Electronic Waste Management - Issues and Challenges
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Lecture 03
E - Waste Overview (Contd.)

Welcome back. So, let us start our discussion for where we left in the previous module, we looked at the Indian a specific scenario and some comparison with the global scenario in terms of E-Waste management. Now will start it in terms of that why questions. So, why E-Waste management is important, what are the concern? So, we will start looking at what are the elements of concern, what are the chemicals of concerned in terms of electronic waste management.

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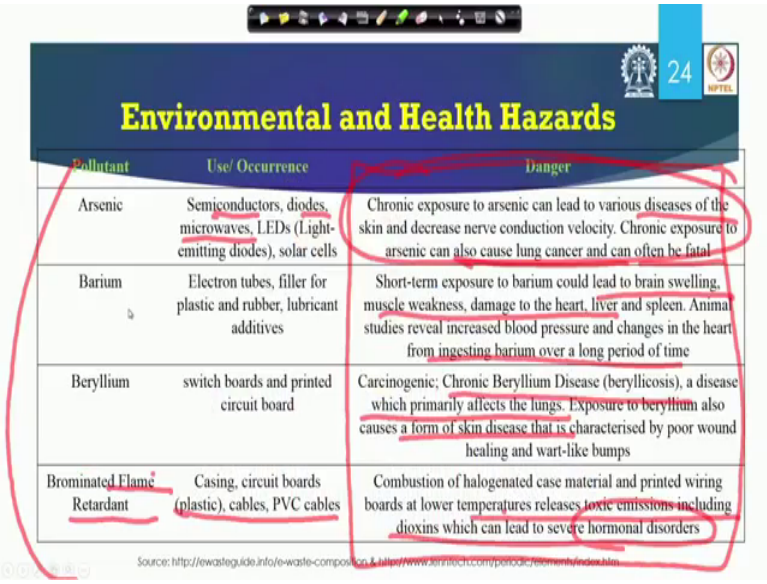

So, if you look at we put there are several elements from the periodic table, and again these I am not going to cover in like line the line from each of these elements, I will provide you this slides so that you can read it, and on especially on the danger part. So, we will just cover the first two columns in more detail and then just very cells quickly will talk about this third column in this, but for the from this table we have we have actually the list is pretty long.

So, it is started with and the list has been provided in alphabetical way. So, it does not mean that arsenic is the number one element that shows up in electronic waste, actually

lead is where we see most electronic waste the higher amount is lead, but in terms of since we listed it we put them in alphabetical order. So, a electronics that we carry fair phone ipad or anything I will a laptop and other stuff carries many of these heavy metals or metalloids.

Arsenic is used in semiconductors we use them in semiconductor, diodes, microwaves, LEDs and solar cell. The solar cell also uses arsenic and we all know is we are sit like I am talking to you sitting in West Bengal and West Bengal and Bangladesh we do have several areas of arsenic pollution issues, there is even in Bihar we have arsenic pollution Madhya Pradesh, Rajasthan. So, there are pockets of many places in the country where we have arsenic issues. But most of those arsenic are geo genic not we are not talking about arsenic from electronic waste has went there, but arsenic is a potential carcinogen. It is a chronic exposure to arsenic can lead to various diseases and also at least can cause lung cancer and can often be fatal.

So, for this part this, this column I would let you read it is all a general description, I am just all highlight few points over there. Then barium; barium it is a used in electron tubes filler for plastics rubbers lubricants, additives, beryllium which used in switch boards and printed circuit boards, we have brominated flame retardants. Brominated flame retardancy when you are using your laptop especially if a carrying the laptop and you on your lap, laptop is called because you work you can put that the small computer on your lap and work from there. So, this. So, when you are working like that you see that many after maybe a half an hour forty minutes depending on the model and make of the laptop, you start feeling the lot of warm it is a very warm there, because it started getting hot.

