Water Economics and Governance
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Lecture – 27
Conflicts in Water Pricing

Hello friends. So, we will continue with the discussion on to the water pricing, last session we have been talking about that there are needs of reform and how independent regulator is required to judiciously set the water tariffs in India and as have been basically observed as a encouraging case study from the power sector in India. So, when the tariffs setting process is started there are various questions that needs to be taken care of and that needs to be answered. Now, these questions are conflicting in nature and that results several conflicts in water pricing.

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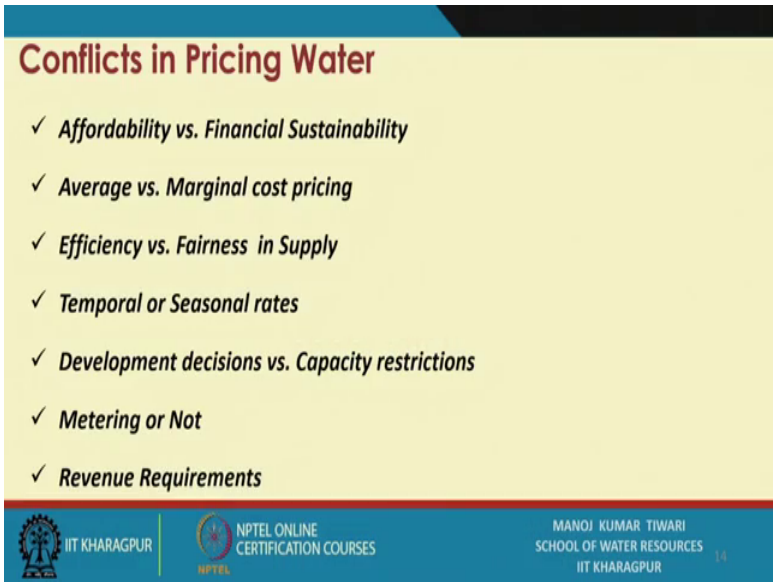

So, we will be discussing the some of these conflicts in this session, the conflicts include whether one should go for the affordability or financial sustainability then average cost pricing or marginal cost pricing. One should give more attention towards the efficiency which could be of any nature again a kind of economic efficiency as well or the fairness in supply which sort of equity and of all these criteria. Whether go for temporal or seasonal rates, then there are conflicts between the development decisions and capacity restrictions whether it should be metered or not and then how to meet the revenue

requirement, what scale of revenue requirements should be there how it can be optimized and how it can be meet. So, these are the larger questions that one needs to look after even if it is a regulator regulatory body.

So, the regulator needs to look after all these conflicts after getting the desired or the required input from various stakeholders including the operator or including the civil societies including consumer ends.

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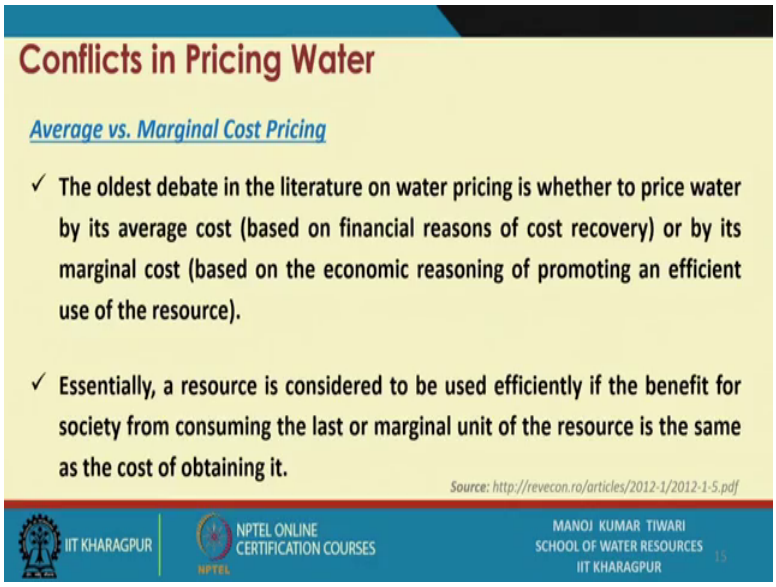

So, to start with the oldest debate in the literature on water pricing is whether one should go with average cost pricing or marginal cost pricing. So, the average cost which is based on the financial reasons of cost recovery or the marginal cost, which is based on the economic reasoning of promoting an efficient use of the resource.

So, there is a conflict like which type of pricing strategy should be adopted. So, the pricing structure we discussed earlier we could have a different structure for getting those prices, but how much is to be recovered, the calculation of that needs to calculate the cost and cost is whether to take average cost of the utility operations or the marginal cost that question is of very prevalent. So, essentially a resource is considered to be used efficiently, if the benefit from society consuming the last or the marginal unit of the resource is the same as the cost of obtaining it.

