Waste Water Treatment and Recycling
Prof. Manoj Kumar Tiwari
School of Water Resources
Indian Institute of Technology, Kharagpur

Lecture - 56
Wastewater Reuse and Recycling Centralized Vs Decentralized Recycling

Hello everyone and welcome back. So, we are into the last class of week 11, last lecture of week 11. And this week we have been talking about the Waste Water Reuse and Recycling aspects. So, starting from the basic concept of reuse and recycling and then the various attributes of recycling we discussed.

So, this particular class in the end we will be talking about the centralized versus decentralized system in the perspective of waste water recycling. So, we had a very basic discussion on what centralized and what decentralized systems are in the first week of this course. So, we will again quickly have recap of those and then we will discuss the recycling and reuse aspects with these systems.

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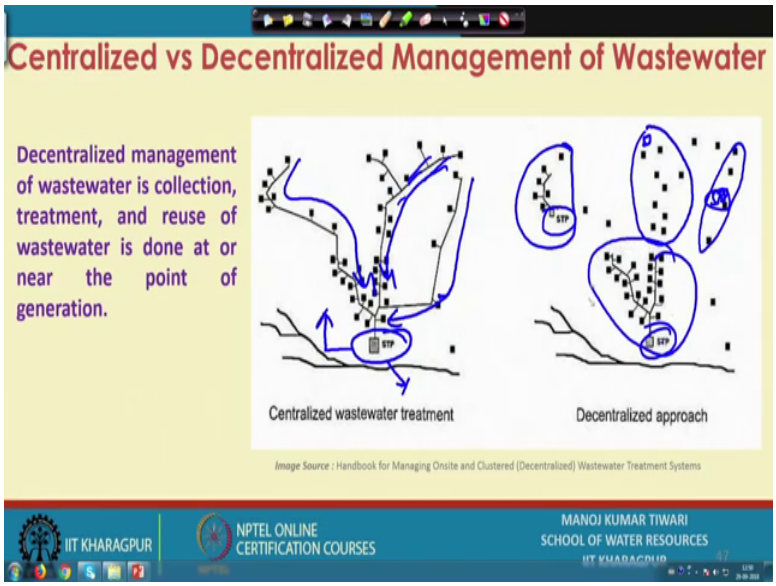

So, how these systems are beneficial or they have certain disadvantages in case if we plan to go for the reuse and recycling. So, to begin with the decentralized management of waste water is the collection treatment and reuse of waste water with where and when it is done either at the point of generation or very near to the point of generation. Whereas, the centralized systems are the systems where the waste water is collected from the

different sectors, different zones and then is kind of transported to a central treatment facility.

So, like let say we have say these are the different places different areas from where waste water is being generated. So, we collect all these waste water and eventually all of these is generalized to just one single point and then it comes to a STP where this is treated.

And after this treatment it usually in the centralized system it is disposed of or even if it is to be reused so then after that it has to be reused. Whereas the decentralized system is we break this chain of transporting all these, so in a smaller clusters let us say we have one cluster here, so we can make 1 STP smaller STP here itself, we can make one STP here itself or we can make these clusters combined and make one STP say here, we can combine these cluster and say make one STP here.

So, that way we can have various like me split out this, the area the locality the reason of the entire city into various subzones and then we end up kind of treat collecting, treating and recycling the waste water within the different zones.

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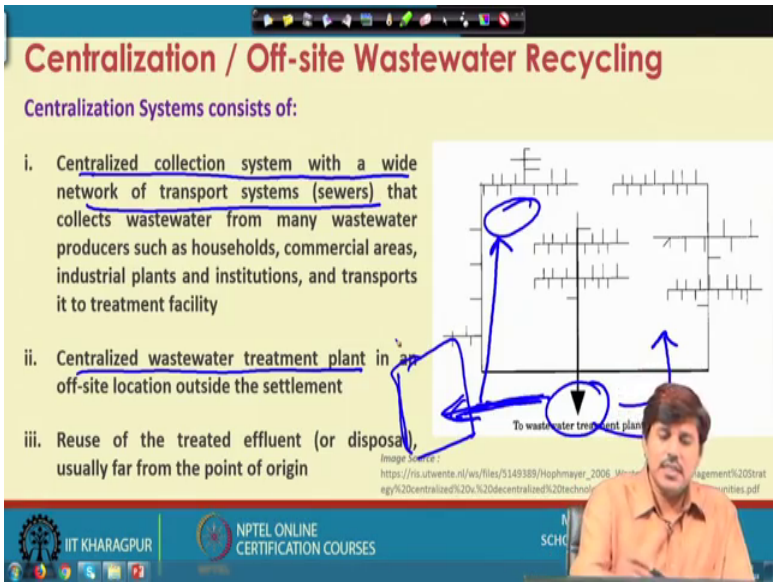

So, there are different kind of you see if in centralized system as well as decentralized system, there are various attributes. So, essentially in centralized system it will consist of

a centralized collection system ok, so that is one of the important aspect. It will have a centralized collection system and for this purpose we need a wide network of sewers.

