Course on Integrated Waste Management for a Smart City
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Module 1
Lecture No 2
Introduction (Contd.)

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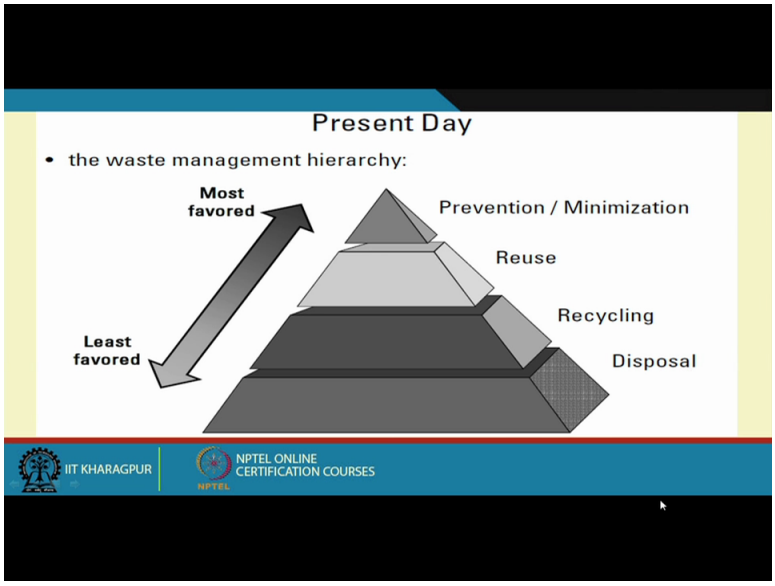

Okay so let us continue where we left in the previous module we were talking about different ways of managing the waste where we have reduced, reuse, recycle. So this is a in this particular slide that you see this is a typical hierarchy that is you will find in any of the waste management rules throughout the world, you pick any of the waste management rules whichever country you want to and you will see this kind of waste hierarchy.

So what does it show, it is basically telling us that we should try to prevent the garbage on the left as you can see there is the most favored and least favored, so as we go towards the top that is actually what most of the rules favors, so what is the most of the rules favored around the world to prevent and minimize, you have to reduce the waste the 1st of all we want to prevent the waste that is being produced so produce less and less amount of waste and then even if it is produced try to minimize the quantity so that is the most favored option then the 2nd favored is re-use, if you can reuse the waste rather than throwing it away.

Then your recycle and then finally disposal, so that is in what the rules tells us what is the throughout the world but what is actually happening this is kind of the reverse of that. So the size of this pyramid the different components that you see the different slices of this pyramid

most the biggest one is disposal, so that kind of gives you it is a proportional to what kind of percentage goes in different stream so most of the waste is being dispose today and less is recycle and even less is reuse and even less is prevented or minimized.

So that is that kind of unfortunate part of that but even the rules suggest that we should try to have more and more prevention, minimization, reuse but unfortunately we are what is happening on the ground is opposite of that and that is not only in Indian context that is a global context in globally also we have been disposing. When we say disposing even thermal treatment, incineration plants those are also considered part of the disposal stream and of course people can debate whether it is a treatment or disposal but for now we will consider it as a part of a disposal stream and so more and more waste is being disposed at even you will see in few slides down the line as well.

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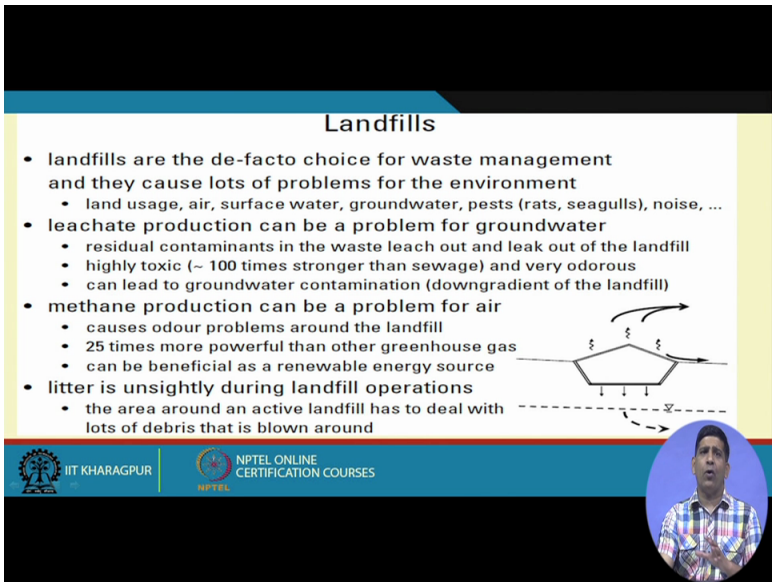

