Course on Integrated Waste Management for a Smart City
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Module 5
Lecture No 21
Waste Collection and Transport

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Okay so welcome back to the week 5 of this course, so we are already done by one third of the course is already over so because it is 12 week course we have finished week 4 we are now in week 5 so will start the week 5 materials and if you have if you remember from the previous week that we were talking about waste collection, we were talking about the transport, we were talking about the segregation, so we will continue doing that because there

was some discussion left in the particular material and then we will go towards landfill disposal if you have if you go back and look goes outline we have landfill disposal, we will talk less in landfill disposal then will talk more actually about anaerobic digestion, composting waste-to-energy and those treatments technologies.

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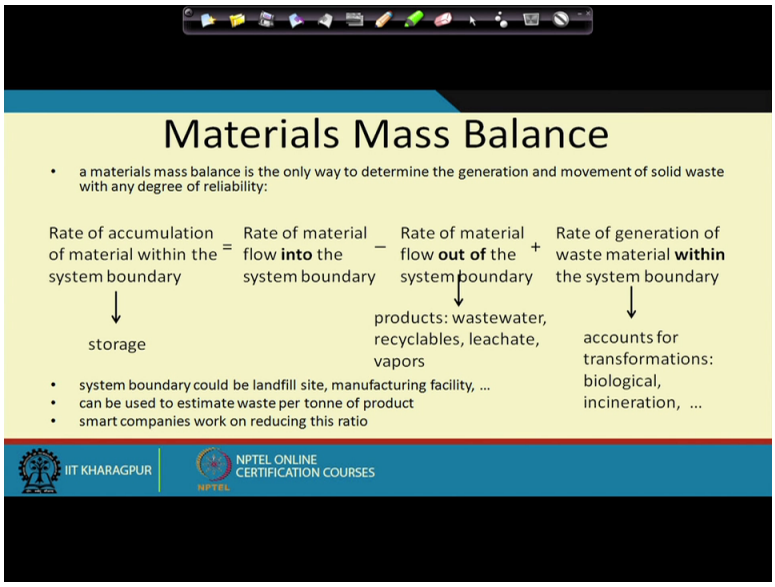

So let us get started so we were so we were talking about in terms of how to calculate how much waste is produced so this is kind of last set of discussion we were having in the previous module that if you have to calculate how much waste is produced, how will you do that? Because remember we have to know how much waste is produced then only we can design the transportation system for it, we can design the collection system for it so one of the basic component in terms of when we go for designing of a integrated waste management plant designing of the whole interior waste management system.

One of the basic thing you need to know is how much the total waste produced and what is the composition of the waste and again the composition of the waste is specially in the Indian context as of today since waste gets connected from our houses goes to the primary collection Centre which is at the side of the road and then from there it goes to maybe a secondary collection and then finally to the landfill or dump side wherever. So in between there are some of the organic waste may decomposed specially in the hot climate.

Some more organic waste maybe even away by the animals, some of the recyclables which is still left although most of the recyclables are managed through the Kabadiwalas in India but people who come to your house to buy those recyclable but in case if any recyclable is left in

the waste stream that gets picked up by the rag pickers at the collection Centre. So if again if I have said that in the past several times I think I will again said one more time as that waste composition it is, you have to know the waste composition of the point that you targeting or any sort of treatment.

What am trying to say is that say if you want to composting plant or want to set up an anaerobic digestive plant and if it take the amount of food waste that is produced at individual houses but we do not have a separate collection of food waste, everything there is this mixed up and then if we and then things get eaten by animals, part of it gets decomposed on the waste, so by the time we still it comes to the dumb site today, it may not have that much of compostable material because part of it is gone or sometimes most of it may be gone.

Same thing on the recycling sector so make your first of may not be available because they have not taken away from the rag pickers. So we do really be careful about in terms of the waste composition and waste composition along the length like how it changes from the houses to the primary collection Centre to the secondary correction Centre and finally to the dumpsite, so that we do understand that as well.