So, when it starts getting hot, there are it if this if there is a trigger of any kind of short circuit or anything happening it may catch fire. To prevent that we use this brominated flame retardants. So, preventing of flame retardant as you can see when is it retarding the flame. So, you are not let in the flame to propagate. So, that is why it is a brominated flame retardant, it is a halogenated compound bromine is a halogenated compound, and used in casing circuit boards, cables, PVC cables. So, and then here it is leads to if you at let us say lower temperature releases toxic emissions, dioxins which can lead to a severe hormonal problem. So, here for beryllium we know the chronic beryllium disease, the disease which primarily affects the lungs, it also causes skin disease and for barium it can leads to brain swelling, muscle weakness, damage to heart liver is spleen. So, they have

seen the blood pressure changes, changes in the heart from ingesting barium. So, all these have certain a concern that is why we are worried about electronic waste management, electronic with proper management of E-Waste, because we have all these pollutants there and not only on this, we have in sorry we have these pollutants there and then that leads to several danger that the health impact is there from there from these pollutants.

So, just again continuing the list if you can go to the next. So, we have cadmium, chrome which is chromium, cobalt, copper, lead again these are in alphabetical order.

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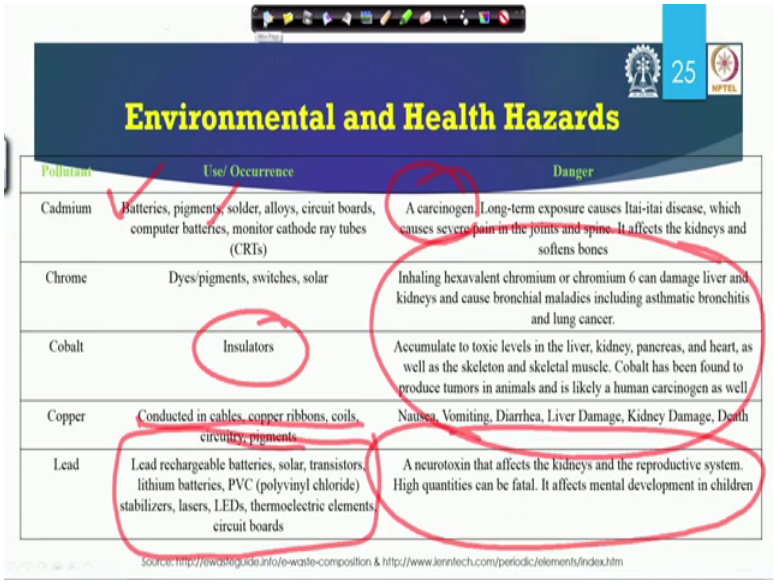

Cadmium nickel cadmium batteries, you always hear about cadmium nickel cadmium batteries which is batteries it is used in batteries, used in pigments, solder the soldering which is done on the printed wire board, circuit boards, computer batteries, cathode ray tubes cadmium is used a lot. Cadmium is a carcinogen as you can carcinogen means is something which can cause cancer. Long exposure also cause itai disease itai disease means the our body actually gets confused between cadmium and calcium. Though all of us has a looked at periodic table at some point in our life. So, if you remember from the periodic table that cadmium and calcium they are together a very close to each other in the periodic table. So, our body gets confused between cadmium and calcium, and it thinks that it is calcium, we all need calcium that is why when you are young your mother was kept on telling you to eat milk sorry drink milk, because milk has calcium

there. We need calcium for the growth of our bone, growth of the teeth, and later on in our life may when we get older many times we use calcium supplement as well to keep our bones is in a good condition.

So, but if the body get confused between calcium and cadmium, and cadmium gets into our body; whenever we need calcium the cadmium goes there, but the cadmium does not do the function of calcium. So, it is becomes our bone becomes brittle and it starts creating problem. So, in that case what is what happens is it is leads to a lot of problem in terms of like a bone damage and other stuff. So, that is why cadmium it is a very much of a concern in terms of electronic waste cadmium coming from the E-Waste. Then chromium is used in dyes pigment switches and also in solar panels, cobalt is used as insulators. So, cobalt is used as a insulator, copper wires. So, their copper, ribbons circuits, pigments led which is number one. Number one concern in terms of electronic waste is because of led. Led is a neurotoxin, it affects kidney reproductive system; it also damages the brain development.

So, it is that is why we if you go to a petrol pump today, you when you fill up your car or a bike you see on the label there it says unleaded gasoline why it says unleaded gasoline; that means, at some point of time we had lead in that gasoline, is not it in that is why it says unleaded. Why we got rid of lead from the gasoline. So, all this smoke pipes the exhaust pipes of this car or the bike it has a lower level, and when our kids are walking on the road they are also at that level too, and then when this is smoke coming out, and if it gets ingest it goes into the lungs of goes into the body of these small kids, it affects their brain development. So, it is a neurotoxin, that is leads is creates problem that even the whole roman there is a theory that the Roman Empire that collapsed because of the consumption of alcohol in a leaded vessel. So, with the leaded vessel alcohol low p h, led got released into the alcohol and people drank those alcohol and they become their brains got damaged they because started acting crazy, they start fighting them on each other and the roman empire collapsed.

