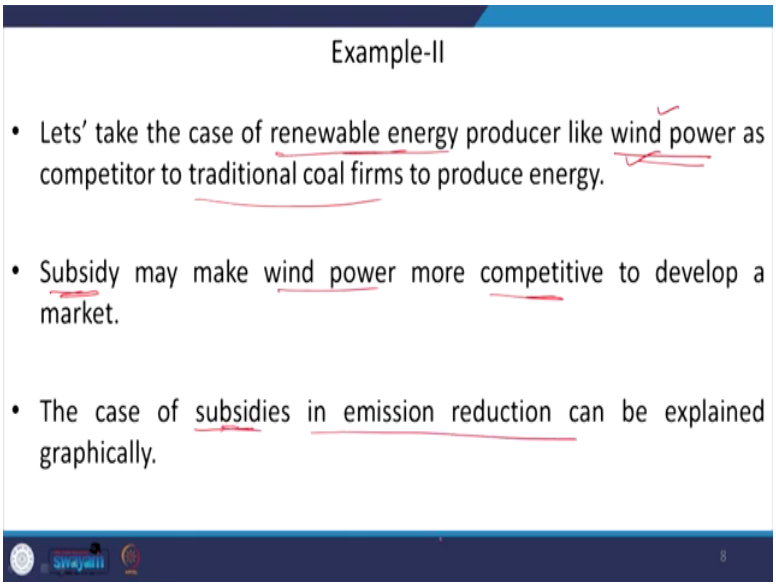

So, likewise, we can take another example. So, here let us take the example is bit different here and here let us take the case of renewable energy right. So, among this renewable energy; we can take any source like wind power. So, now, we are considering wind power with the with the traditional coal firms for producing energy right.

So, now the case is that; if we if the government needs to see that this wind firm wind power production is competitive with respect to the conventional sources of energy producer then this subsidy can be one of the incentives for making this wind power more competitive with respect to your traditional firms of energy production right.

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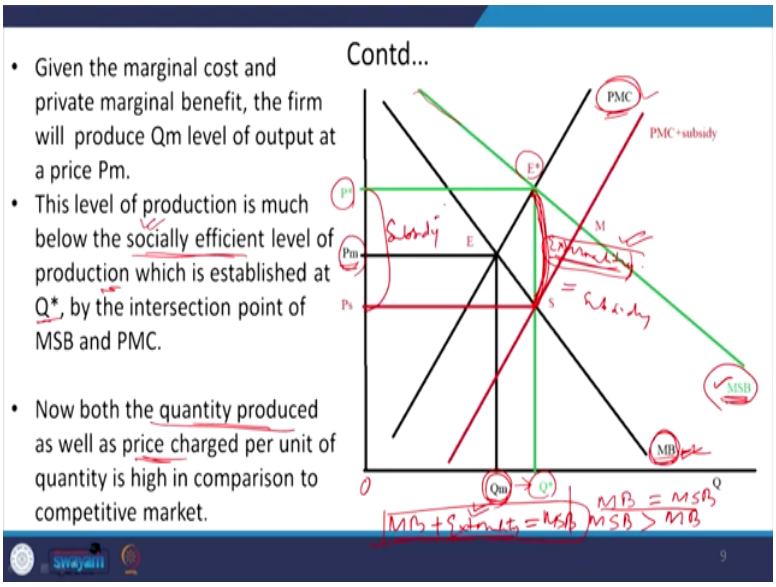

So, in this case we can take the subsidies in the emissions reductions right, which can be explained in terms of a graphical manner. So, now, we can discuss that how to find the equilibrium level of production price so; obviously, it is the marginal benefit it is given. And the marginal cost private marginal cost or marginal cost you are saying right that is given. So, the intersection point of this marginal benefit curve and the marginal cost curve this is at e right.

So, given this marginal cost on private marginal benefit. Here the industry or the firm here it will be producing the output that is Qm level of output right and what is the price for it this is the Pm price. So, at Pm price Qm level of production that is the green production, green energy production will be continued. But, however, if you see this is the marginal benefit ok, but we have not taken into account what is the benefit that that the society is getting.