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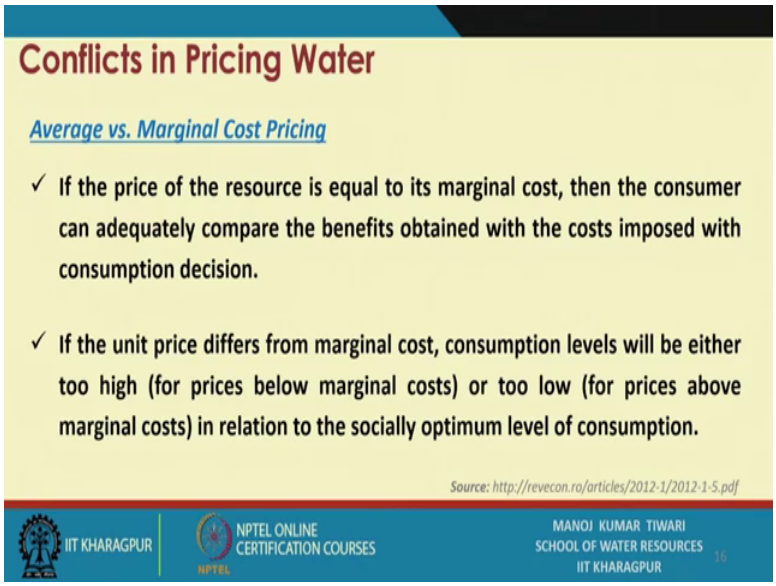

So, that is what marginal cost pricing takes clue from and that is why it is considered sustainable rather more sustainable as opposed to average. So, if the price of the resource is equal to its marginal cost, consumer can adequately compare the benefits obtained with the cost imposed with the consumption decision.

So, because if such is the case if it, if the price is equal to the marginal cost. So, consumer knows that this kind of environmental benefits what I am deriving from using this water, whether it is comparable to its actual marginal cost in terms of resource consumption decision or not. Now, if the unit price differs from marginal cost, consumption level would be either too high; that means, the price is below marginal cost or too low when the prices are above marginal cost.

So, this sort of complicates the situation and in relation to the socially optimum level of consumption the price ideally or theoretically or financially should be set near the marginal cost because too high price will be sort of indicating that we are, we are operating not in concurrence with the marginal cost, if prices are either too high or too low.

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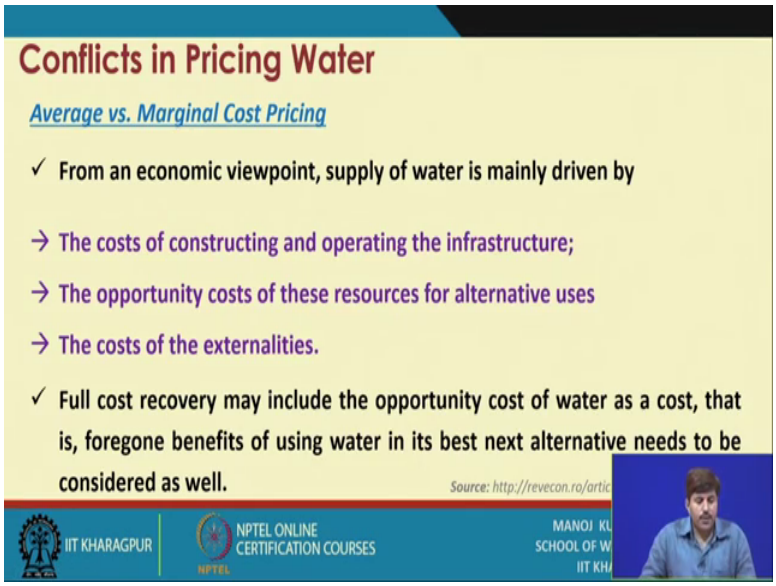

Now, from the economic viewpoint the supply of water is mainly driven by the cost of construction and operating the infrastructure, then the opportunity cost of these resources for alternative uses and the cost of externalities.

So, opportunity cost again if you see there are 3, 4 different type of opportunity cost can be included, but the inclusion of a opportunity cost in the full cost recovery particularly for the urban water supply is itself questionable because opportunity cost is considering the alternate use of a resource. Now, if you see that there is if you see the water rights criteria that no water has to be supplied has to be made affordable or has to be made available to the customer in certain quantity.

So, if you are following that policy if you are following that criteria. So, for that particular quantity of water there is no other use because that has to go to the customer only. So, if that water is intended to go for the customer and there is no possible alternate use of that water. So, then the opportunity cost for that water is 0, because there is no alternate use and opportunity cost comes from the idea of alternative uses of that water. Whereas, if it is a competitive market and you see that there is water can be sold for the much higher prices to the business entities and other sectors commercial or industrial sectors then that water which is too high opportunity cost.