So, that is one theory may be true may not be true, but lead does lead to neuro; lead exposure does lead to impact on brain development it is a well established fact with lots of research done on different subjects, and there are some even data like an epidemiological data which supports that. So, lead is a big issue that is why this whole

issue of electronic waste is started, then you have others it is there you can read about these for the other impact.

So, essentially what all these pollutant does, it has some sort of negative impact on our body. So, that is why we are worried about them.

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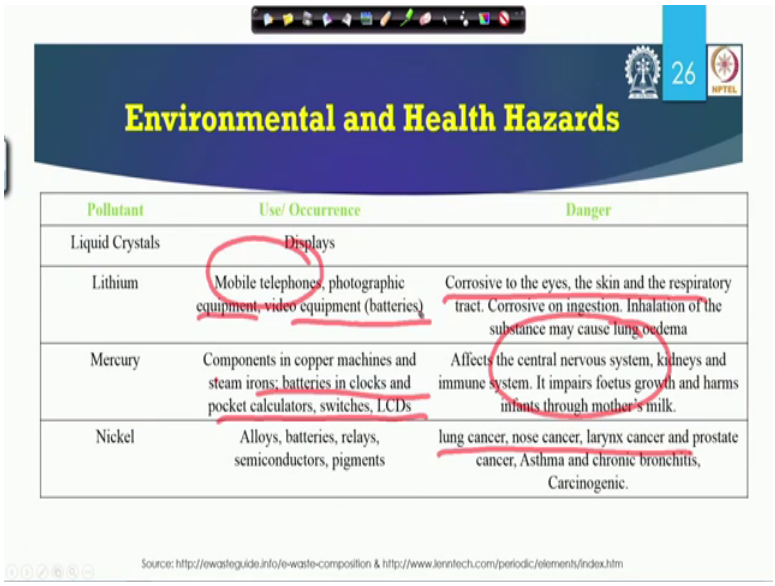

Then we have lithium liquid crystals are there, lithium is there, mercury another big pollutant mercury, which is present nickel is present. So, components in the mercury is there in copper machines, the steam irons, they are also there in batteries, they are there in the batteries in clocks pocket calculator switches LCDs, they affect the central nervous system, kidneys and the immune system, nickel, lung cancer, nose cancer. So, and lithium is a corrosive to the eye.

So, all these have certain negative impact and lithium is lot of in mobile telephone, we see lithium there photographic equipment, video equipment batteries, lithium is there. So, that is lithium batteries. So, you always hear about that. So, all of these had certain negative environmental impact in our human health impact that is why we are worried about that.

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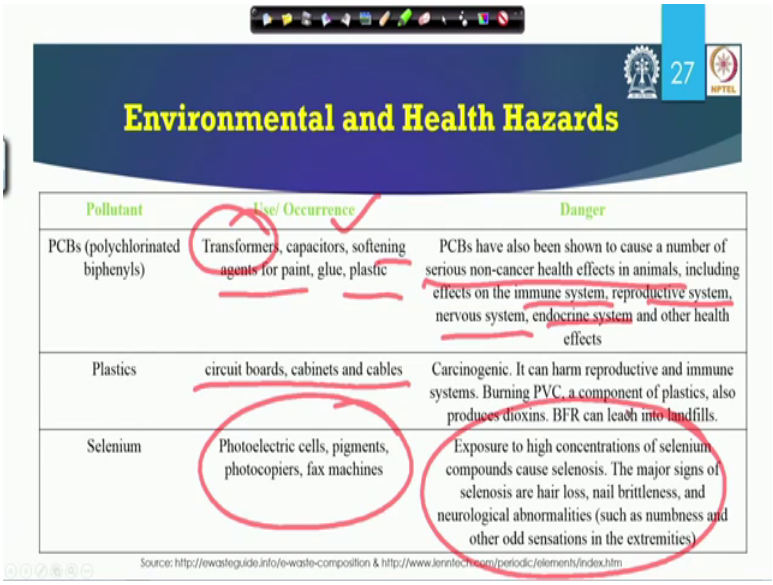