So, this is the marginal benefit is the benefit that the private producer or the producer producing unit of this energy eh green energy firm it is getting, but we have not take into account what this society is getting in terms of benefits. So, if you are including this eh societal benefits then this marginal benefit will be more right. So, how to take this? So, here in order to find the socially efficient level of production right. What we need to see? We need to see that this marginal benefit must be equivalent to the marginal social benefit.

But, here we are finding this marginal social benefit is greater than the marginal benefit right. So, because these two are not equivalent what we need to do that this marginal benefit must be including the case of externalities in order to make these two with equivalent to the marginal social benefit right.

So, what do you have done here, then in order to find the and this is the level the condition is that when this marginal social benefit is equivalent to your marginal benefit then we are saying the socially optimum level of output and production is happening right. So, what we are doing that we need to actually see where is the marginal social benefit. What we are doing, we are doing we are including right. This externality with the marginal benefit.

So, let us say this is the marginal benefit right. Here we are adding this externality level now we are getting the true benefits that the society is getting from the production of this output. So, it is represented in terms of marginal social benefit right. So, now, we can find out what is the socially efficient level of production.

So, now we are getting a new demand curve in terms of marginal social benefit and your supply curve is this one right. So, the intersection point at e star, we are having this production level that is OQ star. So, this OQ star is now said to be the socially efficient level of production at what price that is OP price.

So, earlier if you are not taken into if we are not taking this externality into account at that point of time the social the output level total output level produces was OQm and the price charge is OPm right, but after taking into account this externalities now the production has

increased right. So, from this you can see both the quantity produced as well as price charge for the production unit of production it has gone up ok.

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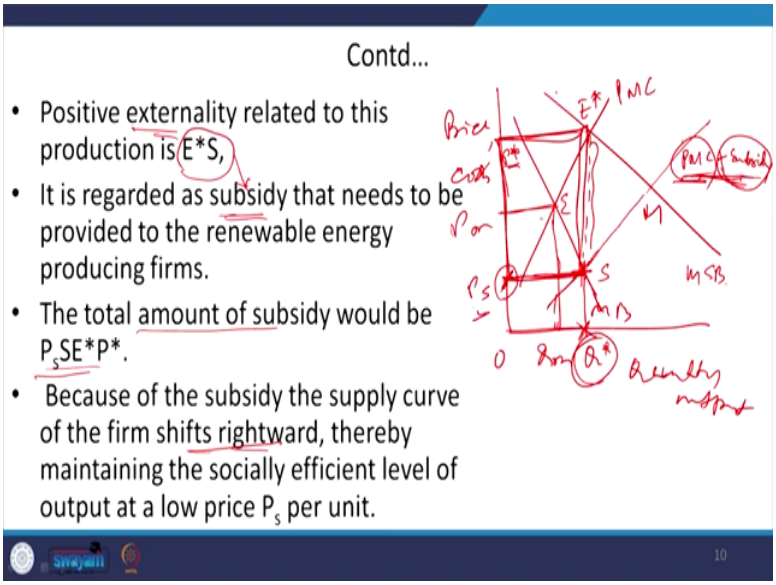

So, now we are considering that; what is the positive externality here? So, here the positive externalities related to this production is defined as the ES, E star ES. So, this is the positive externalities and our objective is that in order to hence this is a positive externality, the policy, the regulator must be giving this much of subsidy to the green firm industry right.

So, this externalities would be equivalent to your subsidy E star S is equivalent to this P star Ps in the subsidy level. So, the positive externalities that is related to this level of production is defined here E star S and this is also regarded as the subsidy because this amount is equivalent to your subsidy amount that must be paid in order to internalize this externalities.

So, now what is the total amount of subsidy? That the firm will be getting. So, this is the rectangle area. So, this rectangle area is the Ps SE P star right. So, that we can actually repeat here. This is the quantity of output that you are, we are just repeating the previous graph. So, here we are taking into account the price and costs.

This is your marginal benefit that we have taken into account and this is the marginal cost right. What we are saying that there is externality that is why marginal benefit will not would be somehow here reflecting the social marginal social benefit. So, now, what you are saying that this marginal benefit and social benefit must be equivalent.

So, how we are going to make it equivalent? if we are going to what is the difference, the difference between marginal social benefit and marginal benefit is this much right. So, now, the producer must be getting this amount of subsidy. So, this is your marginal cost when subsidy is included is provided. So, P this Pmc plus subsidy is reflected by this line ok.