So, there has to be kind of wide network of sewer lines which covers the entire area and some how collect it to the single treatment system ok. Then there needs a centralized waste water treatment facilty ok. So, the all sewage or all the waste water which is collected, when it is channelized to single point. So, that volume becomes quite huge so that, bulk volume has to be processed or has to be treated in the waste water treatment facility.

So, we need that size of a treatment plant which is your centralized treatment facility. And then we will actually look for or we will go for the various reuse of application of the treated effluent or disposal, if you want to dispose it off. So, then we will think about the disposing the treated effluent or reusing purpose.

So, in a centralized reuse system, if we say that centralized water recycling system, so there will be another component which we discussed in the last class also that then there has to be again a distribution system which kind of this treated water is further taken to the area of application. So, if the area of application is a such that, it has to be kind of again redistributed for municipal uses. So, then we need a proper distribution systems for that waste water if it is to be sent to some say agricultural facility. So, we can see depending upon the land size and water requirements how much this water can fulfill this demand. So, then water needs to be channelized to that treatment, that irrigation facility ok. So, that are the essential components over there.

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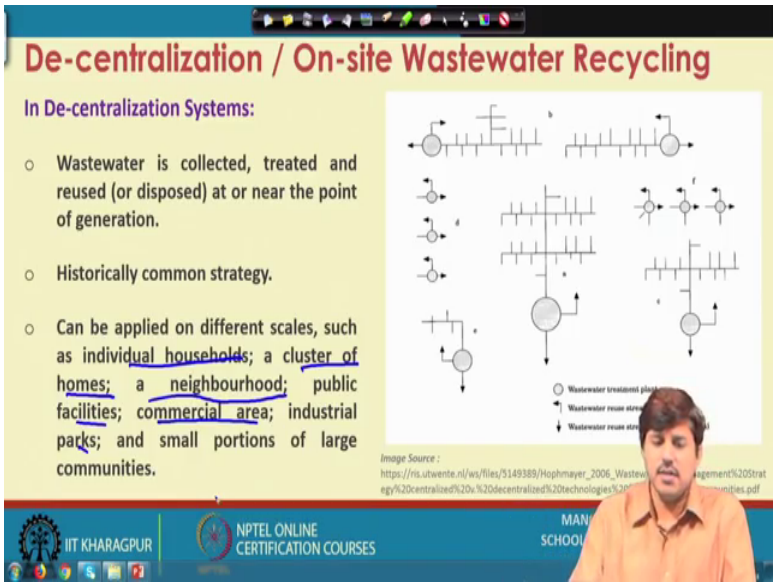

Now if you see for the decentralized system, so in decentralized system since the waste water is collected treated or reused at the point which is very close to or which is very near to generation in that way.

This has been historically common strategy because, when we were under civilization, so this concept of a sewage network collecting the entire cities sewage together and then processing in a central facility is relatively much never concept; much newer means as in like in probably in beginning of 19 century or so.

So earlier what so ever the waste water which was being produced from local scale, village scale, house hold scale or small town or cities so people used to manage that in a generally house hold scale because, there was no centralized collection system. So, making those kind of like device septic tank or putting it through a kind irrigation basin just draining it off to a field. So, all that was kind of decentralized system because, it is not that the entire reasons waste water was being collected together, that was not the case back at that time. The decentralized system can be applied to different scale ok.

So, the scale decentralization is very important to what scale we decentralized. The smallest scale is going to be the individual household scale then, we can have actually a cluster of various homes or we can have in a neigbourhood, then the public facilities, commercial areas, industrial parts and small portion of large communities. So, if you are having let us say a big city, so a small portion a colony in the that city or maybe say

cluster of colonies in that city market area in that city, so collect the waste of that particular market area and process it simalteonsly, so that kind of like scale could be there.