Then PCBs, plastics, selenium. So, PCBs is your polychlorinated biphenyl, PCB was very popular again used as a it to prevent any sorts of fire and other stuff in transformers, capacitors, it is a softening agent for paints glue and plastic. It is a serious it says has serious non cancer health effects, including effects on immune system reproductive system, nervous system, endocrine systems. So, these are all documented PCBs are plastics circuit boards cab cabinet selenium uses in fact, photocopies fax machines. So, on and then they have their negative health impact right there.

So, these are and the list actually there are some more which will look at.

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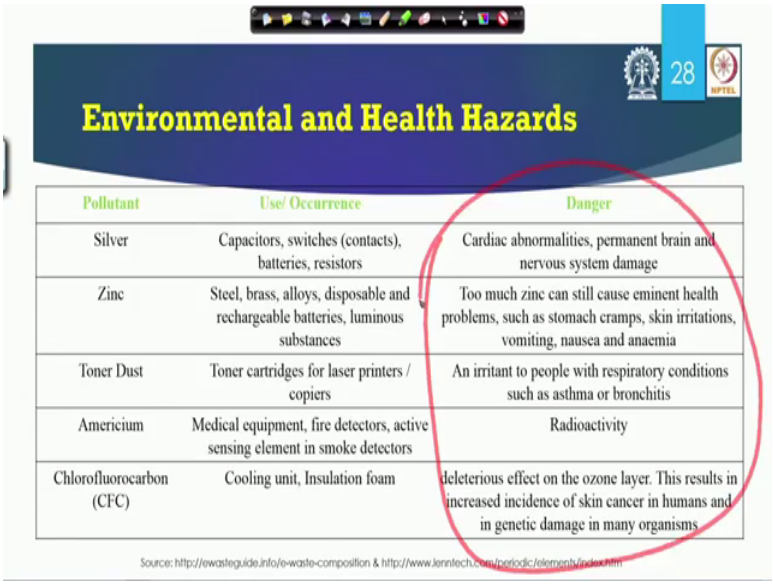

Then we have silver, zinc, toner dust, americium, a chlorofluorocarbon. So, they again they are used in capacitors which is brass alloys, toner cartridge, medical equipment, fire detectors, chlorofluorocarbon uses a cooling unit, insulation form and they have certain health in like a health impact from these which is listed over here. So, it is listed over here as you can see. So, there is a cardiac like a from silver, zinc, toner, dust, americium chlorofluorocarbon similar to what you saw from the other.

So, what we are trying to get out of this long list of pollutants, they are all there on the periodic table. They are used in electronics in different electronics, in different proportion, in different quantities, for it the function that we want out of the electronics these are needed over there. So, first they also have some value, there that cell it most of the electronics items are a bit are you can say things are getting cheaper, but there is still they are comparatively a pricey items. If you go to buy a good cell phone is still 14, 15, 10 to 15, 1000 rupees. So, it is a at least and then of course, there is no limit you can go and buy for several lakhs as well, but this heavy metals are present on those electronics.

Now, when you discard them or when you put them in a environment back, they these will leach off from these when doing the recycling operation especially by the informal sector, they will leach off they will go into the soil, they will go into the water, and then we will have if we use that water if to drink, you are getting exposure to these heavy metals and you saw all the dangers associated with this different heavy metals. If it goes

into the soil, we grow our like a food on those soil, that food may have uptake because of many plants have the plants also get confused between calcium and cadmium like our body does and. So, plant may think that especially there has been documented evidence where they saw that many Paddy which is a staple food the rice were found with cadmium. We could see cadmium showing up in rice thing and the rice plant. So, the paddy thinks that cadmium they cannot distinguish between cadmium and calcium. So, again it will think we tend we want if it is calcium is there it is good is not it.

So, but if cadmium shows up it is bad. So, that is the reason we have to careful. If it goes to the soil it will have impact through the food it every children has a hand to mouth activity, that is another impact we will talk about this in that risk assessment video, and so, this these are. So, essentially lots of heavy metals and other pollutants which is there an electronic waste, we need them because for the function to get out of those electronics.