So when they are disposed landfills which is this is a landfill not a not a dump so there is a difference between the two. Landfills are the de-facto choice for waste management and we like it and we do not like it also you have world map just in in a few slides down the line which will show that landfills are actually the predominant way of waste management pretty much throughout the world, so if they are the defective choice for waste management and but they do cause lots of problem for the environment as well.

problems in terms of the land usage or surface water, ground waters, pets so there are problems associated with that and if you can look at the slide on over here what you see this is a that is the top cover of the landfill on top and then you have the side slope, this is the side

slope and this is the bottom liner this is the side cover sideliner and then you have the once the garbage has been filled up you can put the top cover on top on the landfill as well.

So this as you can think about the this space in here is where the garbage is being dumped, so you in a very simple way you can think about this landfill as a huge polythene bag, so it is a big polythene bag where you putting all the garbage in, so this polythene bag has impervious layer on the side on the bottom, so when the waste degrades it produces certain moisture and that moisture is called leachate, so that leachate since it is being produced, it has to be collected and has to be taken it away otherwise it impact the landfills stability.

So as you have as all of us have has studied in terms in terms of our basic physics also in feud mechanics and other courses that there will be a (())(4:29) there will be a like a pour water pressure than those even the pressure is too high we will have the impact on sea and fire value from our soil mechanics class the geotechnical part even if you do not if you have not taken if you are not a civil engineer has not taken soil mechanics, do not worry just think about from your basics physics as well, so if you have a pressure being built up and that leads to like a unstability of the system and then you will have things collapsing out.

So that is what if you think about the hilly areas specially say if you are from India and you go to Himachal or Sikkim and those areas during the monsoon period you what you see is there is a landslide. Most of the landslide that happens, happens during the monsoon during the rain event, why? Always think about the why part, so why it happens during the rain event? Because the water gets into the ports and then they creates the pour what pressure and the sea and the fire that they the strength of the material goes down because of there is a this pour water pressure facts kind of in the opposite direction and that leads to destruction of the slippage and then you will have destruction of the slope surface.

So to prevent that we have to collect this leachate out and this leachate is what is residual contaminants in the waste, which leak out from the landfill is highly toxic. It is 100 times stronger than the sewage and very odorous very smelly can lead to groundwater contamination downgrade in terms of the landfill so that is why leachate has to be collected and taken it away. Then that is on leachate part, then when the waste degrades it also produces methane, so it produces methane gas.

Anything when it is bio degrades and anaerobic system, it will produce methane, so once things are produced methane, methane has to be removed so it is methane production is a

problem for the air. It is methane does not have the smell but associated gases along with methane, there are several sulphur based gas several other non-methane organic compounds. It is a short from is NMOC they have certain smells specially sulphur gases have some smell and that create the odour problem and methane is 25 times more powerful than CO2 in terms of the greenhouse gas so that is why methane has to be captured and has to be either used for energy purposes or at least flayed.

So you burn this meeting and convert to CO2 so one mole of his methane will burn and produced one mole of CO2, so at least you are reducing the environmental impact associated with that so that is what but again the gas can be used and it can be beneficial, reuse as a renewable energy sources. Whether it is renewable energy or not that is again we there is a debate on that but in some places they call waste to energy as renewable energy and the other when (())(7:31) to gas energy is a renewable energy in another places it is not.

Whether waste is a renewable fuel, we don't know but it is again it is a debatable question some will argue in for and some will argue in the opposite but it is the bottom line is that it can be use this energy since methane has certain heat value it can be used as energy source. Then when you are closer to the landfill litter is a problem the area around the landfill has to deal with lots of debris being blown away. You go to any landfill site from around a kilometer away you will know that you are approaching a landfill because you will see lot of these days specially the plastic all along the side of the road.

We do not see that much in a developed country but you see in a developing country because the developed…there are ways to control it so in developed countries they follow those rules and regulation, there are actually the implementation of the rules is much better although the rules are pretty much the same but that is why they do not you do not see it over there but in here you see that. So if you do not want to go for landfill, what are the alternatives?