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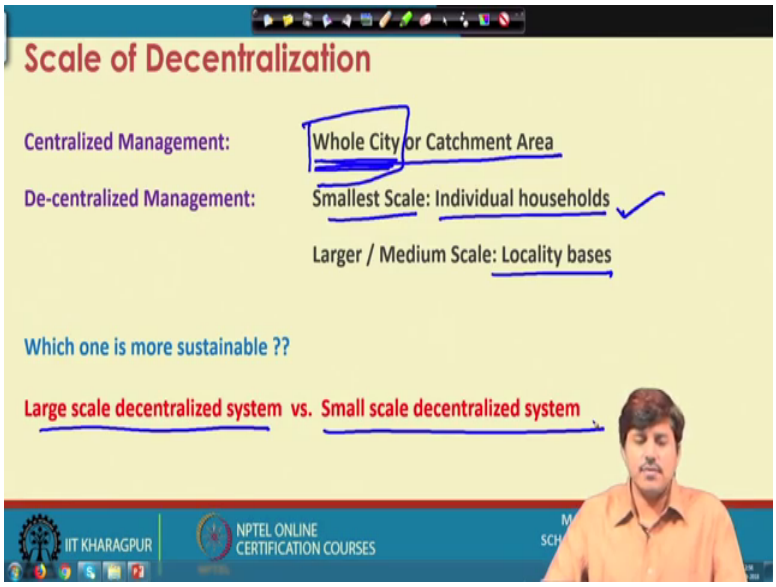

So if we see this scale of decentralization, so centralized management essentially is the whole city or the catchment area ok. That is what we call centralized management. Generally whole city because entire catchment area is never possible to tap ok so, essentially if you see like from hydro logical prospective, so there is nothing as such centralized systems because it is almost impossible to tap the entire catchement area. So, it becomes like the scale of decentralization to what scale we decentralize it. So, centralized system of course, centralized system will consider the whole paved area of a city to be processing together whereas, decentralized are smaller system.

So, the smallest scale of decentralization is the individual household. So, if individual household are managing their own waste water or their own sewage at a household level itself. So, that again has been a quite a popular strategy bag because people used to go for septic tanks. So, each household used to have a septic tanks or septic tank is what, it is a basically decentralized treatment facility of the waste water or the human excreta which is generated ok.

But then after the kind of development or infrastructure structural growth and when people moved on towards the centralized system so, this individual we like got this sewer

network laid out across the city and then the individual household level, the waste water management systems; whether it is sustainable or not that is a different thing. Because, we cannot say that tank was the best possible solution or was always was sustainable of course, we have more from septic tanks to better systems but that was the probably like in a if talk in terms of centralized versus decentralized system.

So, that is kind of a smallest scale decentralized system where we have a treatment mechanism treatment facility at a house hold level ok. Then from there we went to centralized system and again we are now talking about more communication or more emphasis is being given to the decentralized system. But decentralized system now which is being kind of promoted is not to a smallest scale, but somewhere a little larger decentralized systems or medium scale decentralized system.

So, at just we are saying that we can decentralize it at the various levels at a various scale. So, that way like medium scale some locality or regional basis decentralization is the one which is being in more kind of favored these days. So, which one is the more kind of sustainable whether, a large scale decentralized system versus small scale decentralized system. So, they both have their own advantages and disadvantages ok.

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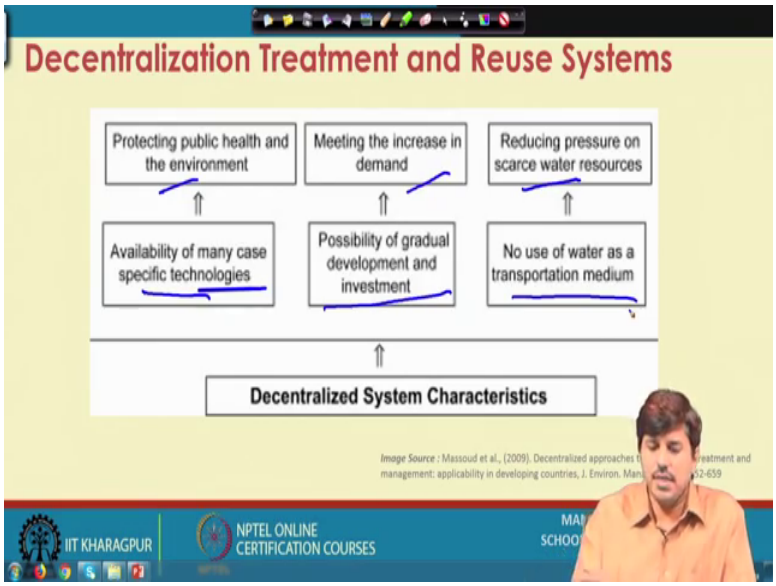

But from financial aspect or environmental aspects it is not always preferable to go for very large system or it is not at the same time preferable to go for individual household level systems or that small level systems because, then the cost aspects management

aspects those things are going to come into the picture. So, if we see how this decentralized treatment and reused systems tend to achieve the goal of treatment and recycling. So, decentralized systems will have kind of availability of many cases and specific technologies that is going to be there.