If managed improperly, they have a very high probability of contaminating the water contaminating the soil, and part of it could go into the air phase as well. So, we need to manage the electronic waste properties, to avoid the danger which has been listed in the third column which I strongly encourage you I did not go by line by line on those I strongly encourage you to read that. You will have this as a this slide will be available to you as a reading material, along with other reading material go through that. Any question asked me on the pair on the discussion forum we will be happy to answer, but. So, that is why we are that is the reason we are talking about, and the other side if you look at these are heavy metals which are being mined from mother nature, being brought into in our like a value chain in the economy.

So, there is a money associated with that. If it is somehow if we can recover these heavy metals and bring it back into the economy, rather than dumping into the soil dumping into the water, dumping in the environment or in a landfill. Say if we can bring it back into the economy by doing this recycling and recovery of these heavy metals, we do not have to go in mined improve, we can use these heavy metals we do not have to go in mined. So, the other precious metals has not been listed here like a gold is also present in a very minute quantity, we will talk about that as well in later in this course.

So, these are the reason why we need to why we are looking at electronic waste in terms of like a different elements present, different pollutant present.

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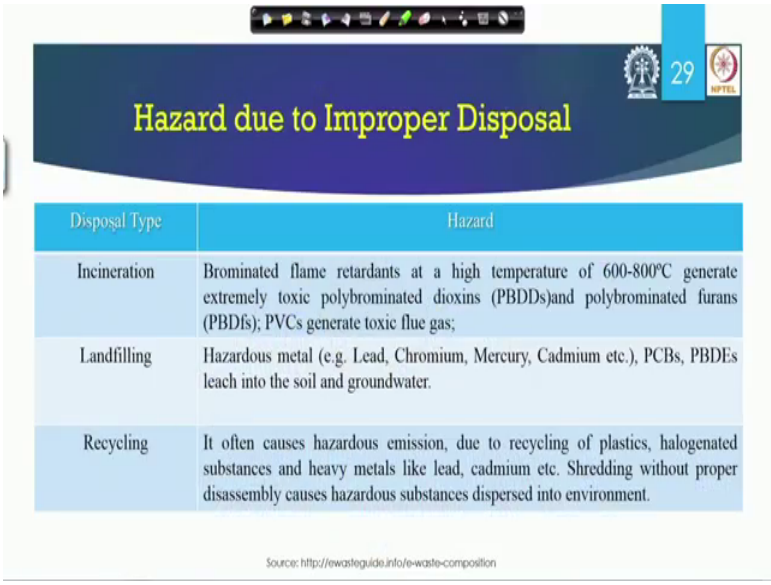

So, disposal type what are the major disposal type? Incineration things are being burnt many times it is a uncontrolled burning of electronic waste, as I told you that will doing the discussion forum will put some you tube link videos, for you to look at and where you will see that E-Waste is just burn in an uncontrolled fashion. And that leads to if you burn at say uncontrolled fashion, it you can have like a brominated flame retardants will can lead to extremely toxic dioxins and furans, PVCs will generate toxic flue gas. If you put it in landfill, landfill you have lead, cadmium, chromium, mercury all these things going in there PCBs, PBDs they can go there landfills in the way the Indian condition right now mostly it is the dump site. So, if it goes to those dump sites, what it will lead to is leaching of these heavy metals into the subsurface, and that will leach can potentially go to the ground water and we can get exposed through that.

So, it is again exposure through the contaminated groundwater could be a problem. Recycling we need to be careful in terms of the hazardous emissions due to the recycling of plastic halogenated heavy metals like cadmium and other stuff, we need to make it we need to make sure the process is safe and proper. So, shredding without proper disassembly that can cause hazardous substance dispersed into the environment. So, we need to be careful in terms of hazardous associated within proper disposal. And then it

comes to that why we should focus on recycling. We do not want to put this electronic waste in landfill that much are in generation, we should try to recycle as I said just earlier few minutes back many of these heavy metals and other elements present there, they have a value, they have been mined from mother nature and gone through all those refinery process and then it is being used in E-Waste. So, rather than putting it back into the landfills or burn it and then make it unusable form can we recycle and make it in a usable form.