Although as a cell in the previous slide landfill is the defector choice which I sure you in couple of slides down there as well I will show you the data that I am why I am saying that but if you don't if you do not want to go for the landfill, what are the alternatives we have? One of the alternatives which is very powerful very popular across the world especially in the high dense population urban areas, is the incineration plant.

Incineration plant is where you take the garbage you burn it you produce electricity out of that and whatever is the residual you can use resources recovery if possible, if you have a

system in place, otherwise you just put it in a landfill but at least 90% of the garbage is gone it got converted to some sort of heat and so that that can be useful as well.

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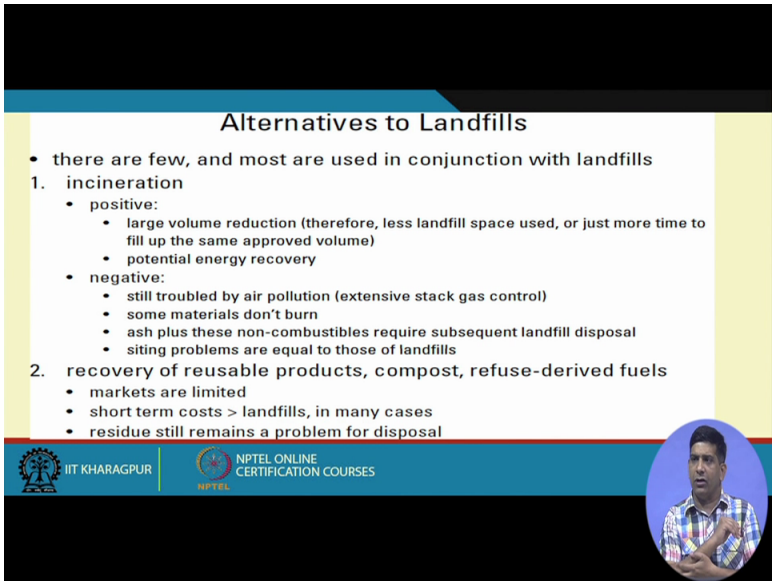

So there are certain positives of going for incineration, you can have large volume reduction volume of the waste going down less landfill space is required and more time to fill the same volume, so if the volume has gone down as a set from 100 tons to around 10 tons of residual, so now the landfill life has gone up by 10 times if in if you are using this 10 tons to go to the landfill.

So that is that always helps because the landfill space is very costly too and then it can be used for potential energy recovery. So you can use energy out of that so in so that is that is always a plus point and the negative part is the trouble of air pollution. So there is always although unsure you when we go towards the thermal treatment chapter, I will show you that there are technologies out there today we so if you do the incineration plant properly it this is it can be done.

It is it is responsible to be done and only thing from an Indian context point of view, what we need to do is we need to at least have some sort of source separation. Although there are technologies out there out today, which can even do waste to energy or incineration plant at very low calorific value. Some technology claims even at 1200 to 1500 kcal per KG which is again a debatable part because we have not seen many of those plants up and running but the claims have been made specially lots of Chinese companies which is trying to get in India in the waste-to-energy plants.

They do claim because they are having low calorific value waste and especially for the mass burn facility where we are bringing everything and putting it into the into the (())(11:08) and then it goes for burning but still people are little bit like worried about air pollution issues although the newer if you look at the newer air pollution data coming out from any of these facilities around the world, it looks we had a pollution control air pollution aspect is under control, as long as the plant is operating this air pollution control systems.

What happens is many times the plant just does not does not want to operate and I do not know who give them those kind of advice because these the equipment goes for these air-pollution control or even receive wage or effluent treatment plant. Those equipment they actually go bad move quickly if it is not being operated so they are supposed to be operated or most of the time, so they should be operated so that you can thigns can be managed, but since they are not operated properly then we have the air-pollution issues where the air-pollution becomes a problem extensive static gas control.

There has been some baggage associated with that as well there is many countries have used in the past has some issues with a pollution again going back to the context of New Zealand, they are totally against doing any sorts of waste incineration because they had some issues in 80s in terms of some improper waste incinerator being plant there. So in terms of negative still troubled by air-pollution some materials do not burn, so what you do with that so you have ash plus this non-combustible, they do require subsequent landfill disposal.

