Course on Integrated Waste Management for a Smart City
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Module 1
Lecture No 4
Introduction (Contd.)

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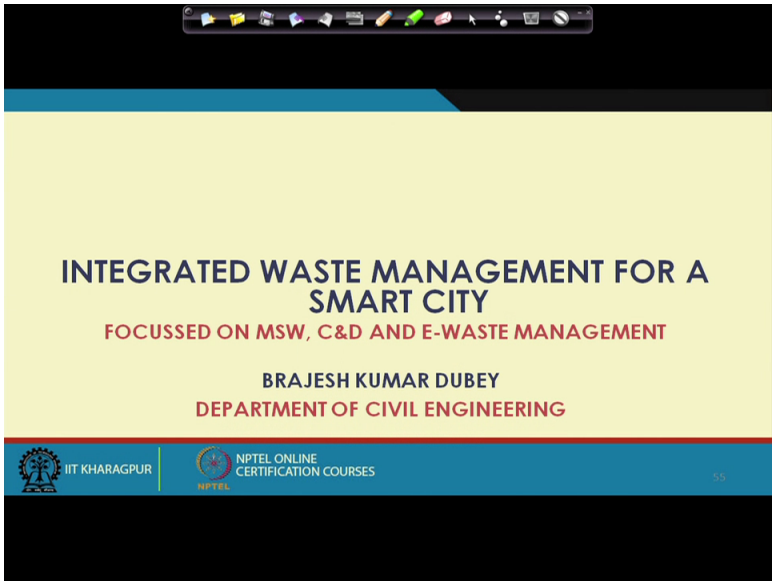

Okay so let's start from where we left in the previous module, we were looking at several pictures of how the waste is being mismanaged I would say rather than managed, where different impacts from the mismanagement of the waste. We will continue looking at that so as a continuation I showed you some pictures from US and lots of pictures from Delhi landfill and then now I am trying we will look at a specific kind of problem out say it is kind of an subset of solid waste municipal solid waste so which is the electronic waste.

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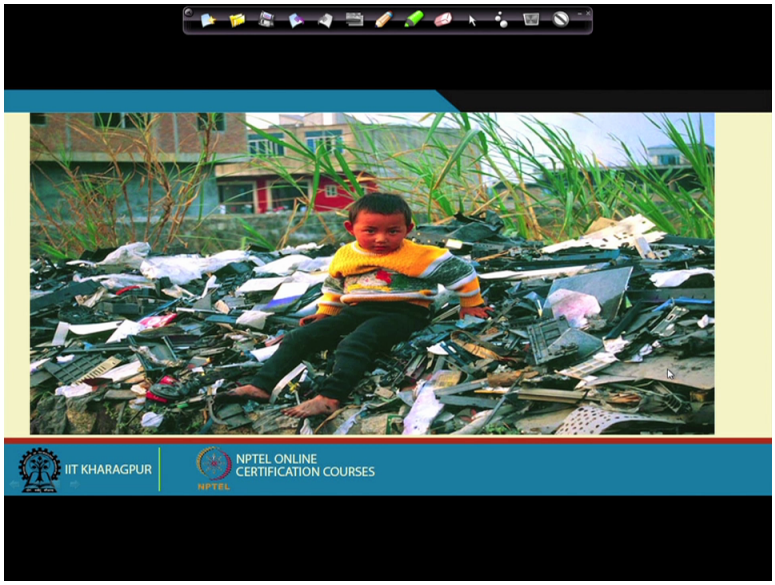

So if you look at this particular picture, this is a kind of if you are looking at the electronic waste management, this is one of the signature picture of electronic waste management, this came from the band website, Basel Action Network, so this particular network has created awareness on electronic waste, I would say they were the 1st organization to create awareness in terms of the electronic waste management.

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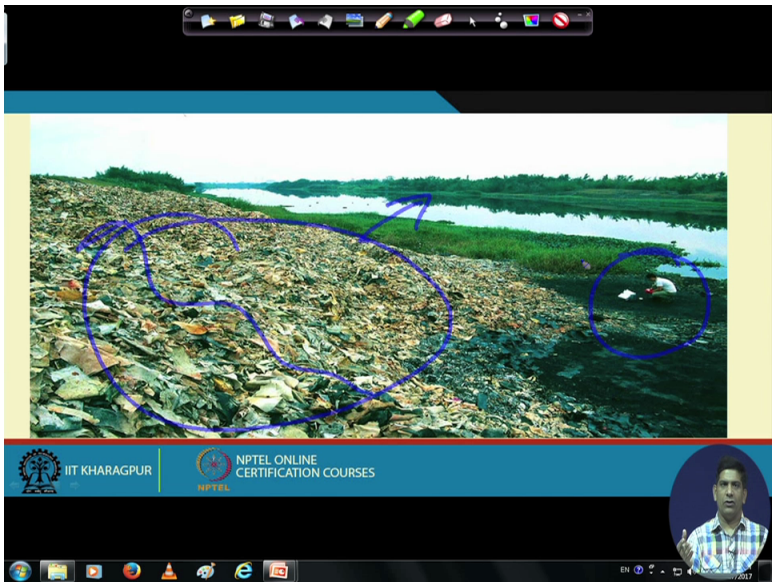

So this picture and the picture next to it as you can see, we can go back and forth to this, both of them actually what they are showing is, they are showing a village in China where the electronic waste coming from the Western world mostly and of course China as India are we are producing lots of electronic waste now but previously they as more and more prosperity

was in the Western countries, more and more electronic gadgets were using in Western countries, of course if you look at the initial e-waste stream, we see more of the waste coming out from the Western world and this Western world the they electronic waste was travelling all the way to China, India, Africa and other places for its disposal, it is happening even today.

So where we see that many of the electronic waste making way to the other countries, so this particular in this particular picture you see a small child sitting on a pile of electronic trash and the next picture shows you a water body nearby and you see like a waste being dumped on in this particular area, where you have this this whole area is being dumped in the waste and then there is water body very close to nearby and this water body is getting polluted from this electronic waste.

So when the PH was tested as you can see over here a gentleman is trying to test a PH and there he found out that the PH was almost 0, so you can think about and so no essentially your aquatic life and with this no aquatic life there that is leading to pollution and then the village has to truck in water from almost 30 km away for the daily usage. So that is mismanagement of waste so in this case electronic waste so as we were talking about in the previous module, why should we care about the waste management?

So these are some of the issues because which leads us to we need to worry about proper management of every type of waste including electronic waste as you can see in this particular example. So far we have looked at how the why we should we care about the waste management? And then we will now we will start focusing on, oaky so what we should do about it? So far if you remember from the 1st video to the 2nd video and the 3rd video, we have been looking at sum of the historical perspective of municipal solid waste management, some of the issues associated with municipal like mismanagement of waste mismanagement or the waste materials, so now we will be looking at what are the ways to manage it.

So if you remember from that hierarchy that we talked about where we talk that source reduction then recycling, reusing, composting, waste-to-energy, landfilling is so these are the ways how the waste is being managed today, so we will go for each of these components and try to cover them in little bit detail and again this is as this is in we are still in the 1st week.