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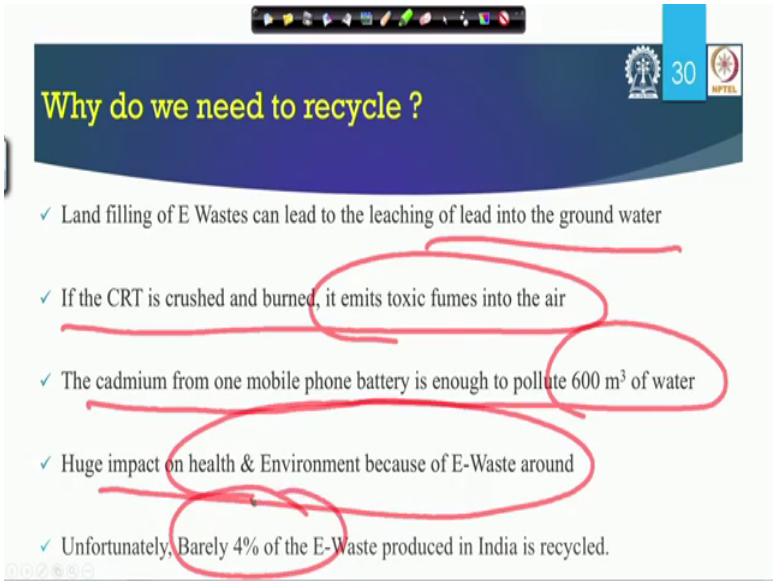

So landfill of E-Waste can lead to leaching of lead and other things into the groundwater, lead is just used as an example here. So, that is goes into the groundwater if the CRT is crushed and burned, it may emits toxic fumes; cadmium from one mobile batteries enough to pollute 600 meter cube of water. So, one from your mobile phone the cadmium that is present there, if you just put it in a river in a where the cadmium becomes available to the river, it can pollute 600 meter cube of water think about that and then. So, there is a huge impact of health and environment because of E-Waste around in terms of improper management of E-Waste, and right now barely four percent of E-Waste produced in India is recycled.

So, nearly 95 percent is just getting dumped because of the poor technology and then things not getting into a proper hands. So, that is why the E-Waste management rules which we will talk about that 2016 came into being it first one was revoked was in was

in 2011, which was supposed to be implemented from 2012, unfortunately nothing much happened then again in 2016 their rule has been refined a little bit is and then we are trying to implement it in the country is we are struggling to implement it even now, but things are being tried to implement it. And there are a lot of new companies are showing up in terms of the E-Waste management companies are hopefully their market will pick up and the registered companies will get the job.

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So, for there is a huge gap between the generation and recycling of E-Waste, and any recycling is good as long as it helps the environment. So, if recycling what do we need to recycle to help our keep the city clean, provide value for obsolete electronic items. So, we can use that many times if you have say three broken down computers. If you can just salvage the material from there and then you make a one working computer, that is actually refurbishment not recycle, but that that should also be encouraged and then there are it can be sold at a cheaper price on OLX or eBay and whatever you want to do that. And if you recycle if you keep it in a within the loop, you are avoiding health hazards things will not go into water will not go into the soil, we have to organise the informal sector that is the that is true for municipal solid waste as well we have a good or informal sector.

Especially in the Indian context or maybe some other developing countries context, the informal sector does a very good job in terms of the collection of the garbage, collection

of the recyclable material from the waste stream, including that for electronic waste. So, electronic waste is this Kabadiwala or the E-Waste recyclers, those who have their nice network, they can come and collect the E-Waste from you and then the problem and with the problem comes in when they are trying to recycle, when they start is starting recycling up to dismantling it is fine, it is not too much of a of technical intensive exercise dismantling you need only some screwdrivers and some of the other tools to take it a part.

So, any electronic waste, when say think about let us take the example of a CPU like the computer that a central processing unit of a computer. If you discarding that you can unscrew it, the top casing is mostly it will be steel like a ferrous metal or it could be plastics now a days, but mostly it is a steel which you saw in see in the disposal stream. So, that can go to a steel recycler and anything which is plastic and go to a plastic recycler, the problem comes when we start looking at that motherboard, printed wire board and all those material where we have lots of nest, and lots of heavy metals and other things present there.

So, we have to start recovering a stuff from these and there where we start recovering these, we start using some of these aquaresia, which is a very concentrated form of nitric acid and sulfuric acid, we start using some of these other extraction methods without any environmental control without even personal protective equipment and that leads to all those exposure to the person working there, air pollution, water pollution and land pollution. So, if that aspect, if somehow we can do a nice move like a marriage of the informal sector and the formal sector, where this informal sector does the collection part and brings it to the formal sector, and the formal sector can take care of.