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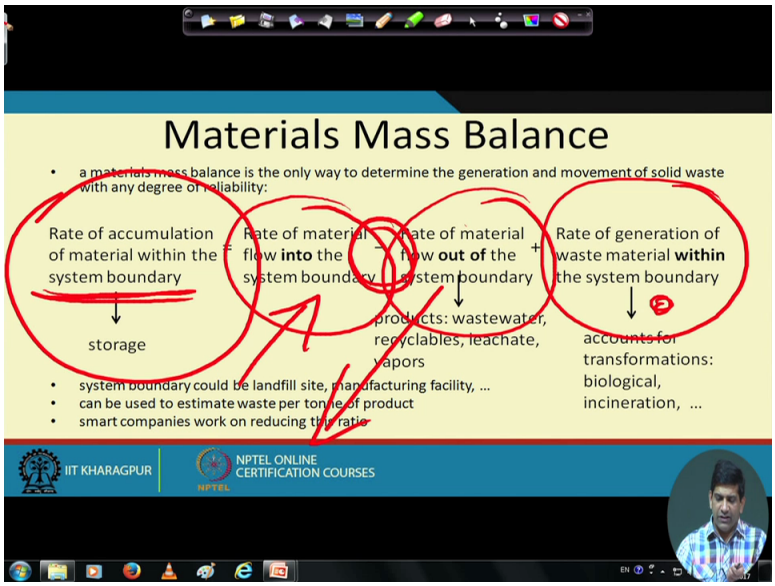

So to understand one of these basic concept of how much waste is produced one of the thing you can do is the Material Mass Balance, what is a material mass balance? Here as you as you can see over this particular sketch that you trying to explain here so you can look at the rate of accusation which is rate of activation of materials within the system boundary, now the system boundary could be say if you trying to design a integrated waste management and

for your city which could be any city say if you are watching if you are taking this course from Bhopal or Nagpur or Mumbai or even like Delhi or any Kolkata or any place.

So if you are interested in that particular city so that becomes a system boundary, so city boundary becomes system boundary. So rate of accusation of the material within the city boundary is whatever is the rate of material coming into the system minus rate of the material going out of system plus if there is any waste being produced within the system boundary itself, so it is like a mass balance.

Remember we do a lot of mass balance equation where you have an import you have an output and there is a reaction and ())(4:55). So similar concept here, so whatever is the rate of accumulation of material is rate of material coming in to the system, rate of the material going out of the system and then whatever is the rate of material being generated in the system itself, so that is the so here is a negative sign which is the output, this is the input, this is the output could be some of the reactions happening within the system.

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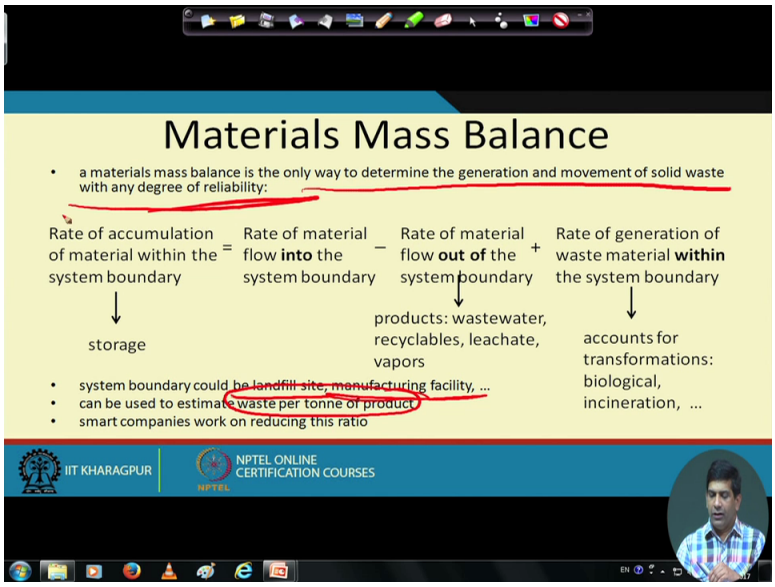

Simple mass balance concept and with this mass balance concept you can calculate how much waste is being produced and again the system boundary could be your if you are doing it for industry system boundary could be the manufacturing facility, if you are worried about the landfill site how much waste will come to the landfill site, system boundary could have a landfill site and what it does it helps us to estimate the waste per tonne of product like among the different product that is made especially for the industrial sector it helps us to find out

how much waste is being produced per tonne of product and as a company I would always like to lower that , is not it?

If I can lower the total amount of waste that is produced per tonne of the product that increases my profit because I have to manage with less amount of waste and lest amount of waste means less amount of money that I will spend on managing that waste. So this is one way of how you can generate it says material mass balance is only way to determine the generation and moment of solid waste and that is actually used quite a bit in terms of estimation of how much waste will be produced because that is needed your trying to go for trying to design of a waste management system.