So, this opportunity cost variation could be very high, it could be going by the policy decision it could be as low as 0 while going by the market dimensions it could be as high

as like the highest use where the commercial entities use water for profit making. So, full cost recovery may include the opportunity cost of water as a cost that foregone the benefit of using water in its next best alternative need to be considered as well.

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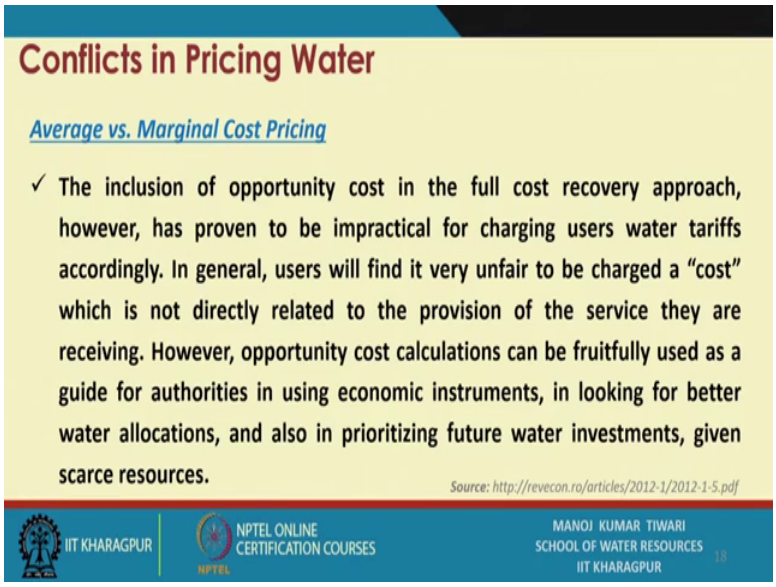

However the inclusion of opportunity cost has proven impractical for charging water from the consumers, charging water tariffs from the consumers because as we were saying that ideally the under the water right the minimum quantity of water or at least the basic minimum quantity of water is to be made available to the customer.

So, there is no other optional use of that water that is the first and probably the only use for that bare minimum quantity of the water and that sense the opportunity cost has to be kept 0 for a public water supply. Although conceptually one can look for other alternate uses as we were discussing, but in terms of meeting the water supply criteria or the response states responsibility to meeting the water requirements under the right to water and sanitation act, it becomes impractical to include any other possible uses of water for the specified quantity of water which is going to public water supplies.

And since there is no particular uses it becomes unjustifiable to use any sort of opportunity cost for that water looking at alternate commercial uses; however, opportunity cost calculation can be fruitfully used to guide the authorities in using the economic instruments for making decision when they tend to select or when they tend to prioritize their future water investments given the scarce resources. So, it is not that

opportunity cost is of no value of course, it should not be ideally included in the tariffs, but it is to be included, it is to be estimated for regulators and for authorities to make a decision that how we can use the different economic instruments or how we can maximize the return on to this or how we can develop the further water sector.

So, if there is a opportunity cost is high for that particular water and you see that different type of sector is having very high demand and could pay very high prices. So, although you are not, you are not going to divert the municipal water supply to the industrial or high demand uses, but you can look for alternate development of supplies for that sector from where you can actually get the high level of returns. So, those sort of calculation add values into the, into the organization for conceptualizing the prioritizing future water investments that where the investment would be more beneficial in a water sector for of course, return point of view.

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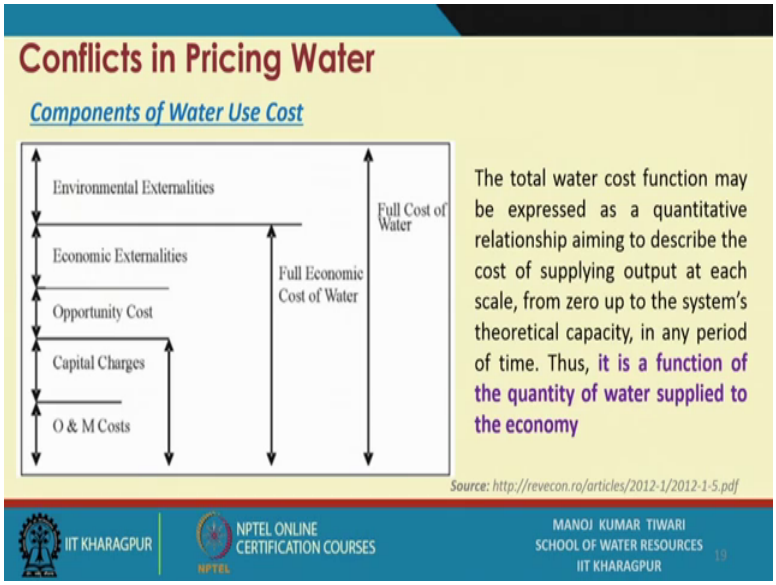

So, if you see the components of water use cost. So, there are there are O and M cost, then there are capital cost, opportunity cost, then economic externalities. So, the economic externalities till this you get the full economic cost of water and then there as there are environmental externalities which also should be included in order to get the full cost of water. Because when we are abstracting water from our resources we are leading certain environmental externality certain environmental cost as well. So, in order to make the system sustainable and we have already discussed that environmental

sustainability or ecological sustainability is one of the important aspects of a sustainable water resource management. So, if we look for that kind of sustainability as well.