There is a possibility of gradual development and investments like in centralized systems, if you want to build treatment plant for say 200 MLD, 200 million litre per day, 500 million litre per day, so you will have to design it at once plan it at once and probably. there is some possibility of phase wise construction for few units if your are planning that way. But otherwise majority of the units construction installation has to be done at one instance ok.

So, there is not enough scope of going for gradual development, where as in a decentralized system because, these are smaller units ok. So, you can take phase wise areas and go on building up this things, so you can basically control your investment in a phase wise manner or you can gradually develop the decentralized systems a which spread over wide area of the city ok. And no use of water as a transport medium that is another thing because, we will not in decentralized system the transportation cost substantially reduced.

So, these like when we say the availability of many cases specific technology, so this helps in protecting public health. A gradual investments meets the aspect of increasing demand or increasing production at this smaller scale and reducing pressure from scarce water resources will be achieved if by kind of reusing or utilizing the that water.

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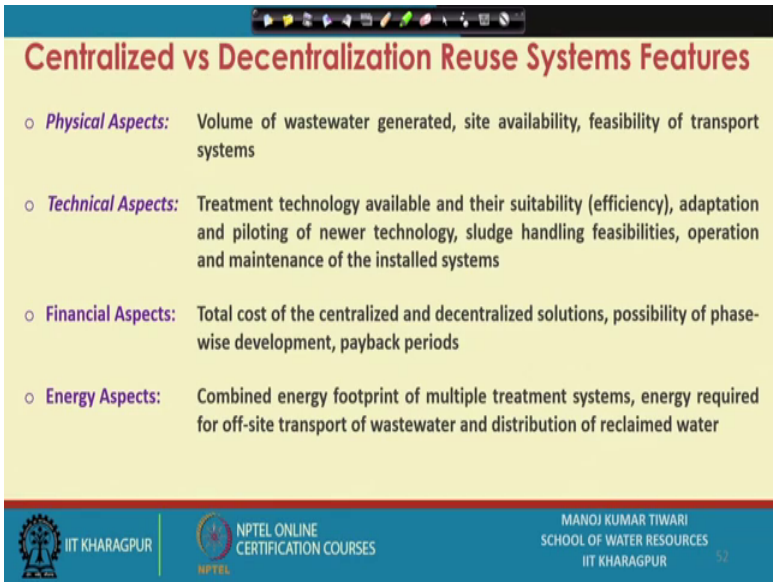

So, if we see the different features of centralized versus decentralized system or from reuse prospective, so first thing like there are several aspects ok, we will have to check, evaluate and analyze these systems. The proposed systems whether it is centralized or decentralized which one is beneficial in what terms, over all these multiple aspects. So, for say physical aspect, we will see volume of waste water generated. So, how much volume of the waste water is being generated from a city.

Now if it is a very large city and you want to go for a centralized system, if you end up generating 1000 million litres of water per day, so how you are going to collect that 1000 million litres of water per day, where you are going to process it ok, whether there is a any site available for that like that large or that big a size available for processing this much of waste water. What you are going to do with that waste water post those things.

So, that will come into the picture. So, that volume of the waste water being generated, the availability of size, the availability of specific site were this can be put through. It is basically not just in the terms of centralized, in terms of decentralized also. Because, if say though 1000 MLD's if you want to say breakdown to into 10 MLD's 100 treatment plants, so you will have to find the 100 sites across that city ok. So, are there 100 locations available to process it that way or if you want to go even smaller 1 MLD are there 1000 locations available to process that water ok.

So, that site availability is a issue in both the sense. In a centralized systems we need 1 much larger site, in a decentralized system we need all those smaller size, but in several numbers ok. So, whether there are like those kind of sites available, so which one is available that could be a decision making tool in here. Then feasibility of transport systems, if you are going to layout a network for collecting all like collecting the sewage from this entirely spread city that much volume of sewage is to be processed, what is going to be the diameter of those sewer lines ok.

So, if you are let us say willing to install sewer pipe, which can carry towards the treatment plant which can carry 3000 million litres per day of flow. So, how what can you imagine what is going to be size of that, so where to lay that network, how to process those pipe networks, is it feasible or not feasible, so that has to be kind of evaluated that has to be seen ok. As suppose to decentralized system, so whether there are that many sites available and then because, in the decentralized system the transport part is very minimum. Because, it is a on sight management so, within a from say locality or within that small market area it becomes far more easy to have a sewer system a small sewer system bringing the water to the treatment facility.