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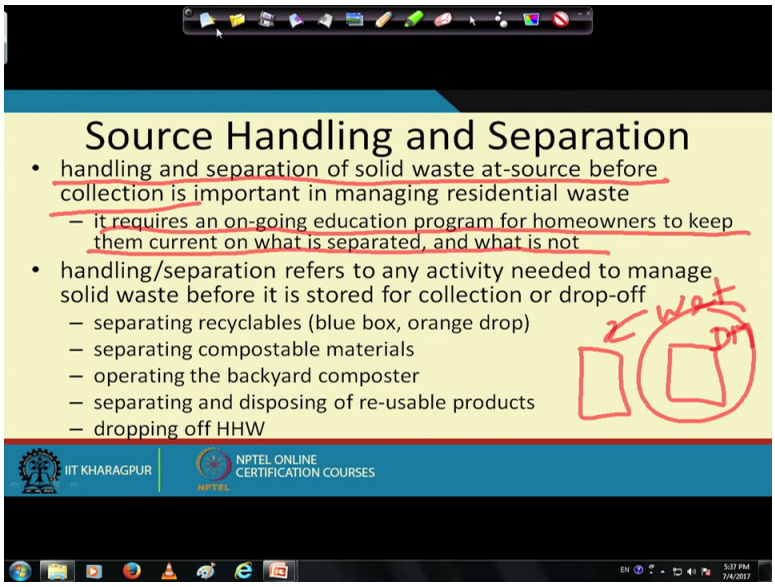

Now source handling and separation that is another big thing like how to how to handle this waste? Once we know the waste how much waste is being produced but waste have different compositions there will be some biodegradable, some are non-biodegradable, some are recyclables, some are could be good to calorific value and so most of the cities around the world, many countries around the world today is wherever they are trying to do some sort of I would say modern waste management system, what they try to go for is at least two-way separation wet and dry.

Wet and dry which wet it is sincerely your organic mostly organic (())(7:14) something which is wet food waste will be the predominant in terms of when you are talking about residences, municipal solid waste, so you have this like a wet waste and then you have a dry waste, so this was like a source separation we try to do it source separation, so handling and

suppression of solid waste is actually very important if you can do that like if you can handle the waste handle and separate the waste at source before collection.

So if you can have a two way bin, so you have one bin and another bin, one bin is for the wet waste and for the other bin we have dry waste so both of them can be collected separately and both of them can be taken to the wet waste, can be taken to anaerobic digestion plant or could go to any composting plant and the dry waste, it can it will potentially it will go either to a waste-to-energy plant to a landfill but in between it can go to a (())(8:11) for just for the removal of any recyclable is still left there.

So many a times even your waste-to-energy plant may have a little bit of (())(8:18) people can take out some of the recyclables are especially the one which does not have good calorific value like like if you have a metal, if we have glass those things could be taken out as well. So for all of these source handling and separation when trying to do a source separation, it actually requires a lot of education, so that is one of the thing like you even you trying to like an if you are, if you are waste operator if you are from a city if you are taking this course from any city who is managing the waste for the city I think you will appreciate the fact that a lot of education is required. It is very difficult to get people to start behaving the way we want them to behave in terms of the waste management.

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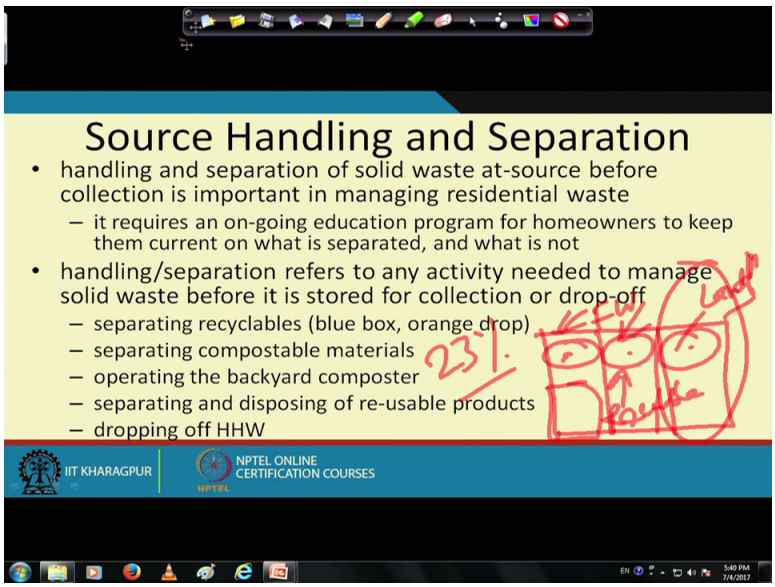