So, the environmental externalities cost should also be included in the full cost of water. So, that way we get the capital charges O and M charges opportunity cost economic externalities and environmental externalities generally for water supply purpose at least the first 2 block that you see here the capital charges and O and M charges needs to be considered as the total cost of utility operations. Even if you are ignoring opportunities cost or environmental externalities or economic externalities which could come from the economic externalities and environmental externalities could be borne by the state as well; however, at least the capital O and M charge should be recovered from the user in order to the sustainable operation of the at least infrastructure.

If we even if we exclude the environmental and economic aspects at least for the sustainable operation of the infrastructure we should recover this cost from the user. The total water cost generally is function of means it can be expressed as a quantitative relationship where aiming to describe the cost of supplying output at each scale. So, from 0 up to the systems theoretical capacity in any period of time. So, thus it becomes a function of quantity of water supplied to the economy.

So, the total cost of water because if you see the cost function. So, the quantitative relationship can be developed in terms of the quantity that is to be supplied because eventually the objective of a water utility is to supply certain quantity of water. So, this that is very obvious one can see that if my quantity is small the investments are going to be small, the probably the capital cost or O and M charges or all these components are going to be smaller. There might not be much of environmental externalities or there might not be a much of economic externalities as well; however, if your water quality, water quantity is large if you are going for a large quantity of abstraction.

So, your infrastructure size increases because it increases the environmental externalities increases. So, with the increase in the quantity the total cost or the full cost of water is also going to be increased. So, that way it like a simply it can be perceived that the cost of water, the total cost of water is going to be a function of the quantity of water supplied. So, your quantity of water supplied less the total cost is likely to be less, your quantity of water supplied more, the total cost is likely to be more.

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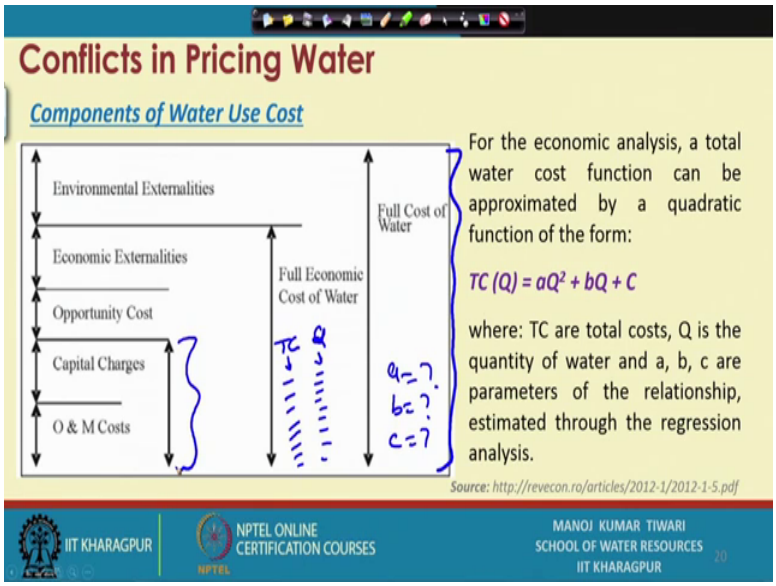

So, from this economic analysis when we say that it is a function of, total cost is a function of the quantity of water supplied. So, generally quadratic function form is, has been used to approximate the relationship between the quantity of water supplied and the total cost of that water. So, that can be seen from here that the total cost, which is a function of q is equal to aQ square plus bQ plus C where the TC is the total cost, Q is the quantity of water supplied and a, b, c are the parameters of relationship which are generally derived using the regression analysis. Certain utilities that this utility has cost this much, this much, this much and the supply quantity for the different utilities we know.

So, if we know all these information the total cost and supply quantity, what we can do is non-linear regression there are various tools, various softwares available for non-linear regression as well. A typical non-linear regression model can be fitted using this equation and then the value of a, b and c can be taken can be obtained from the model and that way one can actually get statistical relationship between the quantity of water supplied with the total cost of the utility which it is going to be cost.

Now, this can be applied to the full cost of water where we include all the cost or to the cost of basic operation and capital cost of the utility or the where opportunity cost another cost are excluded or the full economic cost of water as well. So, by these concept, by these principles one can actually have an idea of the relationship developed

between the total cost and the quantity supplied. Now, estimation of total cost is very important because generally the tariff structures are to be set when, the tariff structures are to be set when the utility is ready for the supplying water.