Then this there are siting problems you have to have a siting issues which is similar to for the landfill as well. So that is incineration is one part which can be used as an alternative to landfill. The other part recovery of reusable products compost or refuse-derived fuels, so it is when you try to recovery again it should be able you should be able to sell it, so if you trying to get some product of that or you are trying to get some material out of these waste stream, you should… Whenever you trying to do that you have to invest certain money in the manufacturing in to the plant in terms of separation, in terms of having manpower could not do all those kind of stuffs. So there is of course a labor cost associated with that.

At the same time when you buy some new of this material recycling facility staff, they are costly, so you have to as a company you have to make money to sustain them to make money to sustain you have to sell its products, whatever you are producing you need to sell it. So it gets very dependent on the market, so if we have a market nearby you are able you may be

are good shape but the market is not nearby things become little bit problematic and the short-term cost the cost is much higher than the landfill cost so that is why the…

When people look at their budget they look at immediate budget more quickly rather than having a more detailed long-term budget or long-term impact, that is why this concept of LCA is very important when you will try to look at things in a bigger prospective in a broader prospective but here it is a short term cause it is short term cause people look at the end they find that the short-term cost is much higher than the landfill cost and that kind of leads to going for the landfill rather than going for this recycling or RDF or (())(14:46) plants.

And any of these processes residue will remain a problem so for the residue we do need landfill so which needs to go there. So in terms of solid waste management this kind of so what is wata solid waste management? As I try to kind of from time to time you will see a slider too way we try to kind of summarize and try to put everybody on same page and then we kind of make progress based on that.

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So in terms of the solid waste management what we have talked so far, it is a comprehensive program where the waste has to be prevented, recycle, composted. So when we say composted, just one of the example treatment technology it can be composed it may be (()) (15:33) it could be waste-to-energy whatever. So it is a comprehensive program of waste prevention, recycling, composting and disposal.

So and then it includes so when you try to do that it includes the management of first of all you need to know how much waste is being produced, so because that is safely trying to

design something, what should be the design data, so the design data is how much waste is produced, how much the raw material I have to work with so that I can design my other stuff around it.

So waste generation and to do that we need to know the waste generation data and of course we need to know the population data as well. Most of the time the solid waste management facilities, they are not designed for a year or 2 years, they are typically designed for 25 – 30 year time period. So when you are looking at 25 – 30 year time period, you have to look at okay what is the current population and what would be the future population. So you have to look at the population forecast you have to look at the population forecast in terms of how the populist note that potatoes it is going to change and for the waste generation it also ideally we should look at the waste generation rate, how the waste generation rate will change.

Today in the urban settings it is around .6 to .7 kg per person per day, that is what CPHEQ manual CPHEQ manual suggest to have a figure of around .6 - .7 KG per person per day but that number may change in future or the way our lifestyle changing we are using more and more packaged material. So things that will lead to more and more waste being produced. So in the developed countries the number actually goes all the way up to sometimes around 1.5 to 2 KG per person per day but then Indian context we are still at around .7 KG per person per day .6 - .7 kg in average, so we need to…and that is from CPHEQ manual.

So that so we need to know that that how much is the waste generated and then so that we can design the storage system, we can design the collection system began designing the transfer and transport system and because everything will depend on what is the waste quantity and also the same time we need to look at the processing cost we need to look at the disposal cost.

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So in terms of the waste management this includes the management of all these different components generation, storage, collection, transport, processing as well as disposal so that kind of say good idea about the waste management system and another important aspect of the waste management is that, is not only the engineering part what we have talked about so far is mostly from the engineering perspective but there is a social dimensional to it as well.

It is a what is the public attitude, unlike water, waste water or air where the public you have to for everyday work you are not really getting a lot of influence from the public you just go out and do your work whatever is required but in terms of the solid waste the you are getting waste every day from the household, so how the household is behaving how they are collecting the waste and disposing there are waste, that becomes critical in your you have to kind of decide how to how to go about that. So that is that is really gets little bit of tricky on that part.

So in terms of the solid waste management it is you need you need to have the understanding of the public attitude what is towards the waste, towards recycling, towards landfill. So many times when we do things we have a public consultation. So it is you need to have some sort of public consultation in terms of if their feedback and that is very important. So the public attitude needs to be understood whether towards waste recycling and then administration of the entire system that is also very important, how the administration of the system is going to work.