Then there are technical aspects. So, treatment technology is available and their suitability. So, there are various treatment technologies which are suitable for only small scale system. There are several technologies which are more suitable for large scale systems. So, we have basically different technologies available and selection of those technologies based on these technical aspects, so what kind of efficiency is needed ok.

Then adoption and piloting of newer technology how feasible it is, so if you are having a centralized systems it becomes very difficult to adopt new technology. If particulary with an existing system if you want to amend something it becomes very difficult because of the scale. If you are having a 1000 MLD plant and if you just want to see if adding 1 unit is going to help or not it becomes very difficult there, but in a smaller systems it is fairly easy you will sizes of unit are much smaller. So, kind of mending your treatment philosophy or kind of revising this treatment scheme is fairly possible fairly easy in the decentralized system.

Then sludge handling feasibilities. Now in centralized systems we have we do generate lot of sludge for which we need a again this sludge handling area those kind of things

which is kind of part of your treatment facility. But in decentralized systems, if you end up generating sludge at a various different locations what you are going to do with the sludge, how you are going to deal with the sludge ok. In centralized facilities it is together processing the slugde an diffusing it watering it then if you want to say we use or dispose it of from one point it is relatively easier. But in decentralized systems if you are adopting a treatment processes we generate lot of sludge, what you are going to do with that sludge in local scale ok.

So, if there are uses for that it becomes preferable, if there are no uses for that becomes a burden of disposing that sludge or handling that sludge in a several small units; say in a 100 small units of 10 MLD as supposed to 1000 MLD unit treatment unit ok. Then operation and maintenance of the installed system, that is another very important aspect because, if we see the like in a centralized systems we can have a devoted team, which takes care of, which looks after the operation maintenance of the plant in a particular manner in a ok. But if you are going to spilt it so if you are say having 1000 plants of 1 MLD or 100 plant 10 MLD instead of 1 of a say 1000 MLD, so how much amount of manpower is needed for handling those 100 units or 1000 units and whether they are skilled or not, so a that operation and maintenance becomes a tricky task particularly in a small system. It might be actually easy technologically, but the requirement of the man power increases many folds ok.

So, you will have to take care of the plant, you will have to take care of the kind of plant operation and its maintenance, its securities. The technologies could be different and so some technologies are like low end maintenance technologies so like if you are adopting a simple natural processes wetland kind of thing which does not require much of the treatment. Or simple process which does not need much of the like skilled operation and maintenance like one can adopt those technologies and then use water possibly for irrigation or horticulture purpose.

If it is permit if the water quality is of that sort, but for reusing the other aspects if you want to go for higher end treatments, so particularly the advance treatment at decentralized scales are at going to be a big challenge ok. But then again there is flexibility with some unit s depending on the kind of reuse potential available, some units may go for high end treatment while some other units may just like go for minimal

treatment for the desired or targeted reuse option. Then there are financial aspects in terms of like the total cost of the centralized and decentralized solution.

So, what is going to be the total cost of centralized and decentralized solution? So, in a decentralized solution we may see that individual units cost is very less, but the what is going to be the total cost because, if you cumulative say that the cost of those 100 treatment facilities as opposed to just one big treatment facility how much cost effective that one big facility is going to be or how much cost effective this smaller 100 facilities is to be.

So, again that depends on the scale of decentralization because, if you are going for say household level treatment we may see that it may prove to be more costly as oppose to 1 centralized system ok. However, if we go for some intermediate scale we may see that that is more economic as opposed to centralized system because, it is not just the cost of treatment plant it is the cost of transportation which is too high in centralized system, which is almost very little decentralized system.

So, if you have to transport that water you have to lay down a pipe network, you have to pump, put the pumping stations main hose arrange kind of the entire sewer network throughout the city carrying those big sewer pipe. So, the chances of failure managing set of distances all those becomes quite like costly affairs in centralized systems.

Where in decentralized systems, the cost of transportation is very minimal, but having so many treatment plants at different locations might in collective or in the combined cost might actually be like it has to be seen it has to be properly evaluated that, which option is more cost effective in terms of the overall solution and then if let say decentralized systems again as we said there are various option or various scale of decentralized.

If we see that household scale decentralized is not going be effective then what scale of decentralized is going to cost effective. Then other aspects is the possibility of phase wise development as we are just talking that is very difficult with the centralized systems and far more easy with the decentralized systems. We need to see what are the payback periods of the investment in a centralized system or a in a decentralized system.

Then there are energy aspect in term of like combined energy footprint of a various treatment systems, the energy required for offsite transport waste water and distribution of the reclaimed water all those need to be properly seen.