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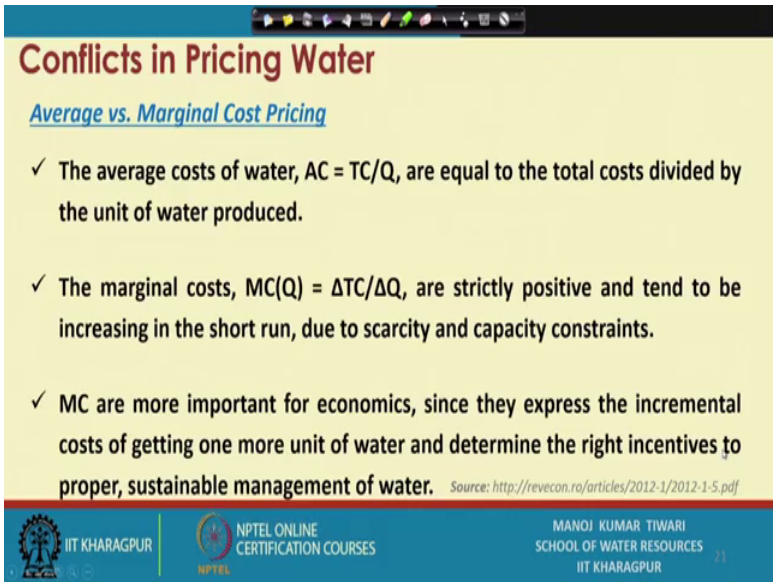

So, the basic the infrastructure or the capital cost is known; however, the O and M and other cost are predicted or there are the externalities cost if it is to be included. So, non tangible cost is converted into the numbers into the tangible forms and then it is to be estimated. So, for individual specific utility, it becomes difficult and there could be a change in the supply volumes as well from time to time because water network generally does not remain fixed as the city expands the amount of water supply it could also be expanding.

So, that way the cost, total cost is also a changing variable and may not essentially be the same. So, now if you see the average and marginal cost pricing system from where we started this discussion; so the average cost of water is actually taken as the total cost by the total quantity of water supplied. So, that is a general average philosophy. How do we determine average value? We take the total number, total value divided by the units of the product. So, here the total cost of utility and the quantity it has supplied will give us the average cost per unit volume of water or per unit quantity of water.

So, that gives us an average cost that for each unit water supplied we have this is this as an our average cost and if you go by your average cost pricing model so that is the cost

to be recovered. Now, any model can be used to recover that cost either your flat prices or uniform prices or your block increasing block tariff systems. The marginal cost on the other hand is talks about the change in the per unit cost for per unit production of the water. So, this is strictly positive because when you are going to add additional unit you are of course, going to increase some amount in the total cost and this tends to be increasing in the short run due to the scarcity and capacity constraints.

So, this marginal cost or which is your MC are more important for economics, since they express the incremental cost of getting one more unit of water and determine the right incentives to proper sustainable management of water. Now, the point is that the average cost is just the financial return on to the utility, I have spent this much I will return this much, but the marginal cost on the other hand is considered more sustainable because it does not consider just what has been spent for the production of water. It spends that ok.

If I am supplying one more unit, if I am going to produce one more unit, how much additional cost would be needed? So, it basically deals the broader environmental aspects as well that the sustainability aspects as well that for additional production of each unit how much additional money is needed and why should not I charge that as from the customers that needs the water.

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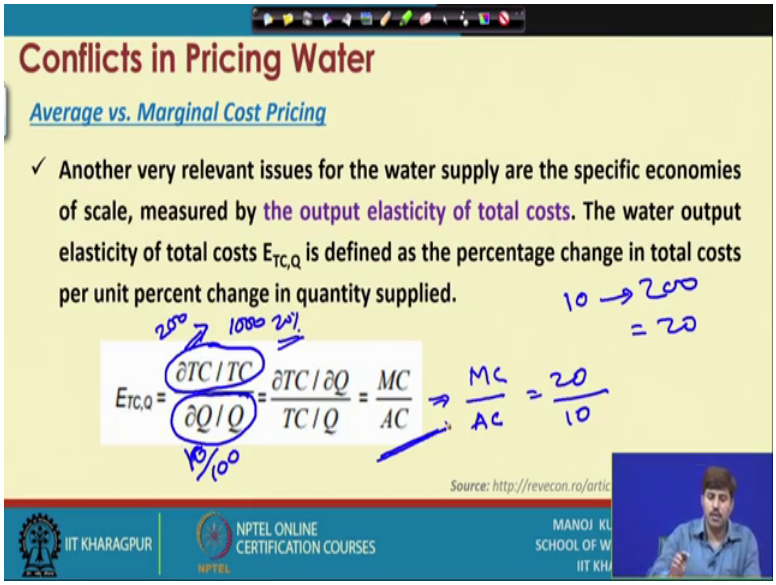

Then, there is another very relevant parameter or very relevant issue for the water supply is the specific economy of scale which is measured through a parameter which is referred

as the output elasticity of the total cost. So, what is output elasticity of the total cost? It is the water input, it is the sort of the output elasticity is the water output elasticity which defines as a percentage change in the total cost per unit percentage change in the quantity supplied.