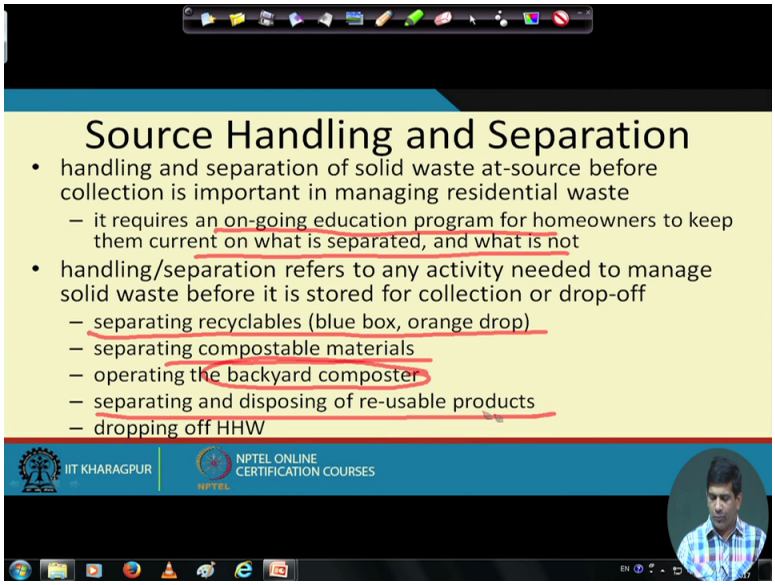

There has been like I was we did a study few years back not in India but it was when I was in US and even if we had a three-way bin. I will show you like it is an essentially we had a three-way bin so it is a this kind of box with 3 compartment and opening is here for each compartment and this was your food waste, this was for recyclables and this is what can go to a landfill like non-recyclable non-food waste and we had this bin all 3 are like a just next to each other and we had this cart sitting in an elementary school, in a primary school, in the secondary school at a university setting and if you and then we looked at the data and how the waste is being collected.

You may be surprised what we found that actually elementary school kids did much better wherein elementary school will be will be did not see any recyclables showing up in this landfill compartment while in a university setting we almost sort 23 percent like 21 to 23 percent of the waste showing up recyclable, recyclables showing up in the landfill bin. Even when you are saying the recyclable bin is right next to it.

So it is people does not have to travel extra to go to the recycle bin but still people where messing up they were mixing up non-recyclable with recyclables and things which can go so this is again lots and lots of education is needed and I am talking about the University, University mostly will expect people to behave much better but I do not know maybe they have some other priorities, they have some other things going on in their life.

So they are not that focused but in elementary school we found much better results actually very low amount of waste of coming to although we did had a flyers we had distributed to the there was stickers on all these boxes where it tells what exactly should go here and what

exactly should go there and then we have a big poster next to this on the wall which was telling them what to do like how to do the separation.

So all those information was provided and it was mostly pictorial so that even people at elementary school level can understand it and of course the teacher must have helped them to at least the beginning of this is like even in a what was trying to say that even in a university setting we were having a hard time getting people to separate the waste and you go to any country in Amsterdam for example.

Amsterdam does a very good job in terms of the waste management but when you talk to the people working in the waste management for the city of Amsterdam they will tell you that the high rise building it is very difficult to get source separated garbage from them although they would like to have it but it was very difficult and then this any city for example like if you set up a very good waste collection with a nice like a wet waste, dry waste collection and thing happening sample in our IIT Kharagpur campus but every year we will have new people coming in to the campus so we need to educate them, so education will be a continuous process.

Most of the cities in the world which has a very good waste management system, they have a team of at least few people dedicated just on educating the mass, educating the mass in terms of source separation, while is important? What is to be done? How much money it saves to the city and so that people are aware. Once you make people aware and once you get people on board it then this program can work.

That is the difference if you remember in the beginning I said in terms of solid waste management other than water, wastewater or air here we actually dealing with people on day-to-day basis. How your system will work depends on what sort of input you will get from individual houses, so that is why there is a lot of people interaction here so we do make sure people understand what you are trying to do and how they can help with that,