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Further there are end use aspects. So, scale of the induced alternatives whether we want end use to be at a localized scale or to a centralized scale, if your end use is going to be on a centralized scale. Let us say for example, in the Singapore, so the new water which kind of treats the sewage and then augment its domestic water supplies. So what happens that is actually since augmenting the domestic water supply. So it is a kind of centralized scale end use from there onwards it is going to the your different eventually like it in the different section different parts of the city along with your waste along with your water supply network ok.

So, if you are end up going for are decentralized waste water treatment facilities, so again after treating you have to transport that water to the centralized facility from where you are going to resupply that water. So, there not much of transportation cost is saved, if your end use option is again a centralized one, but if your end use option is decentralized one let us say irrigating, horticulturing, gardening, flowering. So, these are very local type of end use, the water is being treated here and you can basically put that in the vicinity for the purpose of gardening for the purpose of watering the plants those kind of things.

So these are kind of very localized end use option of the reclaimed water. So, if those kind of options are to be preferred are to be basically opted, then the decentralized systems are going to be better were as if you are going for a centralized end use system, so then even if you go for decentralized treatment, you will need the transport for the point of use. So, that way it is not going to be help full in any way. Then there are various social aspects.

So, proximity to the human settlements because, your centralized systems are generally offsite management, so it is taken the water is transported at some far of facility and from there it passes through sewer lines. So, those things are there, if your sewer lines are not protected you end up exposing a lot of health risk over there, but if your sewer lines are protected that is not much of a concern. So, there is not going to be kind of social objection to those systems, but in a decentralized system we will have to plants in the vicinity of the place where the waste water is being generated primarily.

So, there because of the decentralized scale because of the several plants across this city or across the kind of territory we may have issues in terms of like public acceptability that, if there is human settlement and there might be objection that you cannot make a waste water treatment facility here because, there would be have health risk associated with that ok.

So, there is going to be order issues, overflow issues if your sewage is let us say overflowing then aesthetic issues all those things may create kind of issues with the public perception and public acceptability and then willingness to pick and also the like if I am getting say reuse water for processing here itself. So, those factors eventually affect the willingness to pay as well ok.

So, those are various social aspects then there are environmental aspects, so environmental impact of the centralized and decentralized systems, then energy footprint the net climate change impact, what is the net water productivity from the centralized and decentralized systems. So all these has to be seen and in environmentally most sustainable option would be a kind of a figured out based on these criterias, their impact assessment their energy footprints their climate change impact assessments, so all those things has to be kind of evaluated while going for selection whether of the centralized versus decentralized system.

Then there are institutional aspect, so the institutional on organizational capacity to manage the so many number of treatment plants or a large size of treatment plant, the security of the plant from the theft and vandalism.

So, those kind of aspects may also come into the picture because, as we were just saying that if you are having say 100 number of a smaller treatment plants, so are there like technical skills available to operate and manage those systems there needs security from ensuring the like these plants are safe from theft and vandalism kind of things. While centralized systems it comes to size though if let us say is it feasible technologically or you have institutional or organizational capacity to run construct and operate a plant of that bigger size 1000 MLD of size, so if not and if it is so, if you want to decentralize it to what scale you the institutional capacity to manage. So, those are the some of the kind of aspects which needs to be seen while evaluating this.

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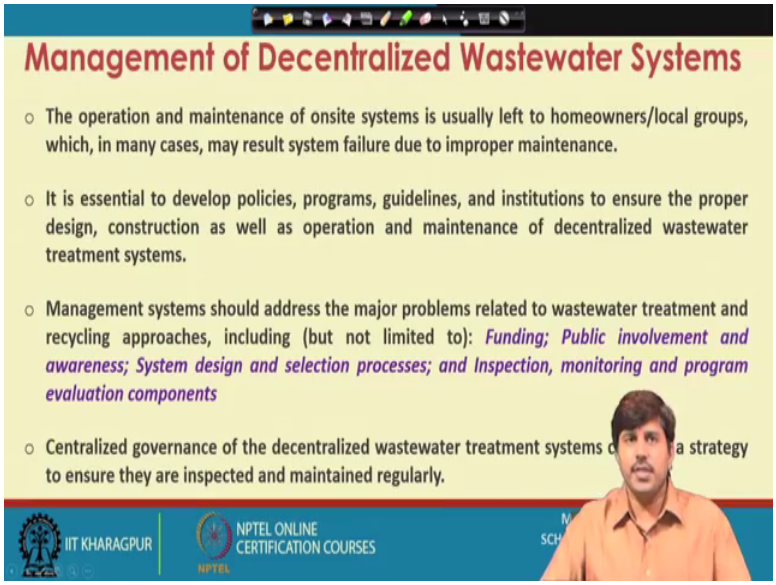

So, if we see the management of the decentralized waste water system, the operation and maintenance of this on site system is usually left to the home owners or the local groups ok. And there may be a problem because, like if the maintenance is not proper, so this system may fail. That is why it is kind of some people recommend that we should develop policies, programs and guidelines as well as institutional capacities to ensure the proper design construction operations maintenance of the these decentralized waste water treatment system as well ok.