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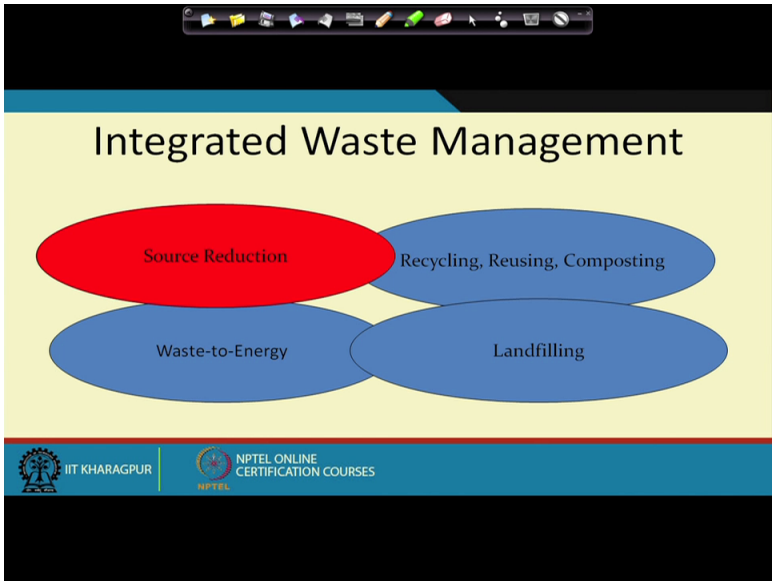

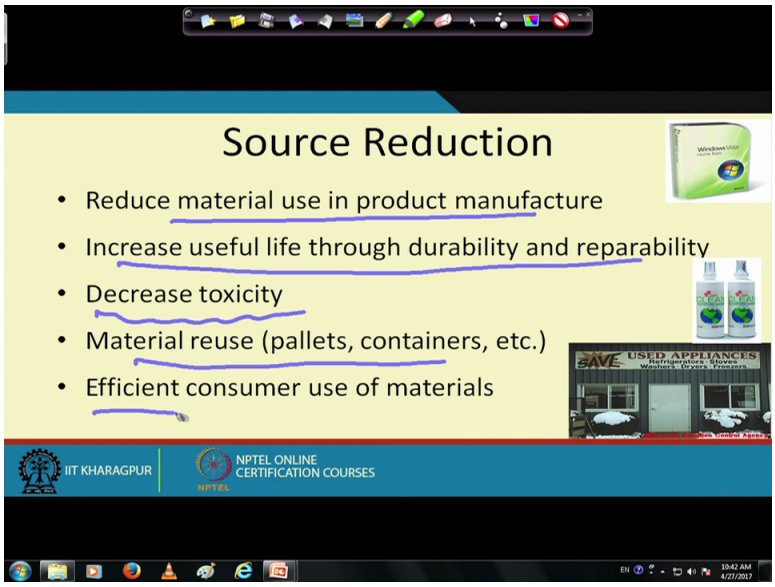

So we are looking at an overview as such many each of these components for example in recycling, composting, waste to energy, landfilling will go in more detail later on. So let start with source reduction part, so when you talk about social reduction, we are trying to say that reduce the material used in product manufacture, so what do you mean by source reduction?

We are trying to say that we will reduce the material used in in the product manufacture, so we want less material to be used in product Manufacturer and that is happening. You see that happening if you look at again I will tend to give you more and more examples from electronics world because all of us you some sort of electronic you are watching this video on an electronic device, so you do have an electronic device at least one you may have several.

So these days you look at any typical middle-class family they in fact pretty much every member will have their own iPad or laptops or something and then you have a smartphone, there will be a TV, multiple TVs in the home, so if you look at all these electronic which we can relate to much easier, as you can see that the materials usage in this electronics are actually going down.

The electronic products are becoming lighter and lighter and they are becoming thinner, so that leads to less material use, we are using less materials and so that is that is one part, there if you are using less material that is what does it mean, you are reducing when it goes to the disposal stream, again we are reducing the waste that will be produced. The total amount of waste produced will also be less.

The other aspect is if we can increase the useful life through durability and reparability, so you can increase their how to make their life better, so it is like not go through this typical in the Western world they call it a Walmart culture and Walmart as you may know, it is a big supermarket where things are very cheap but most of the time nor all the times, most of the time they do not last very longer as oppose to what it used to with other products similar product for other retailers, so because people have this habit of these days of always having something new, so if you buy something very expensive, you cannot buy more often, so that there is a demand for cheaper products which you can use and throw, so to so we but that is against durability and reparability so but now we are kind of going back and saying that lets increase the useful life of a product through durability and reparability. How it will help?

If it is more if it is durable if it last for longer period of time, so we will have less amount of waste being produced, same thing if it can be repaired easily then you can get it repaired rather than buying a new product, so that is that is again the unfortunately these days many times it very difficult to get something repaired and you are forced to buy new things rather than giving the old thing repaired because there is no repair shops and all especially in big cities and many bigger like a high economic country like rich countries around the world.

So and the other aspect in terms of source reduction is decreasing the toxicity, so what does that mean when we are trying we can decrease the toxicity, decreasing toxicity means that you are trying to although you may be using certain material but the material toxicity is less. When we say material toxicity is less means you are using a more environmental friendly material, again looking at this electronics we used to use lot of lead in electronics.

Lead were used in CRTs, lead was use in like a major component of lead in electronic was from coming out from printed wire board, so this printed wire board they the solder that they used the soldering that that you do for all those different chips the soldering had lead in it because that is it was used the lead based solder was used for a long period of time. We all know that lead is a problematic because it does affect our (())(8:24) development, brain development of small kids that is why we have moved to unleaded petrol, we don't use leaded petrol anymore we went to unleaded, unleaded means sometimes we do have lead that is why there is now unleaded.

So it is so that is so we want to get rid of lead we want to get rid of lead of each and every product as much as possible, so if you can go away from lead and use another product that also uses the decreases the toxicity, although the amount of the waste may be the same but the toxicity has gone down. Then material reuse, if you can reuse the material rather than throwing it away pallets, containers those are (())(8:58) used an efficient consumer use of material, like you can once you have the material you use it again and again, if you have some used appliances you can sell it in certain stores or so those kind of things does help you kind of reduce the amount of waste that is being produced at the 1st point.

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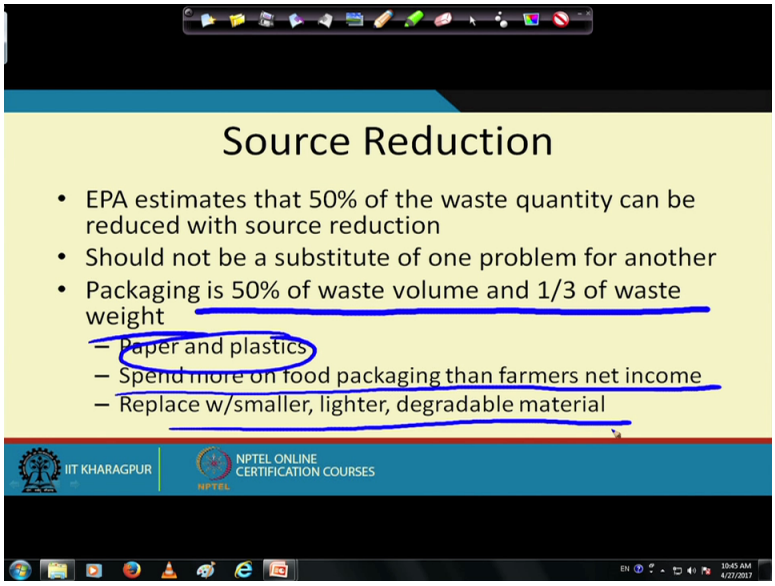

So that is one way of doing it and then the next is you go for a after the source reduction next thing we worry about is you go to like an in terms of the source reduction there was a study done by EPA just to continue on the particular topic the a study done by EPA which estimated that 50% of the waste quantity can be reduced with source reduction, so if we can do the source reduction nearly 50% of the waste quantity be reduced. Think about that in terms of

the nowadays with more and more online shopping we buy small cell phone it comes in a like a package then in a small box on top of it a bigger box and then you get it in your home and you have several packaging material now.

So 50% of the waste quantity and we reduced with source reduction, it should not be substitute from a problem for another problem, so you do not kind of just move from more the one problem from one to one aspect to another aspect, then we will talk about that in a little bit more detail later on and one thing has been found that packaging… So 50% of the waste volume and nearly one third of waste weight is actually the packaging so that is the another problem we have, so lots and lots of packaging is being used and they are mostly paper and plastics. We have we farmers are spending more on food packaging than the farmers net income.

So we are actually spending more on food packaging than the farmer's net income. So and what is what is the solution for that, the solution could be to replace with a smaller lighter and degradable material, we can come up with a smaller material, lighter and that is already happening. There are smaller lighter material are being used and degradable materials are being used in terms of trying to come up with it kind of packaging.

So bottom line in terms of source reduction is that there are ways we can reduce the amount of waste that is being produced by doing some sort of like a some sort of investment in in terms of better packaging less packaging more so that will (())(11:33) use of less toxicity of material and those things will help in terms of reducing the amount of waste is being produced, so that is in terms of the source reduction part.