Planning like learning of task and schedule the design and construct a program all sorts of and then so that in terms of planning we have design, construct, operate, expand and then even for landfill for other waste management facilities programs and then the legislation part, so it is not always the technical part which is important we have the public attitude, the administration, the planning legislation all these things has to be taken into consideration to have a good solid waste management.

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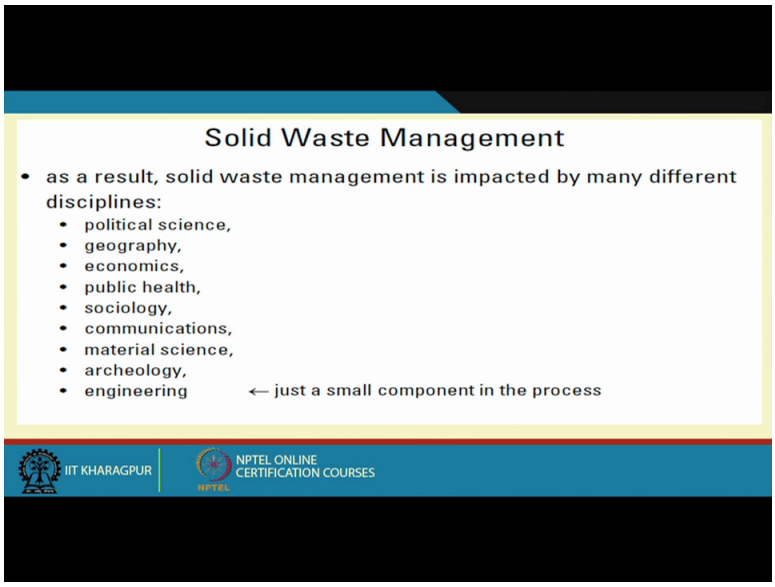

So that is why when I said earlier it is not only the engineering part, it is the management part which is very critical as well. So as a result the solid waste management is impacted by many different disciplines so you need to have some knowledge of political science which is it is it is important in terms of how the politics will play out whether you will get the site for the landfill whether you are not get the site for the landfill, so you need to have a little bit of understanding of that the geography of the area, economists whether you will be able to sell your recyclable, whether the project is going to be self-sufficient and public health issues, sociology issues sociology in terms of the behavior aspect because since you are getting the garbage every day from the household, how this household will behave and will give you the garbage that becomes very important.

So if they are if you are trying to do a source separation and if you do not get cooperation from the individual houses then you will you are in a deep trouble actually terms of doing for the subsequent steps because you need to get the waste separated. So there are lots of issues and when we go into the collection part will talk about that there as well, so that is that is very important and so that is the sociology part. Communication, how to talk how to make

sure they communicate of the issues to the public that is again very important, if you do not communicate issues in a in a decent way in a clear way you will have a problem what Nestle had for Maggie last year.

So you need to make sure that the communication is correct. Material science because we are trying to use different materials for liners, for daily cover and for (())(21:37) so there is a use of material science. Archaeology, archaeology where many people are actually interested in how the waste is changing over time there are some people some writers who through research the waste composition like what kind of waste that particular waste is producing, what kind of waste that particular region is producing.

That gives idea of what…what is the mindset of the people? So those kinds of things also grows in there and of course the engineering, so it is not only a it is that is basically a joke, it is not a small component process is a very important component of the process but the other aspects makes to be looked into as well which many time as an engineer we overlook we do not actually look at those processes very carefully. So if the design and the management process we have to takes the best practice is planning, public health, economics, engineering, conservation, aesthetics and environmental issues.

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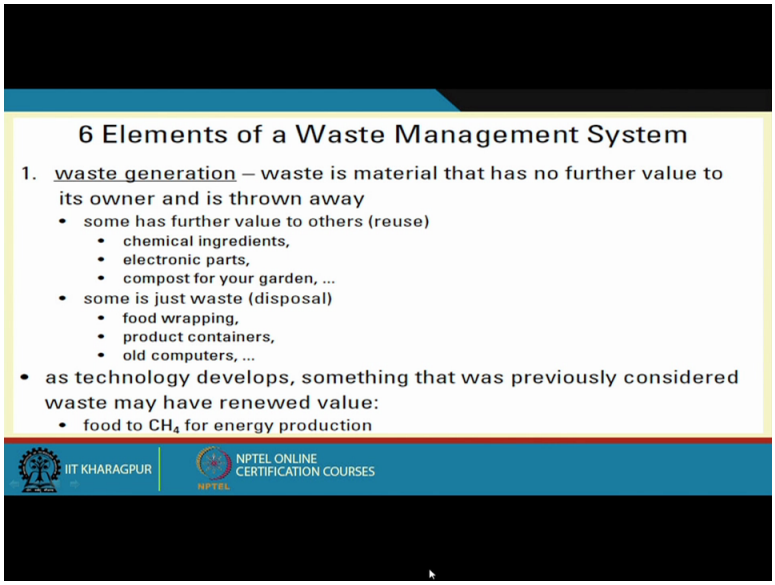