And this management system should address several points like funding, the public environment and their awareness, the system design and selection processes, the inspection and monitoring programs and evaluation of these decentralized facilities.

So, some people in fact, recommend that there could be a centralized governance for the decentralized waste water treatment systems as well. So, that strategy is being recommended by some that even though, there could be like one this city or utility can go for decentralized treatment facilities decentralized treatment and recycling options. But it should be inspected, maintained and monitored from kind of more comprehensive way and there has to be centralized governance at least for inspection purpose that these utilities are functioning in a proper manner.

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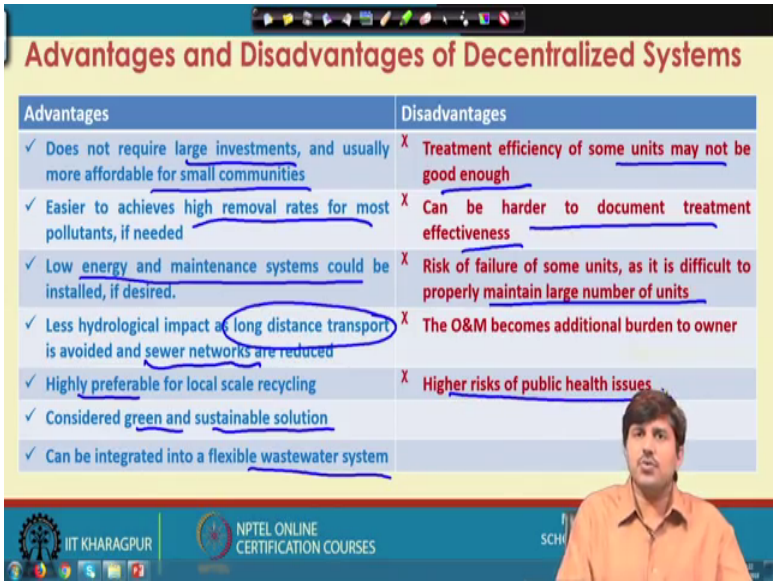

So, if we look at the various advantages and disadvantages of these central systems, so the decentralized system that which is advantage for decentralized system is obivous disadvantages for decentralized one. And disadvantages of decentralized systems are relative advantage for centralized system that. So, if we see the decentralized systems does not require the large investement and usually more affordable for a smaller communities.

So, that is one point were they score more over the centralized systems. Further if needed we can like we can achieve the higher removal rates for most of the pollutants because, it is a small scale. So, if let us say you want to use that for a industrial processes and from a

decentralized systems it is far easy to kind of then treat that water to a level of ion exchange or RO system and use it. But going for that high end or advance treatment system for a centralized solution is going to be immensely costly ok.

You can if plan to use RO say for 1 MLD plant versus you planned to use a RO for a 1000 MLD plant you can see the kind of infrastructure investment initial investment and operational maintenance cost would be needed for that ok. Same way, if needed, if desired the low energy and maintenance system could also be installed.

So, like in place of conventional centralized treatment facility were you go for activated sludge process which uses a lot of energy, we can go for low energy and low maintenance system in the form of say wetlands or anaerobic processes or other systems where their energy requirement is low, if our reuse quality criteria permits that ok. Further, there is going to be less hydrological impact as you are you are going to provide this long distance transport ok.

And you are also going to avoid the big sewer networks. So, that way the hydrological impacts are less. For local scale recycling these are highly preferable system, they are the considered green and sustainable solution and they can be integrated into flexible waste water system. So, we can get flexibility of reusing the water to different scale, different types, different grades of water can be produced, so all those flexibilities there.

Whereas in the disadvantages front if we see, so treatment efficiency of some unit may not be going good enough ok. So, that is the problem because of that could be because of operation and maintenance issues or could be because of the kind of technology which has been adopted. Further, it can be harder to document the treatment effectiveness because, there are so many small number of facilities, so many large number of smaller facilities. So, how you are going to monitor document those things.

So, if your say you want to analyze the treatment effectiveness in a centralized systems, you can grab some sample from in inflow, some sample from outflow and your done, but in a smaller treatment facilities instead of 100 treatment plants and you are say 1 2 analyses some samples in duplicate in flow and outflow. So just four samples are going to be good enough 2 from inflow and 2 from outflow from a centralized treatment facility, but with a 100 smaller treatment plants you will need 400 samples, 2 from each flow; 2 from each out flow.