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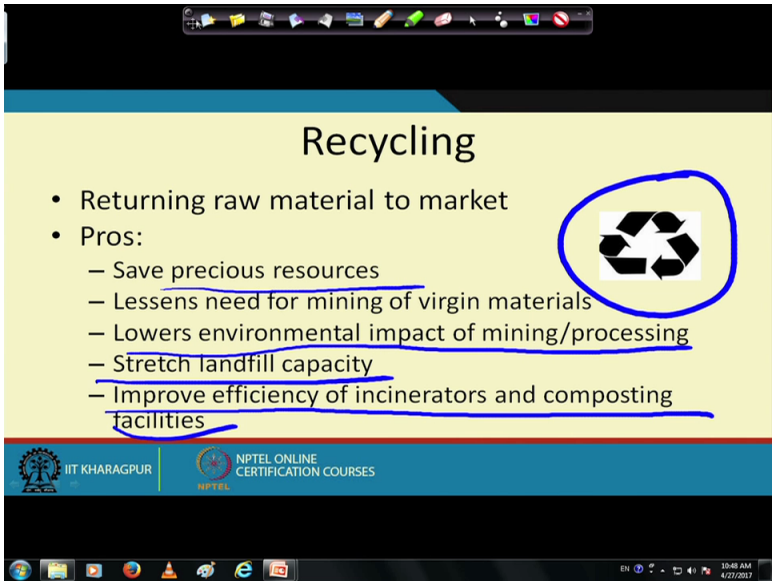

Then we will talk about the recycling part so what is the meaning of recycling? Recycling means that you trying to returning the raw materials to the market, so whatever is the raw material you will you will see many times you see this particular sign in many of these many of the things that you buy will find the sign, the sign tells you that the particle a product, it can be recycle so you see this in a garbage can as well which tells you that you can put recyclables in there. So would the goal of recycling is getting the raw material and putting it back to the market.

So what is the benefit and so benefit is you are saving the resource so you are saving precious resource so you do not have to go to the mining and then mine the things again, so your savings precious resource, that that leads to less in need for mining of virgin material, so you would have to go and mind for virgin materials. One of the most common items that is recycle is the aluminium cans, aluminium cans are recycled a lot and those aluminium cans when they are recycled if think about the aluminium is can, the recycle aluminium say if you have a solid amount of aluminium that are trying to produce recycle aluminium cans versus raw aluminium like going into the minds creating bauxite and trading your aluminium sheets, that you are using at like one 3rd of the energy.

When you are going for recycling, so that is that lowers that that helps in lowering the environmental impact of mining as well as processing. So your environmental impact is less and if you are recycling that means the material will not go to the landfill, so what does that does? It increases the landfill's life so it stretches the landfill capacity and the whole and many times many of those recyclables like metal and other stuffs they do not burn anyway.

So if they go to the waste-to-energy plant that becomes a problem, so in like it also improves the efficiency of incinerators and composting facilities. So recycling does help so which we kind of no that recycling help and then they creates more (())(13:50) they do help in…but so what about the what are the in terms of drawback of recycling.

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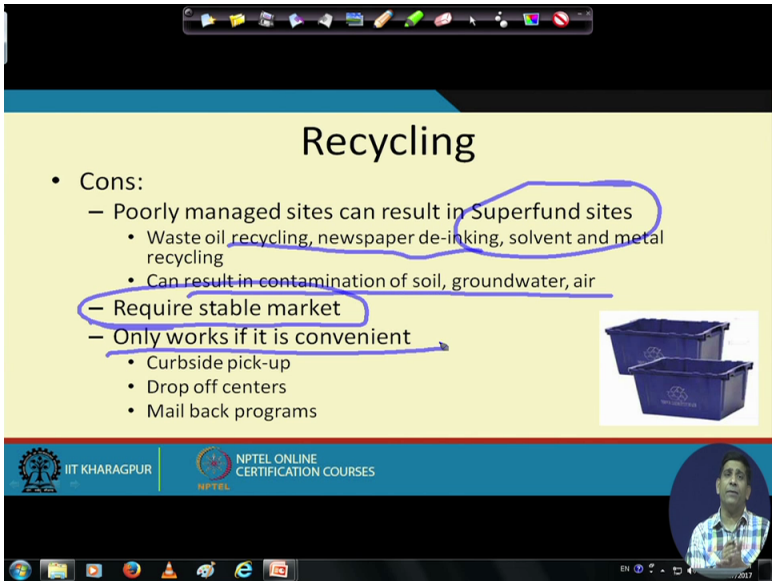

So if you look at the drawback of recycling we call them cons pros and cons, Cons is if you do not manage the site properly, if you trying to do some recycling activities which involves certain heavy metals and the organic solvents and if you do not manage it properly it can result to what is known as superfunds sites.

Now what is this Superfund sites, Superfund is you have it is your we say Superfund to the sites which are contaminated sites it is a name came from the US history where after love canal incident which was one of the I think at the very beginning of this video I mentioned to you about the love canal incident, I would encourage you to go and watch that video on YouTube on love canal, there are several videos out there at least watch couple of them to get a full picture of what we are talking about.

So but Superfund site means contaminated sites, so they are the contaminated sites in US history there were lots of sites which were contaminated in late 60s earlier 70s but there were no there was no company which was taking ownership of those contaminated site, there was no company which government can go to and get this contaminated site clean. So the government came up with a pool of money and that pool of money was called super funds.

So it is a super it is fund it is basically pool of money that was used to clean up the contaminated sites and since that was used, so the those sites started to be called Superfund sites and then it becomes a normal terminology. May people around the world use this term Superfund site but it essentially means a contaminated site, so poor manage site can lead to a

contaminated site especially in the waste oil, recycling, newspaper, de-inking, solvent and metal recycling so those things creates those kinds of problems and if you do that if you do not manage it properly can result in contamination of soil, groundwater and air which is quite obvious and that is one part.

Other thing is that recyclable need stable market and that is fighting I may have mention about that earlier but many a times the recyclables you not able to sell it. We had the instance after 2008 – 2009 global meltdown where the market was down throughout the world countries like New Zealand they were Auckland for example Auckland city, there had a very good job in terms of collecting recyclables but they were not able to sell it because the market for recyclable was China.

China depends on demand from North America or Europe and North America and Europe being in recession could not have the demand for all those fancy toys and other stuffs, so if the demand is not there the manufacturing will be less, so manufacturing is less in China that means the need for raw materials is less, the need for raw materials is less means you cannot buy you cannot sell the raw materials which is the recyclable material from the from the waste stream collected in cities like Auckland or Sydney or whatever. So that is it is a global connection so it is a global village as we call it these days.

So does require stable market that is actually the number 1 issue in terms of recycling, we need to have stable market with that and then you have to make it convenient, it works only when it is convenient, so you have to make it convenient for the people to do recycling it is not easy for to get people do recycling, it is actually much difficult job to get people to get into the habit of recycling and the properly recycling not only habit of doing the recycling but keeping the source separated the garbage, so that the recycling process is more efficient and that includes having a curbside pick-up where you pick-up from the houses you have a drop off centers you can give a mail back program and all those things can be done for that.

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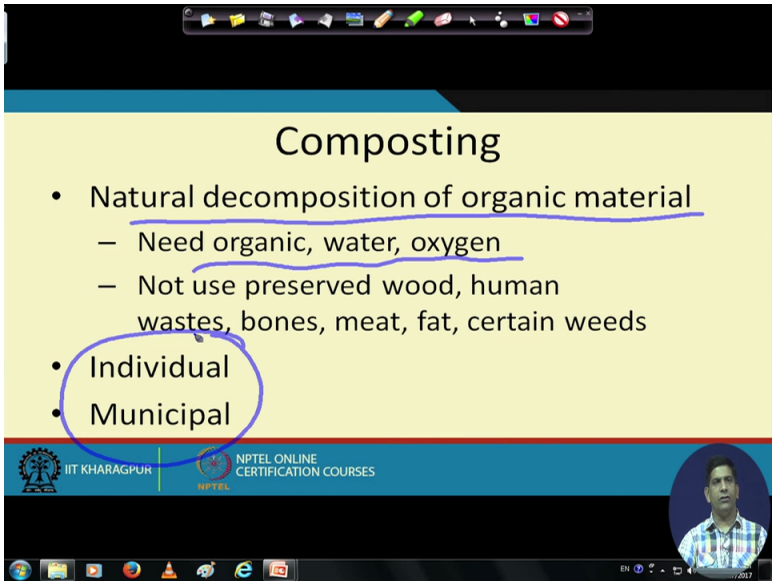

So that is in terms of in terms of the recycling part than the other part we will talk about is on composting, so what when we say composting, usually when we say composting we are talking about anaerobic, for the anaerobic which we will talk about in biological treatment chapter later on, for the anaerobic we are essentially anaerobic digestion it is AD plant anaerobic digestive plant.