So, if you see the percentage change in the total cost is going to be change in the total cost divided by the total cost. So, that would be the percentage change in the total cost for unit addition that way and percentage change in the quantity supplied. So, if my let us say unit is supplying hundred units of water, if I want to produce hundred 10 units of water. So, the percentage change here would be 10 by 100 means I am going to increase it by 10 percent. Now, for the in change in for the change in this 10 unit of the water, for the change for adding this 10 units further you will see how much total cost has increased as opposed to the initial total cost.

So, for example, my initial total cost of the system was let us say 1000 units and for adding additional 10 units I will need to add 200 units further. So, then the percentage change here is 20 percent the cost change. So, this in a way would be equal to the if you see if you solve this, this becomes equal to the marginal cost by the average cost. So, that can be seen because marginal cost in this case for production of additional 10 units, I am spending 200 units of finance. So, my marginal cost is becoming 2. So, that is my marginal cost divided by the average cost. So, average cost for producing 10 unit is like if you see your 100 units were produced and 1000 earlier so the average cost was 10.

So, that way it will give you if you solve this it is going to give you that ratio only. So, this way one can see that the output elasticity of the total cost would actually be average of marginal cost with the average cost of the water production for any further additional unit that is your average.

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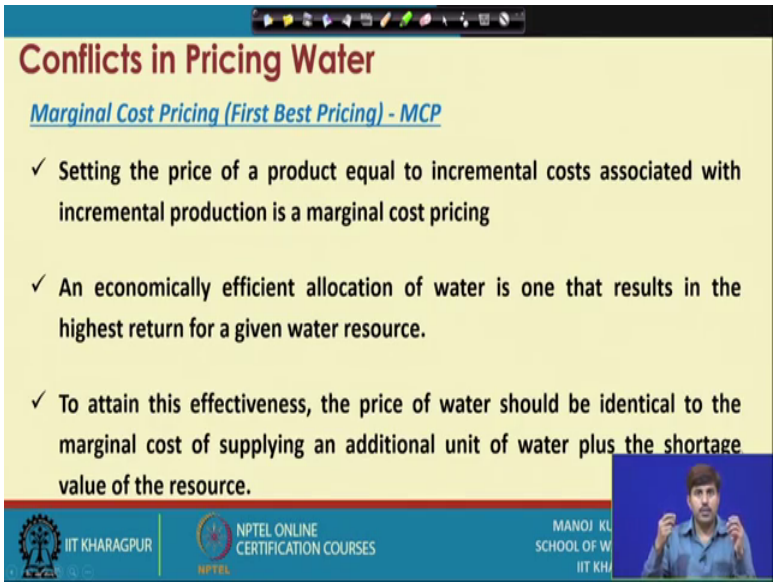

Now, the marginal cost pricing which is considered better and as a basically the first best pricing system is setting the price of a product equal to the incremental cost associated with the incremental production which is typically known as a marginal cost pricing. The economic efficiency, efficient allocation of water is a one that results in the higher return for a given water resource.

So, for example: the charging of, if you take clue from the previous example which we are taking. So, your average cost pricing suggests that you charge at a price of because average price will turn maybe 10 units of your cost, any 10 units in terms of the financials with for the per unit production of water, but marginal cost is higher because it is not including what is the current scenario, it includes the additional of additional supply or addition of another unit production of the water. So, to attend this effectiveness the price of water should be identical to the marginal cost of supplying additional unit of water plus the shortage value of the resource which could be in terms of the environmental externalities.

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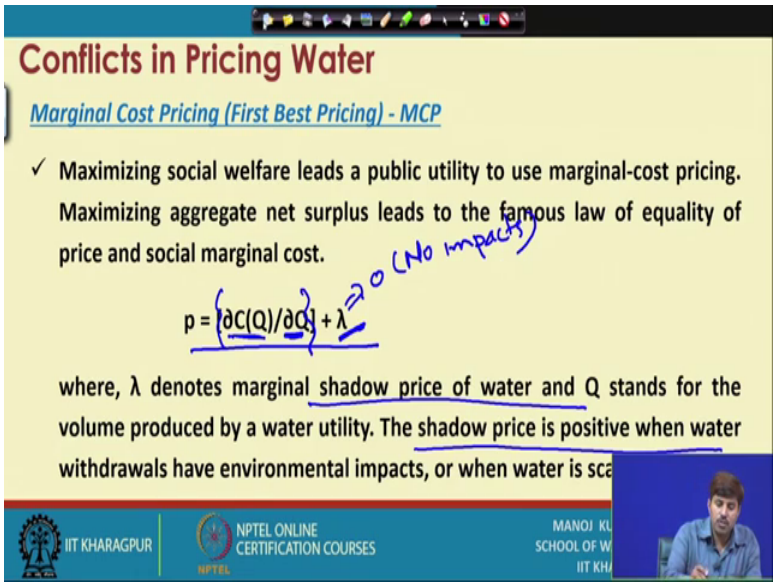

The marginal, maximizing social welfare leads a public utility to use marginal cost pricing. Now, this maximizing aggregate net surplus leads the famous law of quality of price and social marginal cost.