Let the low hanging fruit be with we have a recycling of ferrous metals already happening in the country, we have recycles of certain types of plastics already happening in the country, let us that be handled along with plastics, along with the steel recycling, the major that stuff which is has those heavy metals presents, the printed wire boards and other things motherboard, other different types of boards capacitors and batteries and all those which is present, that requires a specialized recycling system and that when this informal sector tries to do it they end up contaminating a lot to the environment. To avoid that if we can get the formal sector helping the informal sector in that aspect. So, again we have to look at the how the economics will work. Right now this informal

sector they come to our houses and we even give them they even give us some money, say if they take some old cell phone from you, they may give you 200, 300, 400 rupees depending on how good that cell phone he or she is thinking about will fetch him money. Because they will, but if you go for a formal sector, which has set up a company which has to follow is ideally they should SPCBe norm, C PCB norm, ministry of environment and forest they have invested lot of crores, some rupees few crores of rupees on that plant they may not be in a situation to give you some money on the day one. They have to start making some money themselves. So, there has a there will be a break even time, when they will break even and then they will start making profit.

So, to expect getting little bit of money from them to give you a product it is kind of little bit too much. So, if you are especially if you look at the developed countries like if you are in Canada and other places you actually pay for E-Waste disposal rather than getting money from E-Waste disposal. So, that is where the problem comes, people like us does not have you always want little money from everything and say and then the formal sector cannot give us the money, because they do not have money to because they have to follow all the rules and regulations. So, they have to spend a lot of money there, but in formal sector they do not have to follow any rules in regulation. So, they are to give you a few of like a little bit of money, and then we get this E-Waste from you and try to recover whatever they can recover and whatever they cannot they just dump it. They just dump it in the environment and that creates a lot of problem and people like you and me get affected.

So, we are then we pay the medical bills. So, first we get a little bit of money from electronic waste, and later on we as a society I am talking about, and then as a society we ended up paying a little bit of like a lot of money to all these hospitals. So, we have to think what we need should we what is what would be best for the society, how to go about managing that part. So, that is the of the organization of the informal. So, getting this informal sector into the formal sector, and that that will lead to reduction in the environmental degradation so that will in terms of the recycling; the recycling of E-Waste is the most preferred option in terms of managing of E-waste. So, that is in terms of

So, next in the series so far we have talked about what is the E-Waste what are the pollutants there in the Indian scenario, global scenario, how the E-Waste is changing why

we should be worried about it why recycling is important, what is the state of E-Waste recycling in India right now then next. So, we will it start thinking about if you have to quantify E-Waste. So, think about that if we have to design an E-Waste management system for a particular city, the first thing first question that you will come to your mind is how much is out there, how much E-Waste is there, how to find out that number. There have been some studies done in the old times, but if you are if I just focus say if you are focused in Delhi city or Kolkata city or Mumbai city it would be nice to know how much E-Waste is produced in the city itself.

So, for that there is a method that will talk about that is a quantification of E-Waste, and as you can see in here in terms of the quantification of E-Waste, just I will introduce this topic and then will call cover this in detail in the next video.

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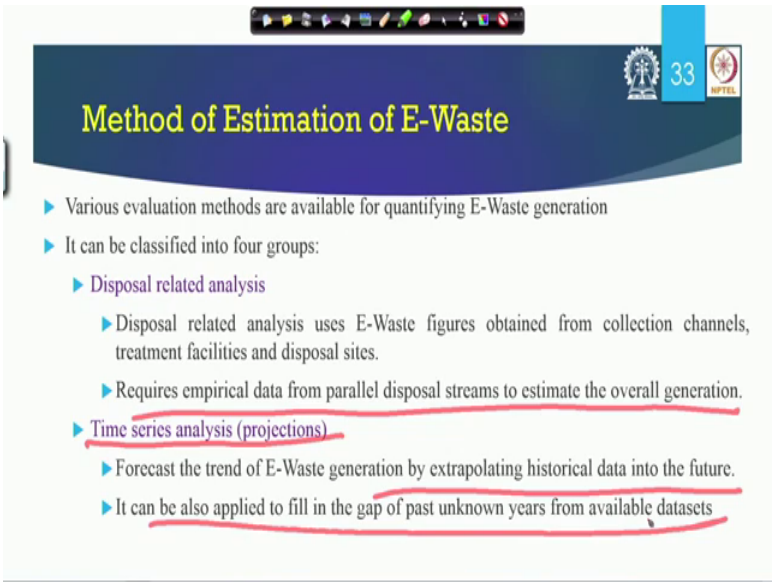