So that is how we have to do this design and management process, so when we do go for that there are with the in terms of Windstar looking at the waste management system there are what many of these books that you pick up you will say that they will they would what we call is 6 elements of the waste management system. So essentially there the whole system has

been divided into 6 parts so number 1 is waste generation, if the waste generation is not there we do not have to do any waste management, is it not?

If the people do not show any garbage there will be no garbage to work with, so but people will throw out because that is the way our society is working there are certain product or process or materials which we do not need to use so with that actually does get dump in a in a trash can. So waste is a material when you dump in the trash can, it has no further value to its owner but that doesn't mean the waste does not have any value left. Some has further value to others where in terms of the reuse, which is the chemical ingredient, electronic parts or composed for your garden you can do that.

Some is just the waste, so if we have food wrapping, product containers all old computers those are mostly the waste, but again here as this last bullet suggest as technology develops, something which is a waste today may not be a waste tomorrow, so for example food waste to methane and for energy generation for energy production. So that food waste like you can say 20 some years ago or 25 - 30 years ago, nobody was talking about getting energy out of food waste, although maybe we are producing less food waste as well but whatever food waste we are producing there is there is no discussion on how to convert this food waste to energy.

Today that is the hot topic, so it's as because the technology has developed which makes it to be profitable and to do it especially if you do it in large-scale, when you try to convert this food waste to energy using anaerobic digestive and then you use that energy for producing electricity or other stuffs.

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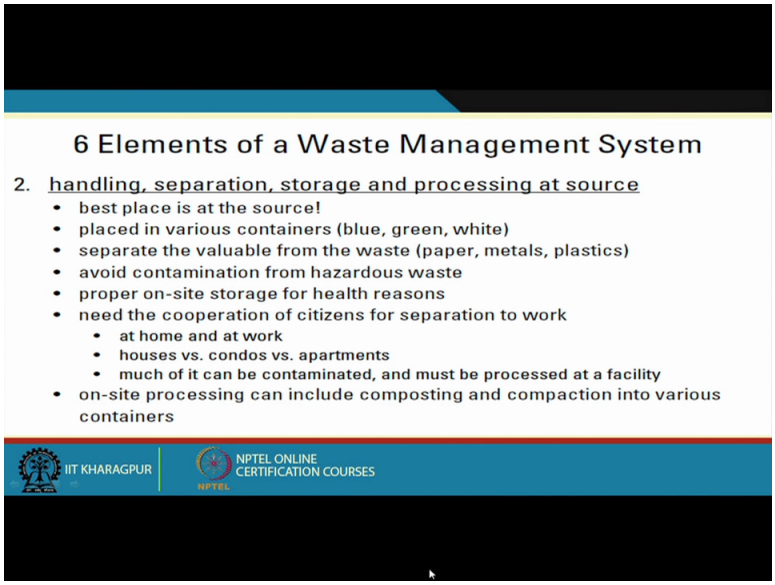

So that is the waste generation part and the 2nd part is the handling, separation, storage and processing at source. So if you can do the suppression at source so you can put it in various containers like blue, green and white. In Indian context we have 2 containers green and grey, so green is for the food waste for like our your indirect food waste so that is and blue is for recyclables and so we use like wet and dry very can suppress the garbage. In the Indian context right now the thing is we have to separate the garbage in terms of wet and dry.

So dry is mostly recyclable and other stuffs and wet is what can be mostly organic in nature. So if you can do the waste separation at source and you put it in blue, green and white that has been different countries uses different colors (())(25:37) and then you make sure that you separate the valuables from the waste. They have the paper, plastic, metals those things should be separate.

In India again in Indian context we have the kabadiwalas coming to our houses and collecting many of these. In big cities that is becoming little bit rare but it is still happening with a paper metals and plastic gets collected any way. And then you make sure that there is no contamination from hazardous waste.