So for the composting, composting means it is a natural decomposition of organic material and that is it is natural decomposition is happening in other places too, it is not that only it is happening in in it is it is happening in a controlled environment. If you go if you go to any of the natural system you will see some decomposition is happening so just after you leave a I would say little bit of organic material on just on your back yard and just watch it, without doing anything to it.

Just if you keep a watch on it you will see that gradually it will degrade so that is the that is the gradual you are like a natural decomposition process under anaerobic conditions and that is again it is composting to but why we cannot just we can if says if we take the food waste or other organic waste and just leave it in the natural environment, it is not going to degrade very faster it takes a longer period of time and during that period it will be a nuisance.

It will create soil pollution it may create pollution and all those kind of issues will come up, so to avoid that we need to have a proper composting plant to take care of all these organic waste and treated a little bit faster, you accelerate the process so that is that is done in a compost plant and when you are trying to accelerate the process you have to you have to

supply air, you have to do certain controls that we will talk about when we design we do design of a composting plant.

So bottom line is that for it to happen it needs some organic it needs some water it needs oxygen and do you and there are certain things which you should not use anything with a heavy metals (())(20:12) that has some heavy metals, human waste we try to avoid that because of this order issues and other things too, we have to have a proper carbon nitrogen ratio as well. So in terms of the composting you can you can do it either at the individual level or it could be a municipal level composting too, the individual composting is also very popular in in our country and many people do that individual composting at their home too.

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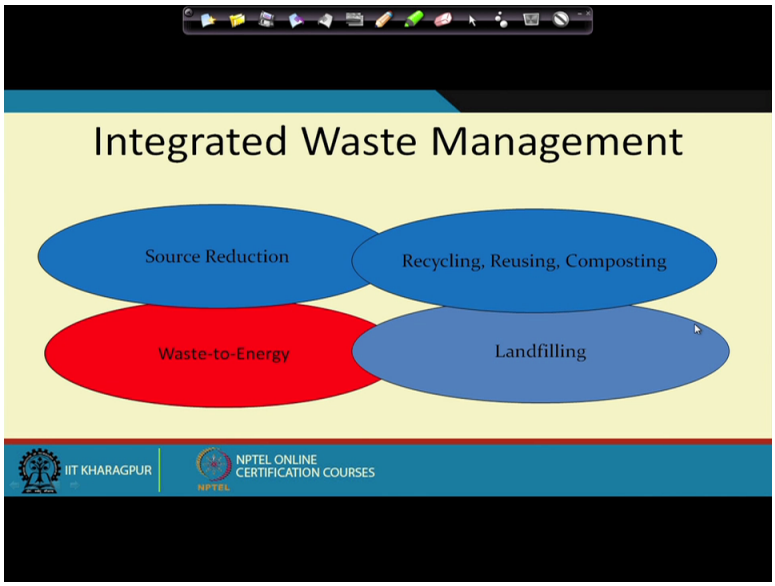

So after composting the next thing will go in terms of in terms of the 4 like a in terms of the integrated waste management part is looking at the waste-to-energy, so trying to produce energy and waste, so and how we can go about that so we will talk about that. So waste-to-energy is being used quite a would not waste-to-energy as a technical like it is an engineered waste-to-energy plant is a newer concept, but using waste for energy for an informal way then open burning, that has been used for I would say ages where people have been burning and trying to get some heat out of that.

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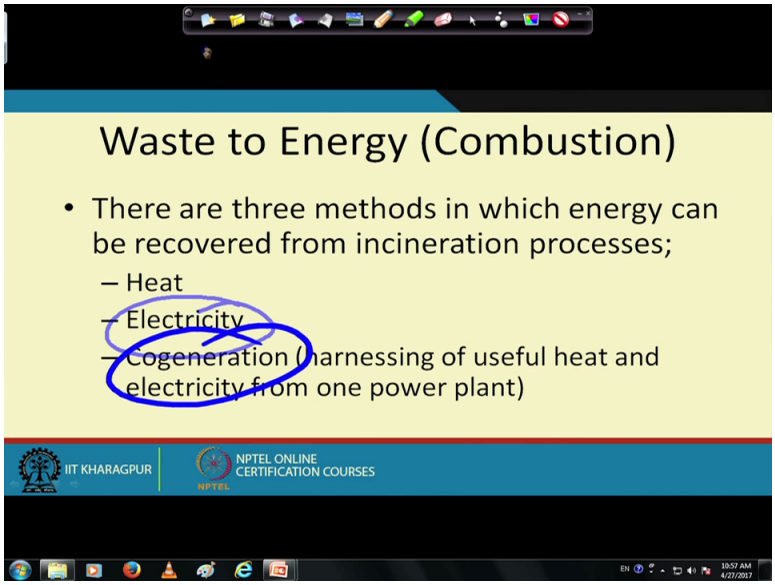

So in terms of the waste-to-energy plant there are 3 methods in which energy can be recovered from the incineration process, one is when the energy is you can you can produce as heat and that heat is essentially coming from the heat value, the heating value that we have the calorific value that you have.

So that is one of the basic requirement of understanding of waste management from a waste-to-energy point of view that we should have good understanding of what is the calorific value, how this calorific value changes how to what you can do to improve the calorific value of a waste stream. So that once the calorific value is high that means it will produce more heat, so we can use that heat and some places they use that heat for district heating system where to heat the nearby houses you can heat you can use that heat for drying certain things so is based on the usage it can be it can be done.

The other thing is that you use it for electricity, so you have this heat being produced you use this you use this heat for you have this heat being produced and then you take this heat use it for this steam and the steam will have turbine running and then you get electricity. Very similar to the coal-based thermal power plant, only thing is that rather than using coal you are using a waste material. Then cogen, cogen is also done which tells you cogen kind of tells you that it is a it is harnessing of useful heat and electricity from one from the one place, so it is both is done as well.

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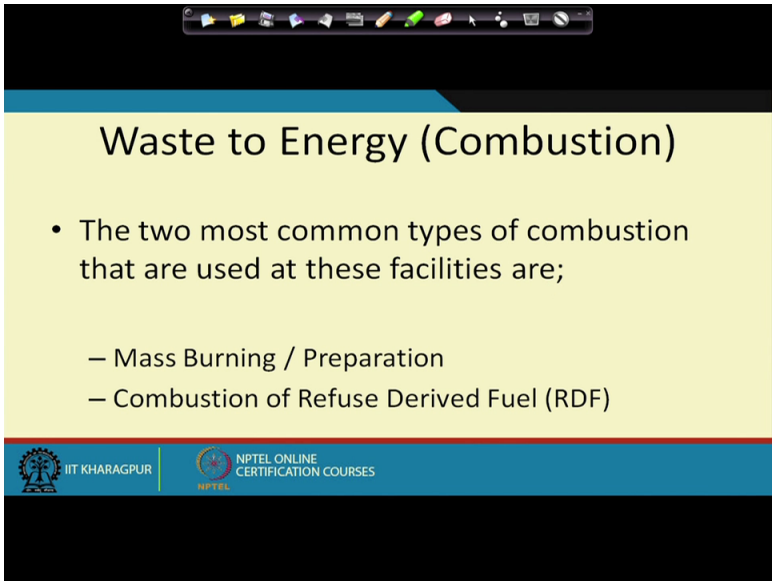

So that is in terms of will continue this into waste-to-energy part the other so in terms of the most common type of combustion that are used at these facilities are mass burning or combustion of refuse derived fuel. So mass burning is means you take the garbage let it come, you take out any unwanted material from that a small aerosol can, a small gas cylinder or something whichever make way to the waste stream, anything you feel like will be damaging to the waste incinerator so you take them out. So that is the and that is the mass burn and then you just burn it directly and I show you a picture that and (())(23:39) of that or you produce RDF.