So, this is your E now this is E star corresponding to this is Pm now this mass the P star level of price. Initially this is Qm and this is Q star. This is m and this is. So, now, we are having the new supply curve that is marginal costs plus your subsidy. So, this supply curve plus your marginal demand curve we are getting a new equilibrium here, this is s corresponding to this the price level is Ps ok. So, what is the total amount of subsidy that the firm will be getting; obviously, it is Ps this line Ps S E and Ps S this E star and P star.

So, this rectangle area is the total subsidy amount that the firm is going to get right. So, as a result when the firm is getting the subsidy. As a result then; obviously, what will happen your marginal cost per subsidy it will be shifting rightward right. And maintaining the efficient level of output that is Q star right. So, the thing is that if you compare what you are getting after subsidy you are getting socially desirable level of output and also the price per unit it has decreased to from P star to Ps level right.

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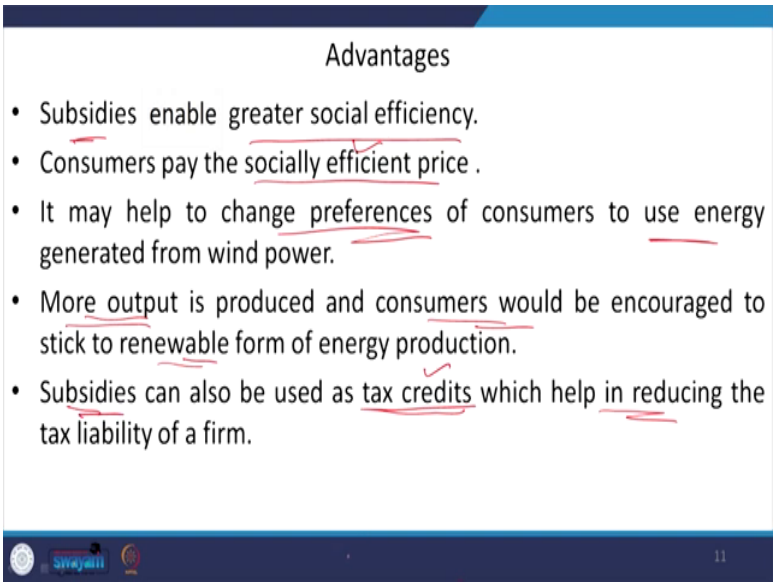

So, from this discussion what we are finding that this subsidies is actually helping us to find a greater social efficiency in terms of more output and less price to be charged per unit right. And therefore, the consumers will be paying the socially efficient price not more price, not more than that.

So, initially what has happened the consumers they were paying a more price in comparison to the socially efficient level of price right. And it also may help to change the preference level of the consumers. Why because earlier they were forced to pay more and now for the same they are paying, they are going to pay less. So, that is why obviously, they will be now thinking about to change their preferences and for shifting the green energy sources ok.

And moreover, here we are saying that, we are producing more output and consumers are also encouraged to shift to the renewable form of production. So, that is why that is the advantages

of this subsidy that we are providing to this industry. And more about the subsidies can also be used a kind as a as a basis for the tax credits right. So that means; they can save the tax the industry they can also save the tax right and in this way it will be reducing their tax liability and; obviously, it is a positive thing for the industry on the firm.

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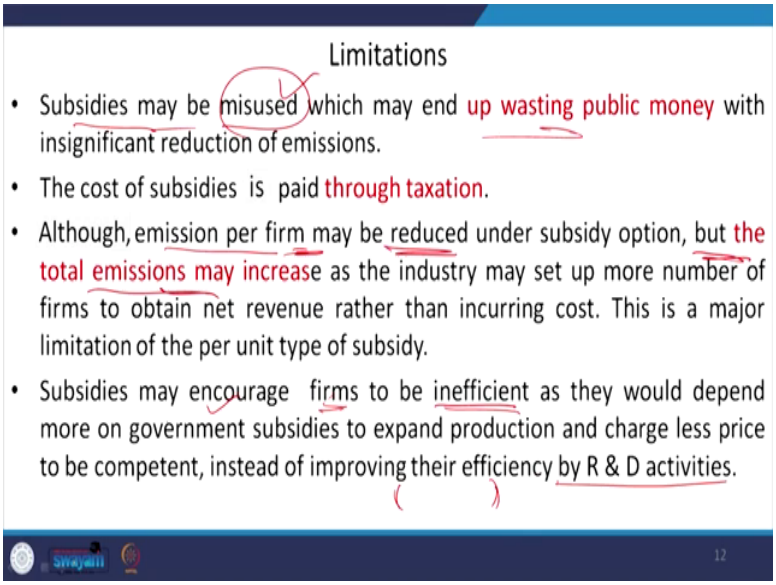