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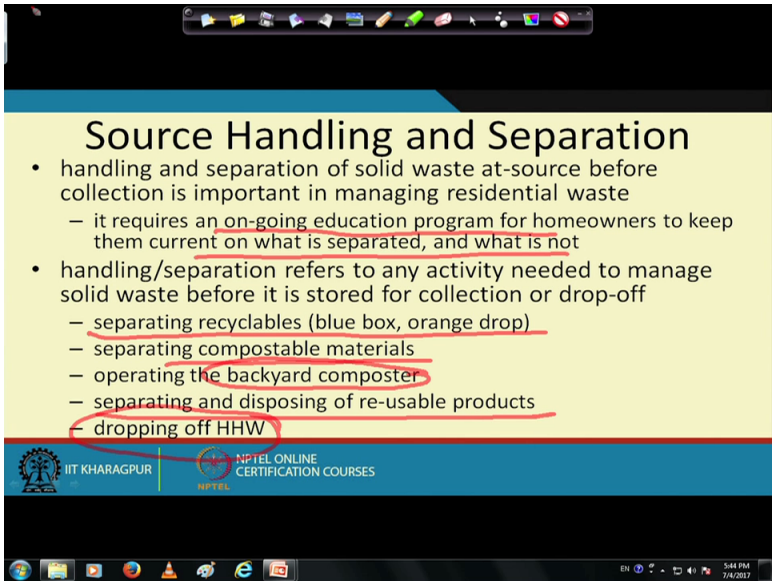

So in terms of here it requires lot of on-going education and for home owners to keep current on what is separated and what is not? What is we are doing the separation and you can separate recyclables like there is a lot of I showed you some pictures as well there you have the blue box, orange boxed and all those programs separating compostable materials that is our wet and dry separation usually wet and dry we do that is to try to separate the organics and that is happening many places in the world.

Even municipal solid waste management rules 2016 which we just covered in the last week you saw that it requires us to do wet and dry separation so wet waste has to be separated, so that is the separating of the compostable material and then you can if you have an individual houses can even operate a backyard composter that might be a good idea that many people do that as well.

Recently I was visiting Canada and just few weeks back there also I saw that even in Canadian climate which is not that warm as we know but is still there, there was visited one of my I would say friend's house and he has a backyard composter. He would be able to use backyard compost and can use it on his on his flower bed and some of the vegetable gardens that he was doing so that it can be done you can make your own compost and there are lots of initiatives like that in from Delhi right now in Bhubaneswar lots of work is going on in this area.

So people are doing some stuff but again in big high-rises building you can make compost if you start making composter everyday you can use certain amount of compost but after that

what? After that you need to kind of find place for the compost and then you can separate and dispose of reusable products, if they have a reasonable product that can be separated and household hazardous waste as we are talking about in a municipal solid waste management rule, it requires us to keep this household hazardous waste separate and it says that it should be collected separately.

So once these rules are implemented, I anticipate that will have something like household hazardous waste collected maybe every 3 months or I do not think it required to be collected every month and probably every 3 months or every 6 months might be good enough so or we can have a drop-off point where people can bring it and drop it off and they can show their driving licence and do that like they do in the Western world.

So those how it could be and a pretty much managed in terms of source handling and separation, so once we have these things done now we have we know if you remember from the very beginning we were talking about how to know the amount of waste? How to know what is the characteristic of waste, what is the composition of waste? Then so we have covered that material so already.

In the first week we did a big overview and then they start going into details, so then we in terms of details other than the rules and regulations, smart city, Swachh Bharta. We have covered how to find out what is the total amount of waste a city would produce? Then we also tried looked at in terms of physical, chemical characteristics of the waste whether it is biodegradable, calorific value and those kind of things we talked about that then we also in this particular chapter has to be and right now we have been discussing about how to do so separation and all those stuff associated with that.

So total amount of waste has been total amount of waste we know that, we know the composition of waste we know how to do this source separation. Next thing is how to collect it? Is not it. So once we have this waste now ready to be collected and to be taking to the waste treating facility or to the disposal facility, so how to do this collection system. So for the collection system, so for the collection system number of has a very simple thing about that save I have to do a collection system for Kharagpur town or whatever town you are sitting right now who are watching this video.

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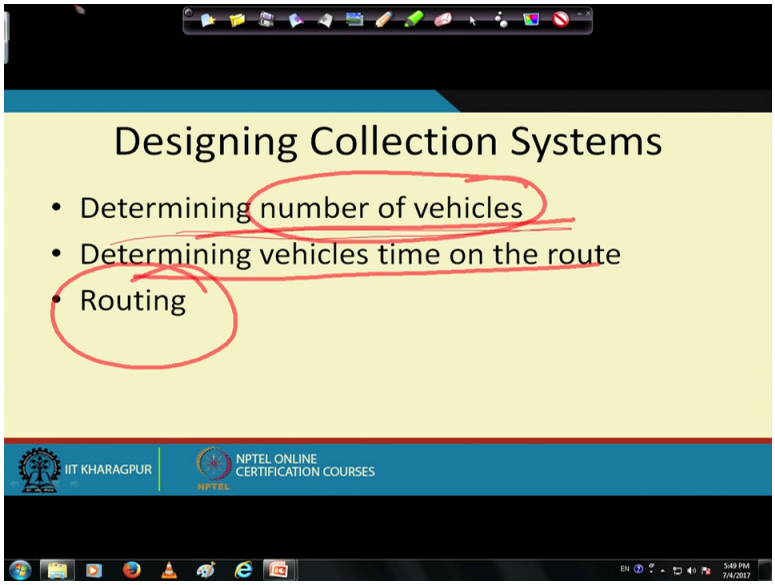