RDF the refuse derived fuel is where you try to do this your refuse derived fuel is that when you try to make this RDF pallet so you have your waste material, you tried a little bit air dry it you crush it you make it a small uniform size then you can make small pallet from that like small pallets and that can be used it is for waste-to-energy plants.

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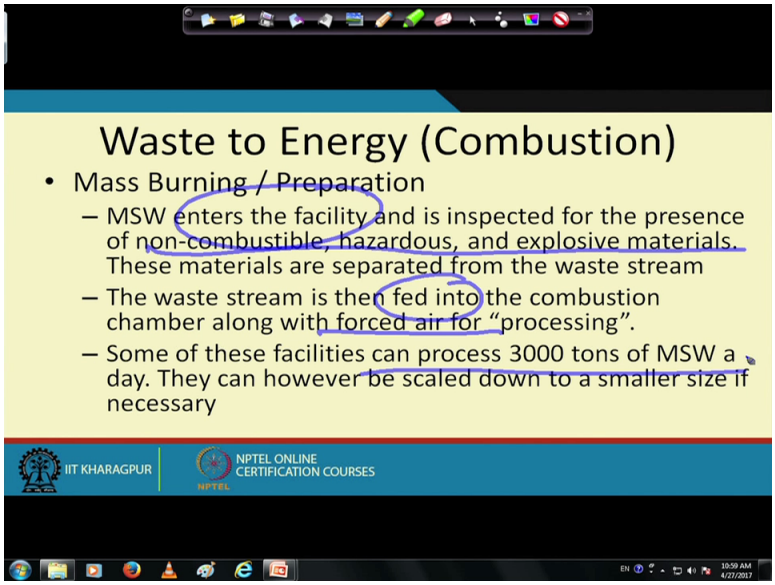

So in terms to the waste-to-energy for the mass burn how the things happens the MSW enters the facility and that once it enters the facility it is inspected for the presence of any non-combustible hazardous material, so we have to make sure there is no non-combustible hazardous or explosive material present.

So we take them out then the waste stream is fed that is fed into a combustion chamber and then you have to supply some air for processing and then that air will help in terms of because combustion is an oxidation process so you see it is you need some air and then the reaction gets done and the plants could be different sizes or the facility could be all the way up to can process up to 3000 tons of MSW a day but many facilities are smaller as well 1000 to 1500 tons per day and that type of facilities are also available and which have been working around the world. So in terms of waste-to-energy so mass burn one part and the other part that you can look at is what we were talking about that you can do waste-to-energy like a refuse derived fuel.

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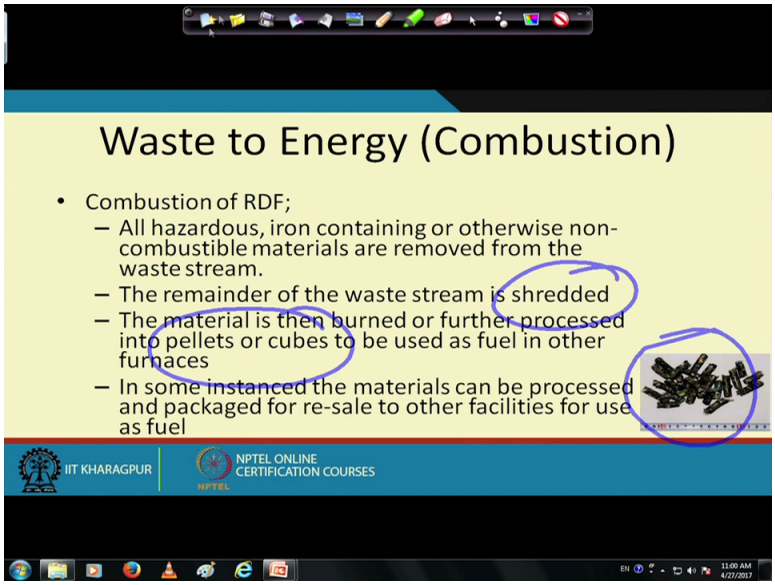

So here you can see on this particular slide that this refuse derived fuel is what you see on this corner over here, those are the small pallets that is being prepared, so how we do that we 1st of all we take all hazardous iron containing or otherwise non-combustible material is removed from the waste stream then the remainder of the waste stream is shredded and after shredding you do the shredding of remainder waste stream and so after shredding you try to…

The material is then burned further processed into pallets so you make a small pallets or cubes that can be used as fuel in other furnaces. In some instances the materials can be processed and packaged for the resale to other facilities for use as fuel. So you do not you may not make the pallet you just process it make it smaller size more uniform size and give it to another factory and they will burn it.

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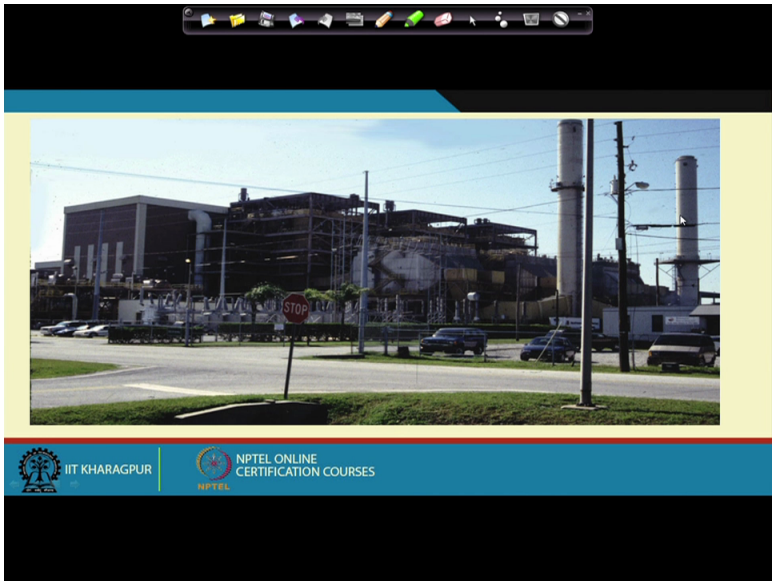