So, it will eventually be in the form of this, where this is the cost of production, this is the marginal cost which we have been discussing earlier. It is the same thing if you see C is the cost here. So, delta C is the total cost for Q production of water and delta Q is the production of water, net amount of water. Now, the marginal cost will have another term delta which is otherwise is going to be basically your average cost because this is the total amount produced means change in the total amount produced for additional unit as well and this is the total cost for that production.

The lambda here denotes marginal shadow price of water and Q stands for the volume produced by the water utility. Now, this shadow price is positive when water withdrawal have environmental impacts and when water is scarce. If water withdrawal is having no further environmental impacts, this lambda will be actually 0 for no impacts. So, when lambda is equal to 0 your marginal cost is in fact, more or less becomes equal to your average cost only, as the price of additional production is taken care of that.

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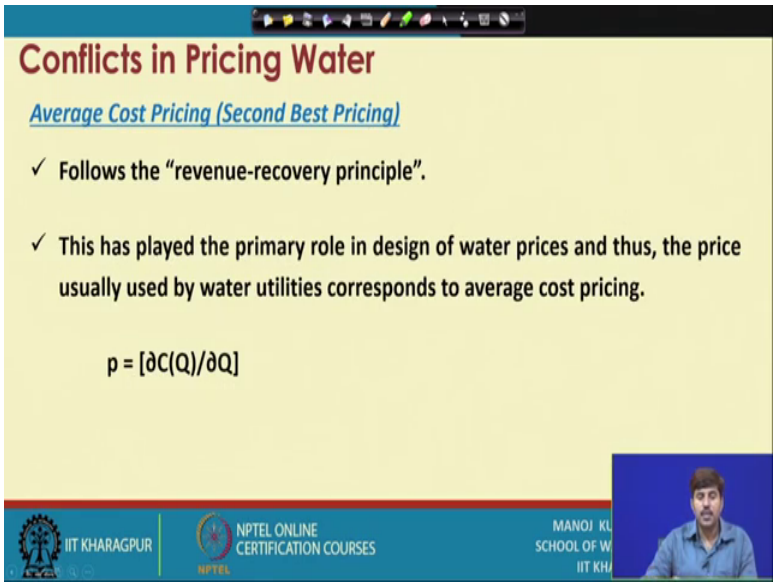

So, the average cost pricing which is also known as second best pricing follows just simple revenue recovery principle and the average cost pricing is the cost of Q production divided by the quantity Q. So, the in order to get the average price and that is the basic difference between the marginal price and average price that marginal price have an additional term which considers that in future if I have to withdraw the water, what externality are going to come into that or not necessarily in terms of externality is this lambda the one we were seeing earlier slide.

So, the lambda here is lambda here is not because of the environmental externalities only. It could be because of future changes in the market for the infrastructure materials as well. So, in order to if you need to expand the water utilities, the rate at which you are getting infrastructure ingredients today you mean they may not be available at the same cost. So, it also in considers that particularly in a long run marginal cost system.

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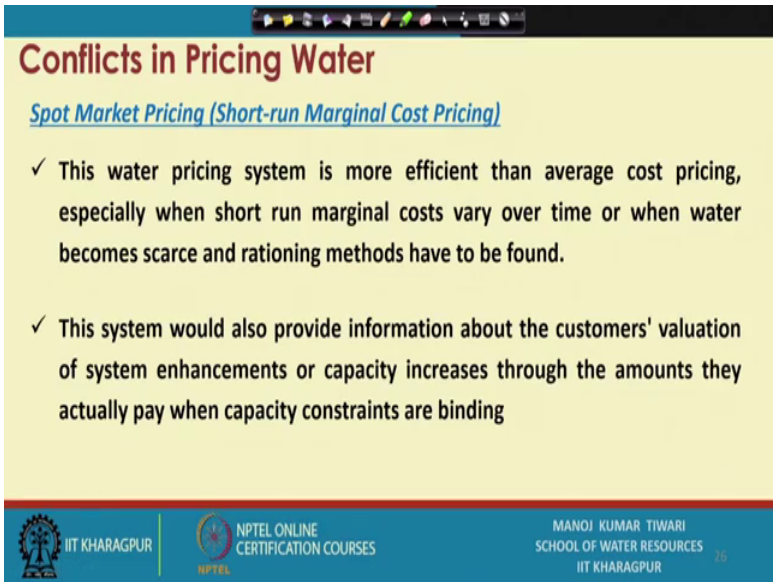

Then there is a when we are talking about longer than marginal cost systems. There are two marginal cost pricing approaches. One is the long run and another is the short run. Short run is also referred as spot market pricing so for this water pricing system is more efficient than average cost pricing especially when shorter run marginal costs vary over time and when water becomes scarce and rational methods have to be found for drawing water or for supplying in order to ensure the resource conservation as well.