So, instead of four you have to analyse 400 samples, so that kind of like it becomes very difficult to analyse that and document, the treatment effectiveness of these so many treatment facilities. Further, risk of failure of some units would be there as it is difficult to properly maintain the large number of units as we are been discussing. The ONM also could become a additional burden to the owner in the smaller treatment plants. And there is could be higher risk of public health issues because of the large number of these facilities.

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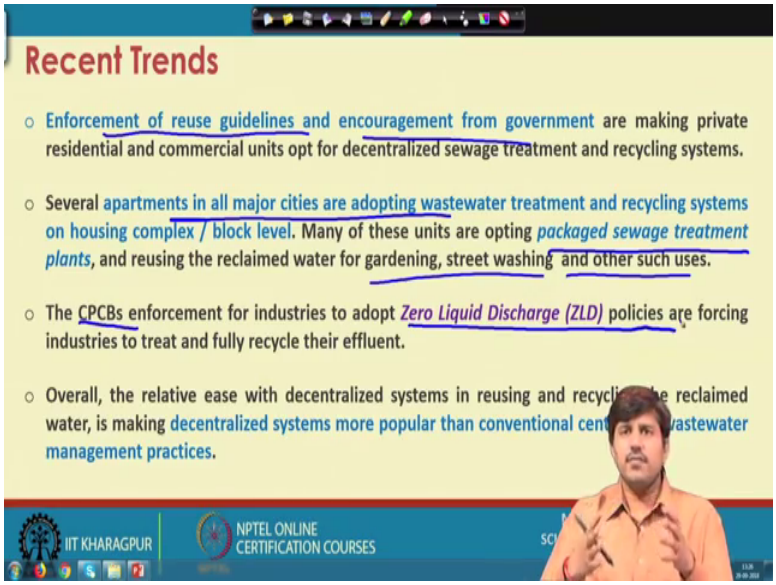

So, that could be some of the kind of issues advantages and disadvantages associated with decentralized treatment systems. So, if we see the recent trends what is the kind of getting more popularized or what is in practice these days.

So, the government are kind of enforcing reuse guidelines as well as encouraging users to go for these reuse and recycling purpose ok, in the form of various incentives. So, like that is what making private residential and commercial units opting for the decentralized sewage treatment and recycling facilities. So, that way there are various kind of apartments in all major cities you will see like in Delhi, Gurgaon, Bombay everywhere.

So, what is done that these in a housing complex level or block level they come up with a with a treatment facility. These treatment facilities are mostly kind of packaged sewage treatment units ok. So, the complex will buy a packaged sewage treatment plant and they treat that sewage to that and then recycle that or reuse that reclaimed water for

gardening, street washing and other such issues. Now the point here is that this is the done again because of the probably enforcement of reuse guidelines or encouragement options.

So, many in cases government or state bodies or the like the city authorities are forcing the complex owners to go for these facilities and at many places these are being encouraged by kind of announcing certain incentives. So, in the form of say certain rebates in the tax or fir those kind of things the rebates are offered and that is how the complex owners or those people eventually go for opting for these facilities ok. In the industrial sector the central pollution control board is enforcing the industries to adopt zero liquid discharge policies ok.

And that is how forcing industries to treat and fully recycle their effluent. So, the concept of CETP's combined in effluent treatment plants were the industries kind of put their different effluents to just one single treatment unit which can treat it and then dispose it off is being discouraged these times these days ok. So, this disposal of the waste from the industry or sending it to combined effluent treatment plant which is a kind of centralized system of course, within the industrial peripheries.

So, those things are being discouraged and the government is kind of enforcing industries to go for zero liquid discharge policies were that fully treat and then recycle their waste within their own territory. So, over all there is kind of relative is in reusing and recycling the reclaimed water when you go for decentralized systems as opposed to centralized systems and this is what is making the decentralized systems more popular than conventional centralized waste water treatment practices. However, the same time we have to see the other aspect that decentralizes fine, but what is going to be the appropriate scale of decentralization.

So, it is not that decentralization at very specific or very fine scale is recommended, but yes like a instead of going for a big centralized systems, it is been practiced and it is being perceived the better solution to go for suitable scale decentralized treatment options.

So, that is what was kind of the summary of a discussions we and next we will conclude this week's lecture, this week's discussions here and next week we are going to talk about various other aspects related to the reuse and recycling of the waste water in terms

of say it is like decision making and the public involvement the such process role of public perception and role of public participation in such systems. So, those things we are going to talk in the next and final week of the course. So, thank you for joining and see you in next week which would be the last week for this course.

Thank you.