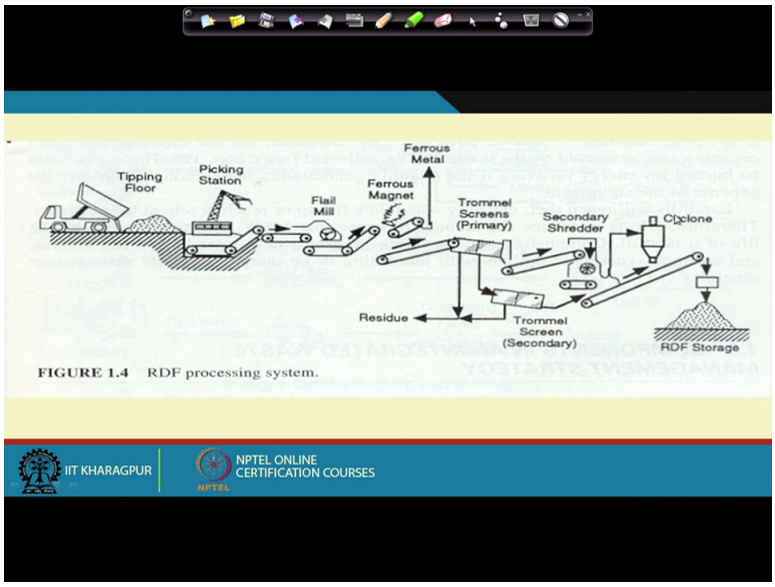

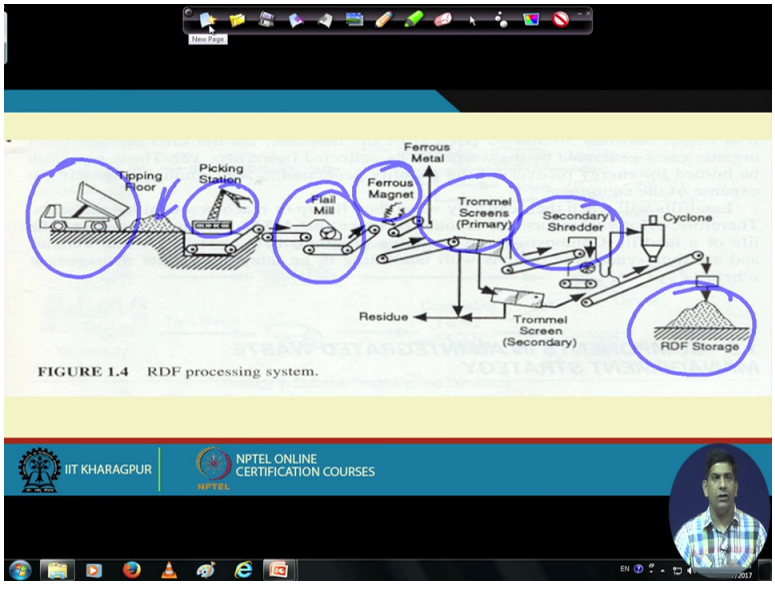

So that is how the waste-to-energy system works in terms of refuse derived fuel and so if you look at the typical waste-to-energy plant, this is how they look like it is very much similar to a like any power plant that we that we have. So this is a typical layout of a RDF processing facility where you have if you can look at it carefully I can walk it through, so here the truck is coming in and it is dropping the garbage in here, so that is where the garbage is coming and then you have a filling station, there is a conveyor in here which is picking the waste and then putting it through its this flail mill, so what does a flail mill will do?

It will size reduce that, then you are passing through this ferrous magnet it will remove the iron part, so ferrous metal is removed, then you take it to a Trommel screen primary where you kind of size reduce it where you take the lower size material and after that also if you need to size reduce further the rest what could not pass through the Trommel screen goes to a secondary shredder, shred it further, then you have a like waste coming off and then finally you have a RDF storage of a waste of certain size. So that can be used as a refused derived fuel. This is how a typical RDF is it is kind of it is it is prepared.

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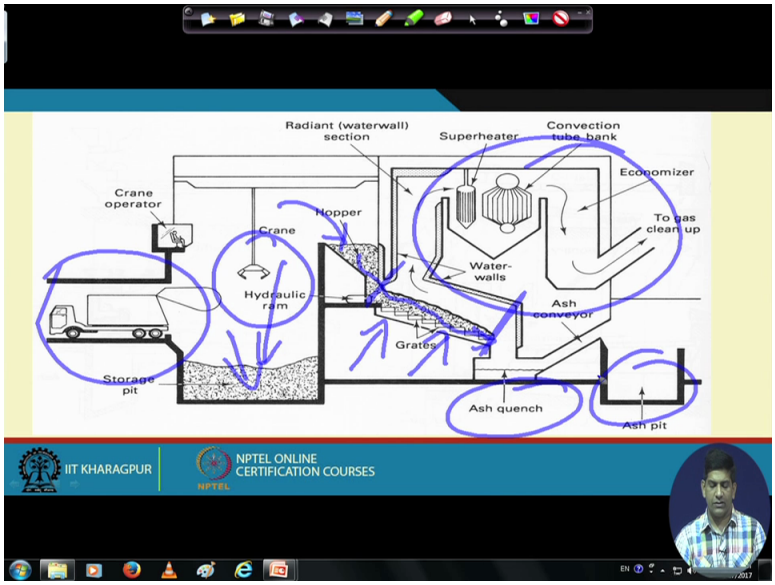

For mass burn its lay out is a bit different, so where you have this truck coming in and where this truck is dropping off this is your truck coming in dropping of the garbage in this big pit, then you have the hydraulic ram which will actually come down and pick this garbage and then feed it to this hopper right here and then the waste will travel down on this on this grates while the oxygen is been supplied from this side so we have oxygen is being supplied from the bottom and then the oxygen helps in the combustion process, so in terms of the time that is taken for the waste to travel from this place to this place should be more than what is a typical reaction time for this kind of ways to get totally combusted and then you have the big air-pollution control system you have the ash quench and all that and then whatever is the ash is produced it take into the ash pit.

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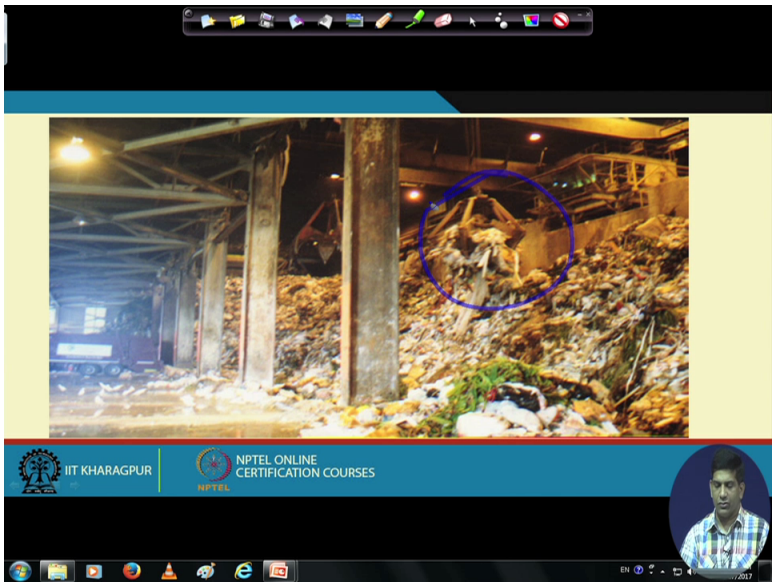

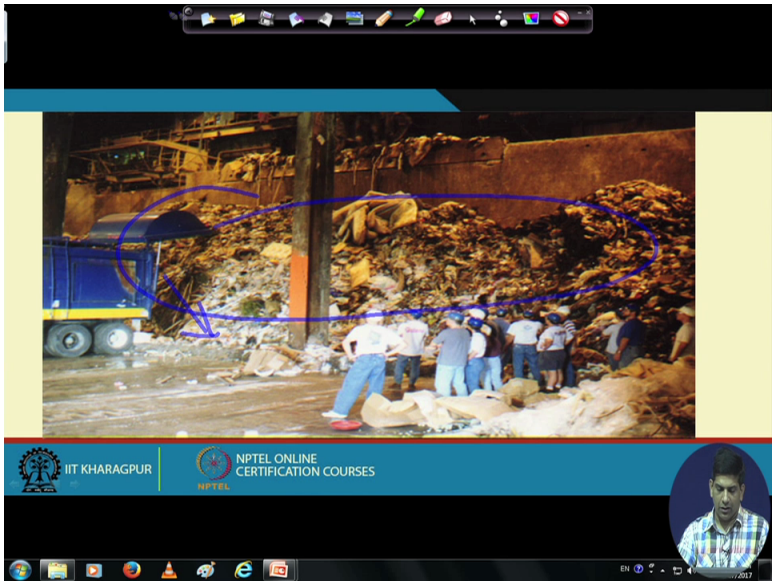

So this is how a typical waste-to-energy system is working, so that is in terms of the waste-to-energy part and then next okay so we will talk about so this is I will show you some pictures so this is again a typical mass burn waste-to-energy you see this is the tipping floor where the waste is being dumped from this garbage truck to the tipping floor that is where the garbage is being dumped and garbage is all piled up on this particular site and then in the next like a in the next instance you see that it is being picked up sorry it is being picked up by this conveyer belt and this the conveyer belt takes it to the waste it drops it into the into those great chamber which will see and it gets dropped in to the great chamber.