So first of all you need to know that how much number of vehicles are required? Is not it. Determining the number of vehicle so that is our one of the first it is how much now what is the total number of vehicles I need and that could be and that will depend on what, that will depend on the waste that is being produced and what kind of vehicle it is. If it is a nowadays many of this newer vehicles which I showed you some pictures, they have a compression inside as well and that helps to keep the garbage, more garbage can be collected and one is the number of vehicle and for that we also need to know determining vehicle time on the route.

So every vehicle will have a certain route, it will go around and collect garbage and then go to the disposal Centre or go to the treatment center unload the garbage, come back and do that routing again, so we also have to do some what is known as the routing. And routing is, it is very similar to routing that you would do for your Flipkart or Amazon or Snapdeal. Say if you buy a product it move from one place to the other place, so it moves so there is a route there is a like a travel associated with that. Here we are talking about the moment of garbage from one place to another place, it is same thing.

So waste has to be transported so it is again the route as to be optimise so that we have it can reach quickly at the same time with less amount of resources. So that is optimisation, route optimisation, linear algebra operations research all those concepts hold good here. So those of you if any of you who is taking this course and you may not be that much into looking at the garbage composition and all that but you are on the side of you are good at maths, you want

to work with computers, even you can contribute in the waste management sector by coming up with better design of the collection system.

If you remember in the very beginning in one of the initial videos I said collection system is actually nearly 60 percent of the waste management cost goes in the collection system. So if you can come up with a better collection if you can come up with a better route management, so that if you reduce even one truck and one truck is the newer one the really fancier one if you try to get that it will be something around 250 thousand dollars.

So even normal ones that we use in India would be at least several lakhs, so for that even if we save that money, so if you can reduce at least one truck and that we can use that money for something else maybe for education to have better recycling system. So those things can be done so that is why routing is very important we will talk about some of this routing stuff as well in our class right now.

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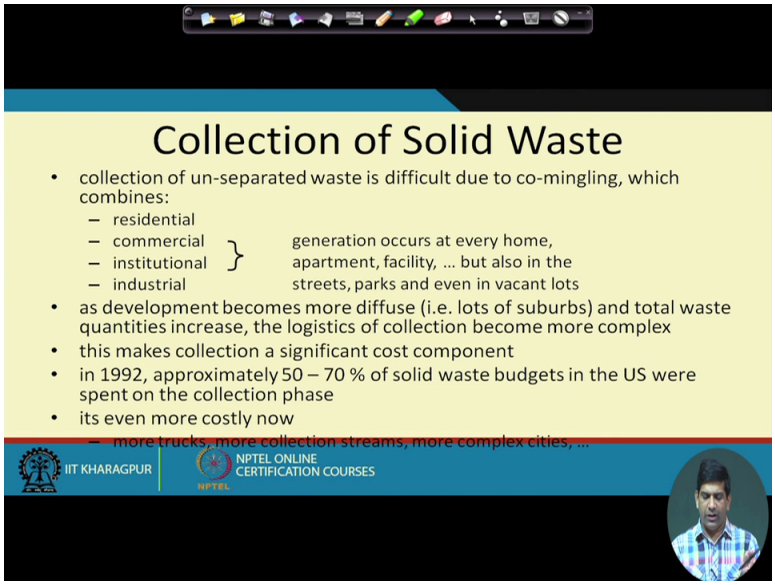

So for the collection of solid waste, it is collection of un-separated waste is if you do not separate it, it becomes like little bit lot of co-mingling, co-mingling of the garbage which combines residential, commercial, institutional, industrial if all of these are combined you are getting a un-separated waste and it becomes more as development becomes more defuse like if you are more and more suburbs coming up, total waste quantity also increase because the waste is coming from home, probably like individual houses, apartment buildings, several facilities, commercial places, malls, small and big malls, shopping areas, vegetable market, regular market and all those different places the waste is coming up.

Parks even vacant lots you will have waste there as well, so the waste can come from variety of locations and so then as City grows and those kind of more into into suburbs, now you have to kind of serve more and more area. So that is also becomes like going from the center of the city, you are going into the suburbs that means you need to cover a bigger area so that also logistics collection becomes more complex and as I said nearly 50 to 70 percent of the solid waste budget in the US were spent on the collection phase.