So, what are they likely or potential limitations or issues that we are having in this market based instruments on the subsidy. So, the first thing is that subsidies are funded by the public money in terms of your tax. So, it is very likely that this subsidies can be misused.

When the subsidies are misused then; obviously, we are saying that public money is wasted right. And another thing is that if you are saying although this emission for the industries right can be can be reduced because subsidies actually making is taken as an incentive for reducing the emissions, but the total emissions it may increase how, the industry may set out some more

units of productions. And in by that way, for a single unit the emissions can be controlled or reduced, but for the industry as a whole this can be increased right.

And moreover, subsidies are argued to be ineffective or inefficient when the subsidy is not encouraging the firm the firms or industry to invest in the R and D activities in order to increase their efficiency right. As you understand this when the when the pollution is more the industrys most actually invest in their R and D activities in order to find out what would be the best practices or best technologies that can be used in order to reduce this pollution level.

But in case of the subsidies this will not be found and that is why the subsidies can be interpreted as an inefficient instrument for controlling the pollution level and sometimes because of this subsidy it may lead to the shortage of supply of this particular goods or services that the firm is firm or industry is producing.

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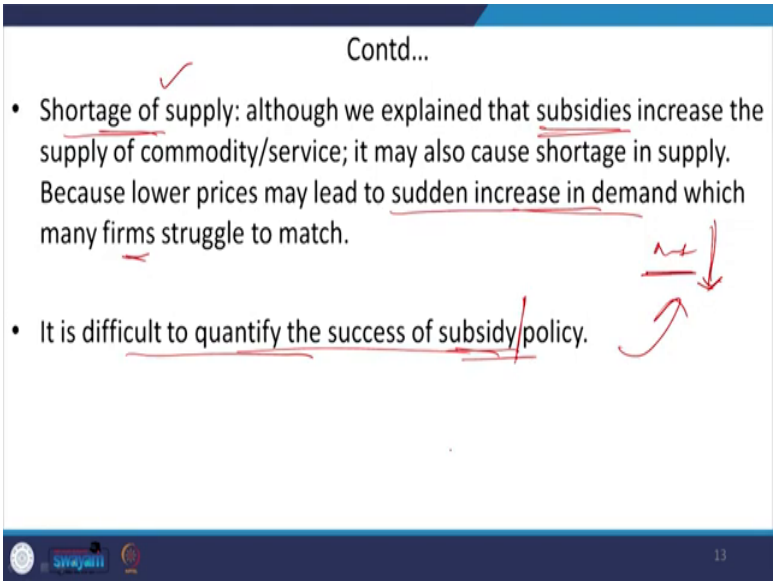

So, generally, what we have found in our diagrammatic presentation that the supply would be increased or output production would be increased, but in some cases when the firm is a small one right and because of these subsidies output are in are expanded and the price is lowered. When the price is lowered then obviously, because of this sudden spots in the demand it may happen right.

So, when the sudden increase in demand happens then; obviously, the firm cannot meet the increase in demand. So, it may lead to again inflationary situation or shortage of supply. And moreover the last, but not least the issues that we are encountering in the in this mode of instruments subsidy that it is very difficult to quantity quantify the effectiveness and success of subsidy policy. So, far the subsidy is here interpreted as a as an instrument of public policy.

So, in that case, we need to actually quantify the success of the subsidy policy, but it is very difficult to quantify take into account the coverage and scope of the subsidy itself ok. So, in our discussion we found the subsidy as an instrument for controlling the pollution level.

In the last, in the next lecture; we will be talking about another form of market based instrument that is the mixture of stacks and subsidy right. So, there will we are going to discuss the deposit refund systems. How it is a kind of hybrid system and it takes into account both the role of the subsidy and the tax and how this d this deposit refund system is going to be effective as an instrument in controlling the emission level.

Thank you.