Proper on-site storage for health reasons and you need to corporation from the citizen at home at work, houses versus condos, apartments and so that is like you need to because as you go from houses to on condos and apartment you are space is getting less. So rather what has been seen is that amount of mix waste keeps on increasing in those scenarios, so those

things like if much of it can get contaminated so that must be processed. On-site processing can be composting or compaction into various containers, so those things are done.

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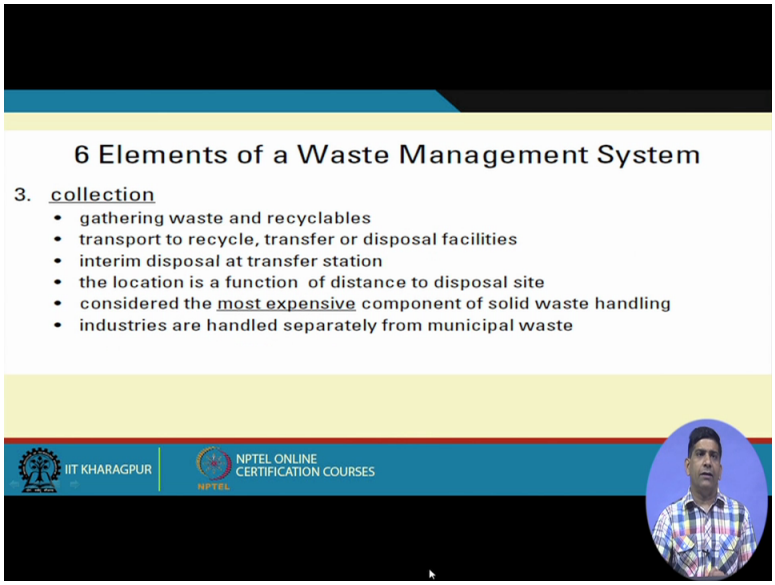

So next step is collection and the collection is actually the most expensive component of solid waste handling, so this is in terms of handling of the waste the collection part is very expensive. What does it mean collection? As the name suggests you gather the waste and recyclables and transport to recycling center for transfer station or to the disposal facilities, so that is where how this system works and locations is so it is like we have an interim disposal at the transfer station where there is smaller trucks bring the garbage at this transfer station which is then converted into a bigger truck, bigger trucks carries the garbage from the transposition to the landfill.

So that depends on the function of distance to the disposal site, if you have the disposal site distance is more having a transport station makes sense and the transposition of the garbage, collection in the transposition of the garbage is considered the most expensive part and industries they handled separately from the municipal waste so the industrial wastes is handed in a different manner.

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So in terms of other part is separation, processing and transformation so once the waste is collected you have to take it to a facility where it can be processed there are special facilities to separate recyclables, it includes spreading, compacting, screens, mechanical separator and all those machines are used in try to show you a small video of that when we go to this particular chapter.

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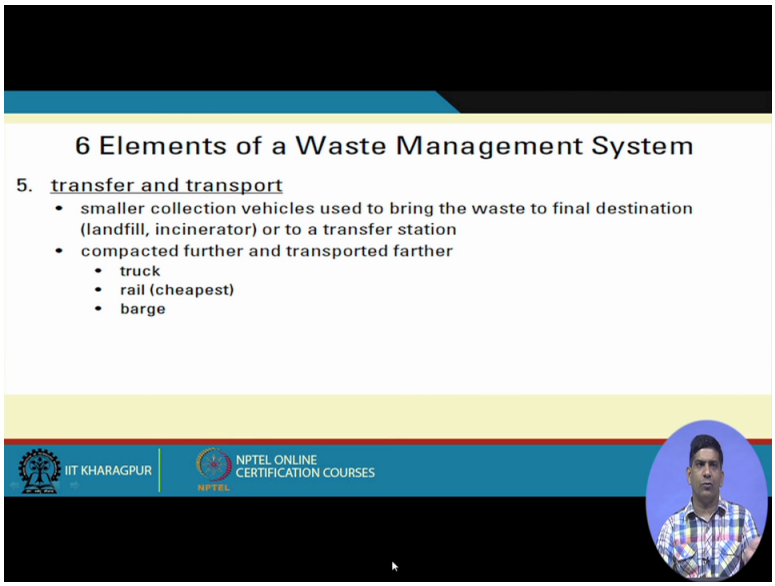

Incineration and composting, they considered they are considered transformation of the waste as well so that particular part and then you have to do transfer and transport, you can use track, rail, barge there is a smaller collection vehicle then transferred to a bigger collection vehicle, so this transfer and transport is very important and so that is the economies of this is

also very important which you look at later too and finally disposed, disposal like landfilling we already talked about.