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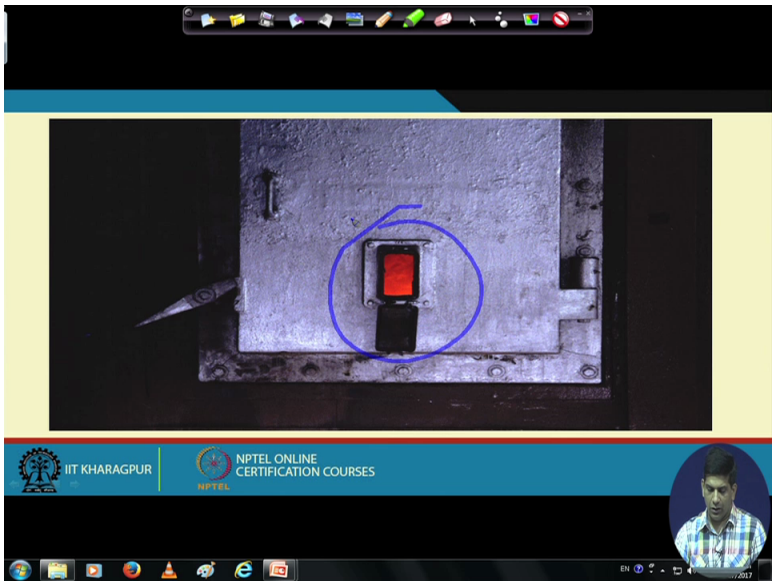

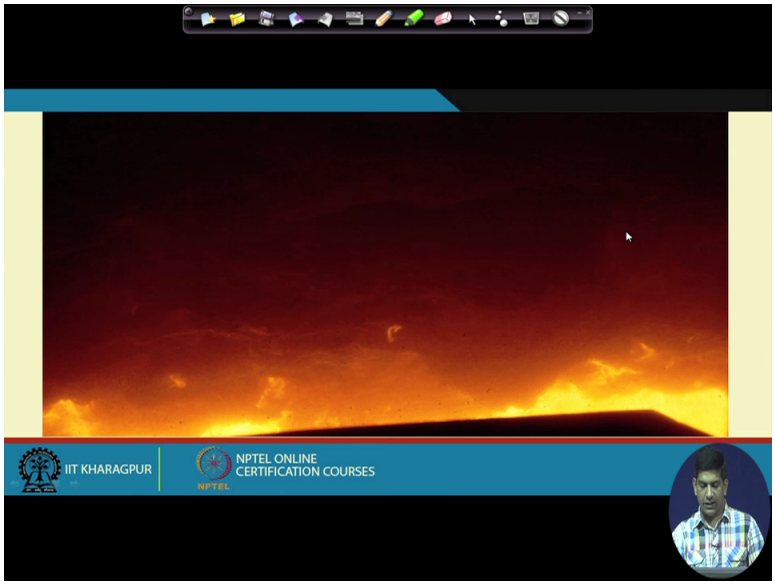
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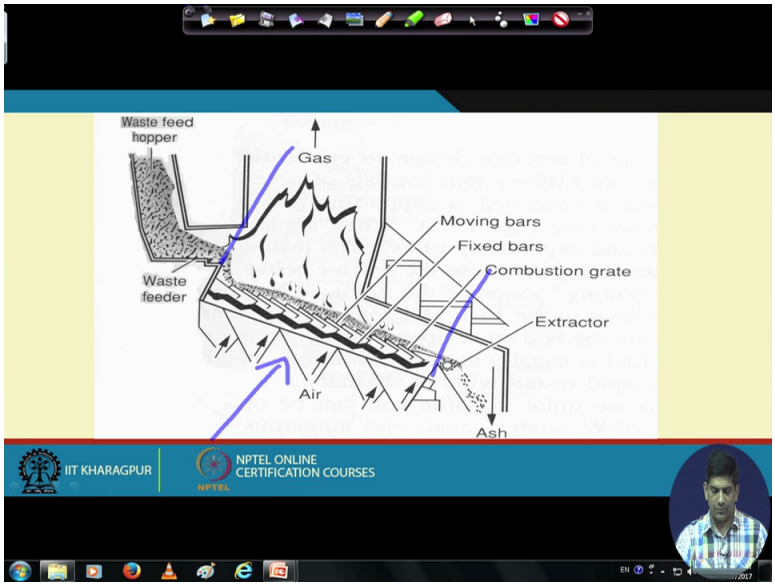
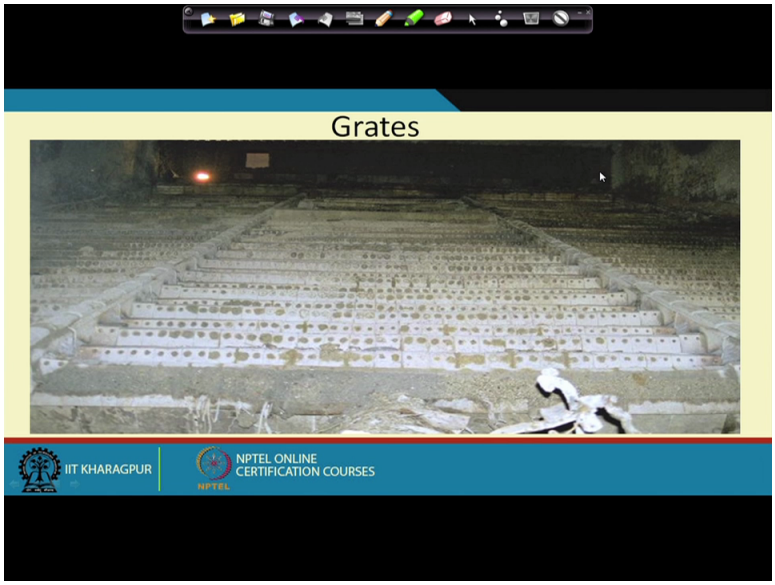

Waste feed hopper
Gas
Moving bars
Fixed bars
Combustion grate
Waste feeder
Extractor
Air
Ash
IIT KHARAGPUR
NPTEL ONLINE CERTIFICATION COURSES


Grates
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Since we cannot see the great working great chamber so you what you can see the color of the things being burned so you see this we can watch it from this particular hole and if you look at this picture more carefully you what you find is this is how things gets burned and where things are getting burned for energy and these are the great system where I was talking to you that the air is being added so that is why you see that air is being added from this side and the waste is travelling from this to this and the amount of time it takes to travel should be actually more than the amount of the reaction time so that helps us into kind of preparing for so this is how the grates look like when it is not in a working condition.

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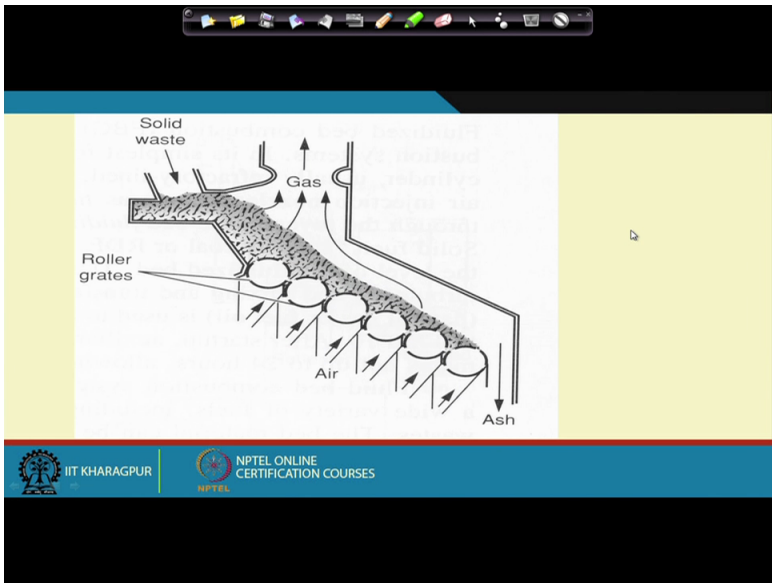