So, your short run marginal cost pricing would also provide information about the customers valuation of system enhancement or capacity increases through the amount they actually pay when the capacity constants are binding. So, this way the short run marginal cost pricing considers this all sort of instantaneous production of additional unit of water and how much it is going to cost in that sense.

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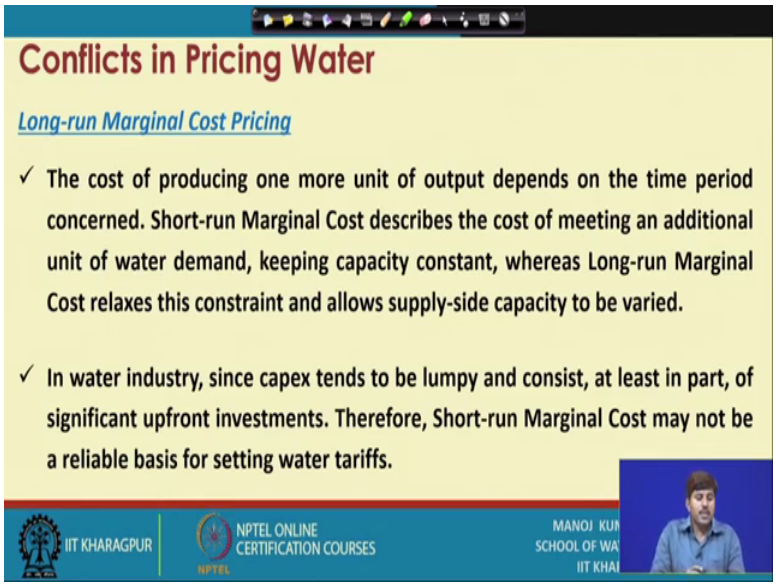

Whereas there is a long run marginal cost pricing, where the cost of producing one more unit of output depends on the time period concerned, because the if you see the long run marginal cost pricing you see that if I for example.

Let us take you have infrastructure for producing 100 million litres of water a day for public water supplies. Your utility is operating at 80 ml d; 80 million liters per day and you can expand up to 100 because your capacity installed is up to 100. So, for producing of any extra unit of water you need not to go for the augmenting capacity. So, if you go for short run marginal cost pricing. So, instantaneous production of one more unit is just instantaneous pumping hours may be little longer the treatment facility may work for a little longer, the cost of chemical and operational features could be a little a more. So, that way you will get certain amount of additional cost, but there is no cost for the infrastructure augmentation in short run. Whereas, if you go for a long run you see that you have to, for next 20 maybe you can you can use your existing infrastructure for augmenting capacity for up to next 20 million liters per day, but beyond that there might be a need coming for the infrastructure expansion as well.

So, for from where that fund is going to come? So, in the long run, one unit of water production would basically need some capacity expansion as well. So, how much that capacity expansion part is going to how much additional amount it is going to impart on one unit of water production in a long run should also be considered in a long run

marginal cost pricing system. So, that way long run marginal cost pricing works better. The short run marginal cost describes the cost of meeting an additional unit of water demand keeping the capacity constant whereas, long run marginal cost has released or relax this constraint of keeping the capacity constant and considers that the supply side capacity need also to be varied.

So, if the capacity is varied, how it is going to impart? What additional amount it is going to impart on the net cost of one unit of production that will be covered only in the long run marginal cost pricing, otherwise short run marginal cost pricing the capacity thing does not accounted for. So, in water industry since the capital expenditure or capex tends to be very lumpy and it is not very sort of reliable or very well defined and at least in part of the significant upfront investments are needed mostly.

So, the short run marginal cost my pricing may not be a reliable basis for setting water tariff. So, when one is willing to use a marginal cost pricing, one should actually target the long run marginal cost pricing. So, we that way we kind of a get a preference that a long run marginal cost pricing is to be preferred over short run marginal cost pricing which is to be preferred over average cost pricing. So, with this kind of with this kind of setup, one can actually see that how much cost is to be recovered through water pricing and in what kind of structure is needed for that we discussed that earlier in the previous week.

But how much of the cost is recovered that calculations can be done based on these criteria. So, this conflict that whether to price for a long run or marginal cost or short run marginal cost or your average cost pricing has been a long issue of debate and eventually from overall environmental economic sustainability prospective it is better to go for a marginal cost pricing than the average cost pricing. So, with this we end the discussion here and we will talk about the other conflicts in the next session.

Thank you.