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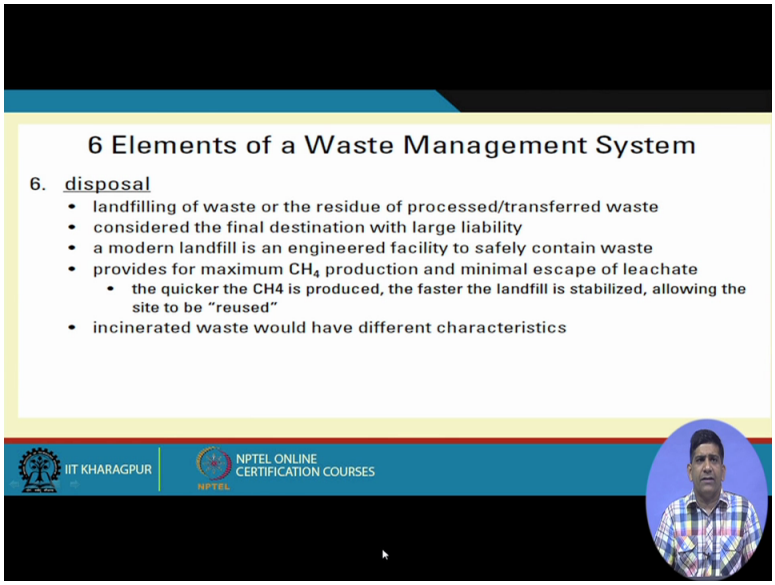

About a landfill is (())(28:40) facility you produce methane and then you can use that methane for energy or you can do the flaring of that so and then incinerated waste could have different could have different characteristics, so you need to make sure that it is not a hazardous waste and then you can dispose it. So that is how the 6th element of the waste management system works.

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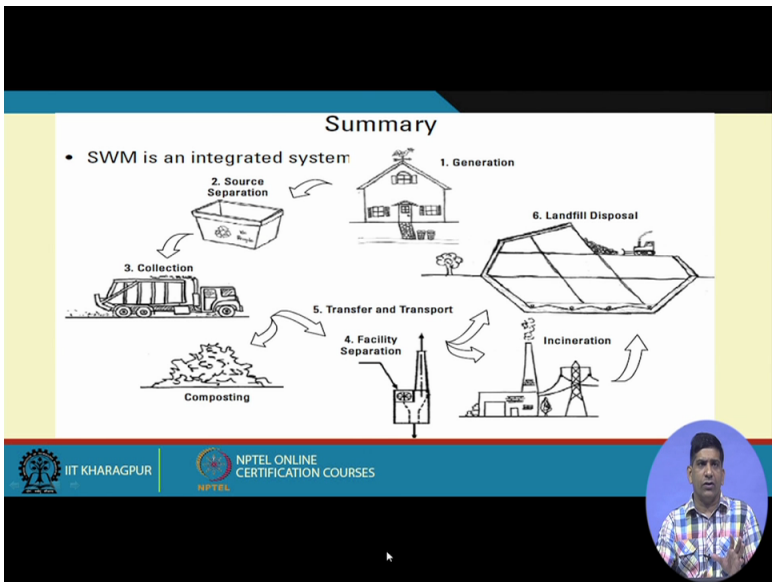

So in summary if you look at the solid waste management is an integrated system, so it is you start from generation that is your number 1, from generation you go to source separation where things are separated out and go to collection part where it gets into the truck and gets collected, then from the collection you can take it the facility separation where it could be separated further and transfer when transport, composting and then finally incineration or landfilling as you can see the this is how things will typically work. So that is can give you a big idea about the waste management system, what are the different components?

So as they goes progresses for this municipal solid waste over the next 8 weeks, we will be going into each of these components and try to have more details about that from an engineering perspective, what are things we need to do? And some of the design aspects associated with that as well, so for that let's stopped this module right now and then we will start our discussion continue our discussion in the next module. Again thank you and welcome.