Just couple of years back I was talking with New Delhi municipal Corporation folks and they said their estimate was nearly around 60 percent, 55 to 60 percent of the cost is going in transportation of collection and transportation of garbage so that was a major cost they were getting as well and it is even more costly. Is getting even more costly, more trucks, more collection teams, more complex cities because the cities are becoming more and more lots and lots of development.

And things are even and if you are in the older city, narrow lanes so you need different types of vehicles because you cannot have a big truck going into the narrow lanes of Varanasi for example or if you are from in Bhagalpur area or any old city you go to, those narrow lanes you cannot really have this big trucks going around so you need to have smaller vehicles go around and collect, so there is a lot of you have 2 come up with different kind of combination and they cannot be one size fits all solution here so it depends on which city you are and how your requirement is, we will come up with your collection system.

How the waste would be collected? That is also another thing like with it should be a door-to-door collection. In Indian context most of the cities we have we are having door-to-door collection and those private housing areas where we have some people coming and picking up garbage from our houses and then they take it to a collection Centre they dump it there and the truck comes and take it from there so but there are like a in terms of collection responsibility is there.

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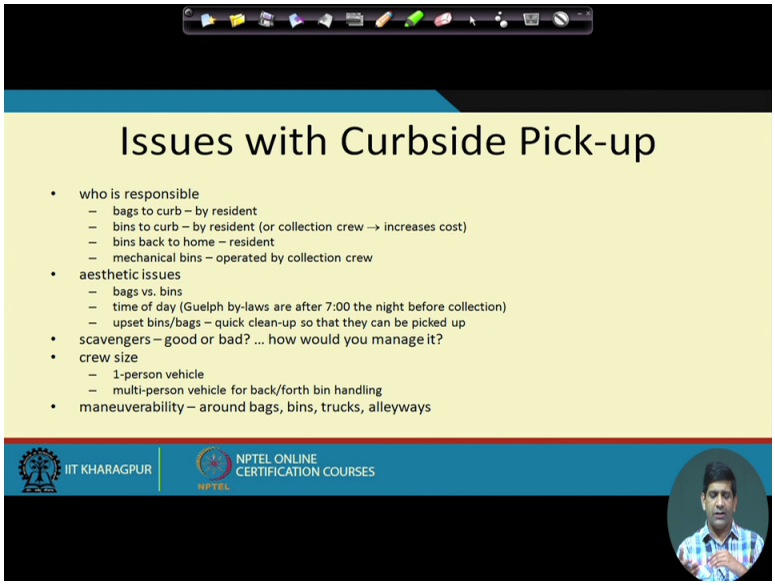

Like if you have your bag to the curbside to the primary collection Centre that is your responsibility as a resident and for bins again if we have a bin system if you put the bin on the curbside that is again the collection the residence is required to do that, you can have collection crew do it but for our individual houses they can go and collected but they will charge extra before it and then bins back to home again residence to that, mechanical bins operated, they get operated by collection crew.

So there was it should also bags versus bins whether we should go for a bag system or a bin system people around the world have kind of decided either way some people were on bags earlier and even, they were on bin earlier they went to bag, so from time to time people keeps on changing but overall either of those 2 actually works. The problem with the bag system which I see sometimes a proper because of the bag, there is lots of additional plastic now going to this landfill but if you have a waste-to-energy plant this plastic has good heat value so that should not be a problem.

And then when will you put say if you are putting your garbage outside the place for collection at what time we should put it, so there is some rules and regulations are there for that as well around 7 PM before like if you collection is tomorrow you put it around 7 PM and then, why because the animals will come and they will try to trip over the bin and you have garbage all over the road and those kind of stuff.

We usually and there are cases of scavengers swell, people will try to come and try to pick up the recyclables from there, so those things do happens usually we have 1 person vehicle or

maybe multi-person vehicle. One person vehicle will take more time for collection if we have multi-person vehicle it will be quicker, then multi-person vehicle means people have to pay as a salary so that is you need to understand that as well. So this basically a trade-off different types of collection system you try to design for but again as I said it depends on what works best in that particular scenario and how the things we will manoeuvre in terms of around backstage a dense, trucks, alleys so you have to look at based on your logistics to decide in terms of the pickup.