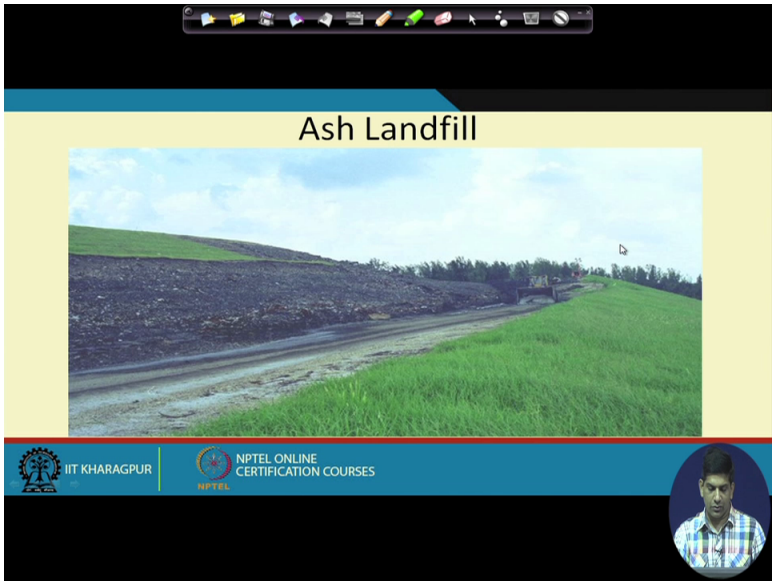

This is other types of grates it could be rather than having a step grater you can have a roller grater and the function is the same where you have waste being produce. So another picture of waste-to-energy plant with a close look and then at the end of the day you have put this ash away in a landfill so this is your ash landfill which has to go.

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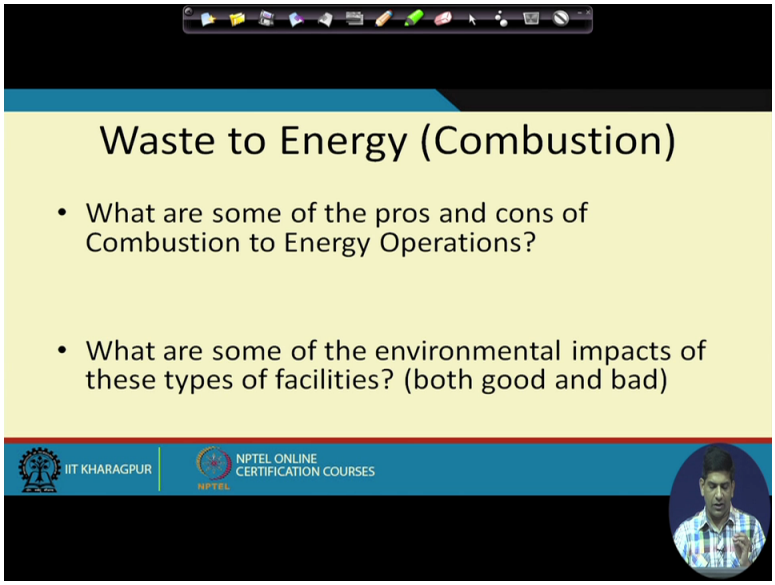

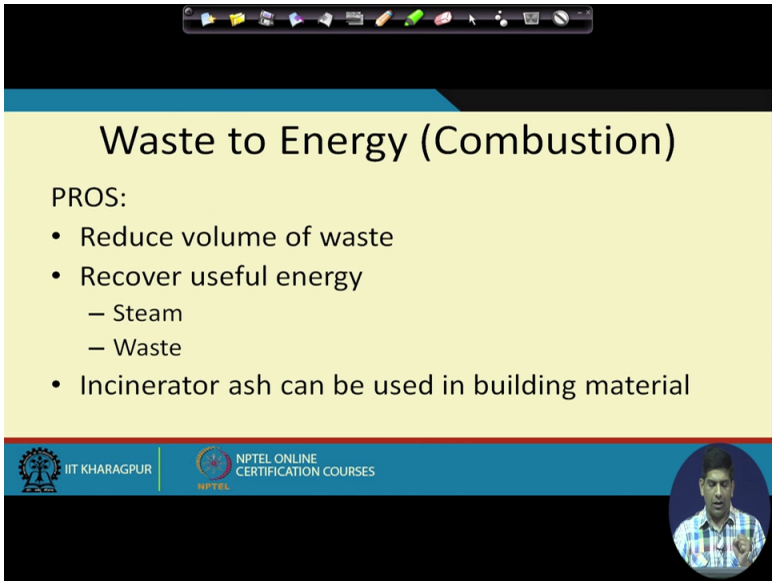

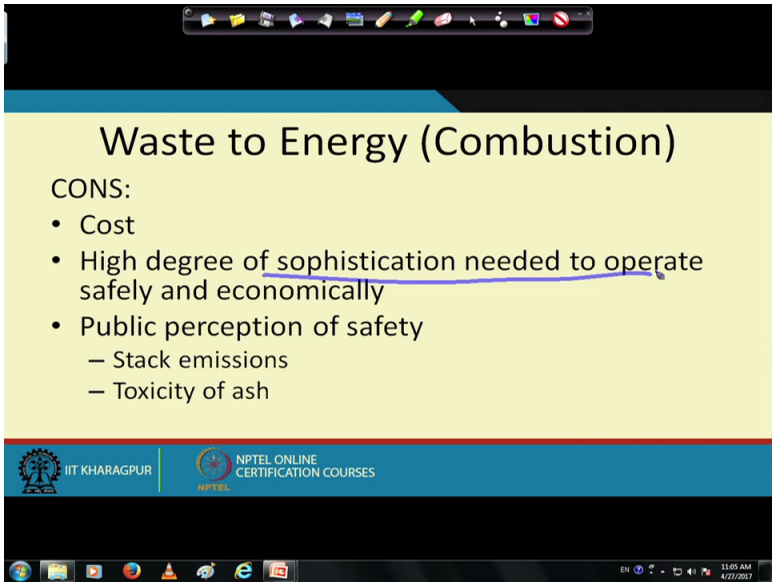

So in terms of waste-to-energy compassion there are some pros and cons, so we will just look at that and then we will close this video, so in terms of the pros and cons of the combustion of energy operation and some of the environmental impacts, pros is that it reduces the volume of waste, the waste that is produces is much less the useful energy, you can get some steam can get some waste, the ash can be used as a building material the in terms of the drawbacks is it is costly.

It is a highly costly exercise and high degree of sophistication needed to operate safely so there is a need for a high degree of sophistication to operate safely and economically and then there is a public perception of safety people is worried about stack emission as well as the toxicity of the ash, so that is in terms of the waste-to-energy part we have, so that is and if you have this is just to kind of have a fun thing at the end.

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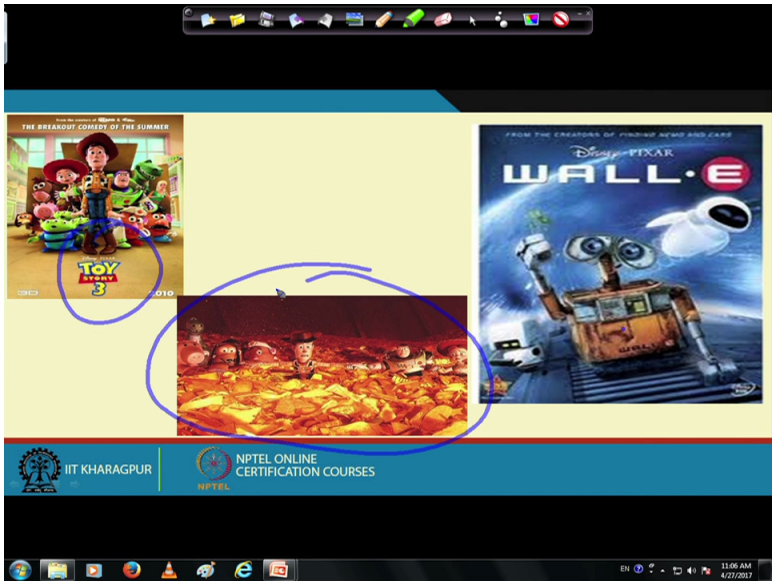

If you have watched certain I do not know whether you have watched this small kids movie, if you have watched toy story 3 the last seen here is where it is actually was incinerator and the next topic that we will talk about in the next module if you have watched Wall-E, Wall-E is nothing but a garbage compactor, so with that let us stop in this particular video and there we will continue in our next module where we talk about other aspects of how the waste is being managed. Thank you.