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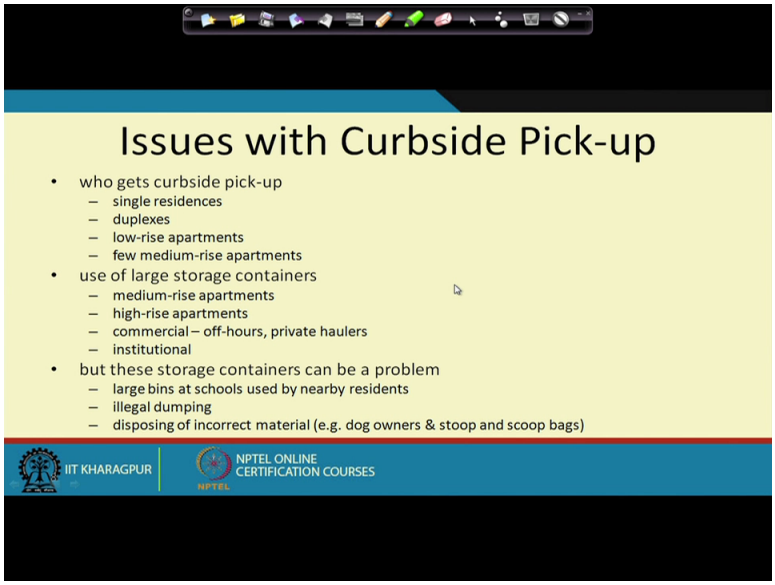

Who gets curbside pickups? Usually single residences, duplexes, low-rise apartments, medium rise apartments they get curbside pickup. Curbside pickup is garbage truck is coming to your house and collecting it, so when I say your house could be the individual houses, it could be an apartment complex and you can use a large storage container like the medium rise apartments, high-rise apartments they use a big container for getting the garbage commercial off hours, private haulers many cities actually are not doing day-to-day collection as we see India in most of the cities in India.

Wherever there is a collection happening the happen every day which is kind of luxury in many parts of the Western world, they do not have everyday collection because it requires lot of because when you have all this mechanised truck and other things is difficult to have everyday collection is basically not practically feasible like economically feasible.

So they have a larger storage container especially so that the waste gets collected and then it gets hauled away and like once in a week or maybe twice in a week it is done. So which

containers could be a big storage containers could be a problem they has been cases where people will use the school because people have to pay remember the bags we were talking about, so people have to buy those bags so rather than buying those bags as a prepaid bag what they will do they will put the garbage in a polythene bag and in the morning walk they go near the school and the school has a big dumpster and so there will just dump it there, so those things are also illegal dumping, disposing of incorrect material those things are also has been found.

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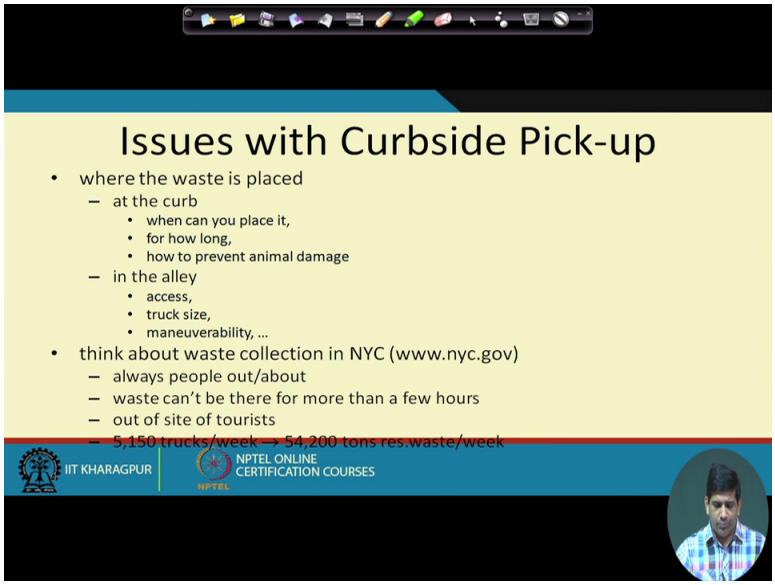

So where the waste is placed, at the curbside you can place it certain place in the evening, you can also do it in alleys, some very heavy as traffic area like New York City there is lot of people on the road so we really cannot do and so they do not want waste in front of the tourist, lot many tourists come there so they try to have it collection done in the middle of the night actually to get the waste collected.

So in terms of the collection we will continue this action in the next video as well, so again I will say that we are kind of day one third of the course is over I hope you are taking the quiz and then keeping up-to-date the material and discussion board is therefore your help, so if you have any questions or anything feel free to put it on the discussion board, we will be more than happy to respond and in case you to send (())(29:17) you can do that too again I hope you are enjoying this course and look forward to seeing you again in the next video. Thank you.