So, in terms of quantification what there are different methods out there, there are various evaluation methods are available, they are put in different groups, there are the disposal related analysis, there is a time series analysis, disposal related analysis what they do is they look at the E-Waste figures obtained from collection the methods treatment facilities, disposal sites or they get the data from the disposal stream. So, they get or they did requires empirical data from parallel to estimate overall generation. So, they will look at the how much is being disposed and based on that they do some

estimation. Time-series analysis is essentially used for projection; we forecast the trend of E-Waste generation by extrapolating the past data.

So, we take the historical data of the past and then we try to extrapolate it in future, and then it can it is used to fill in the gaps of past unknown datasets as well. So, that is in terms of disposal related analysis, time series analysis. So, there are different methods out there you can go on literature.

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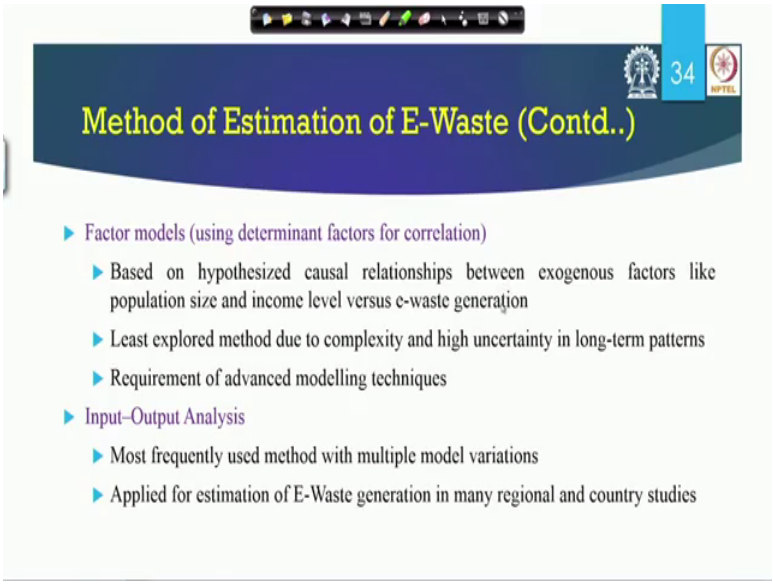

And try to find that a lot of things are there and then there is a factor models input output analysis and.

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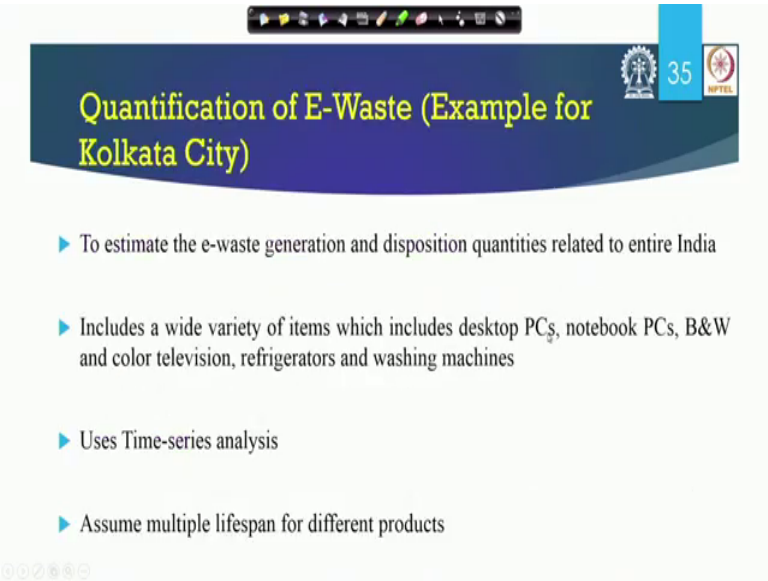

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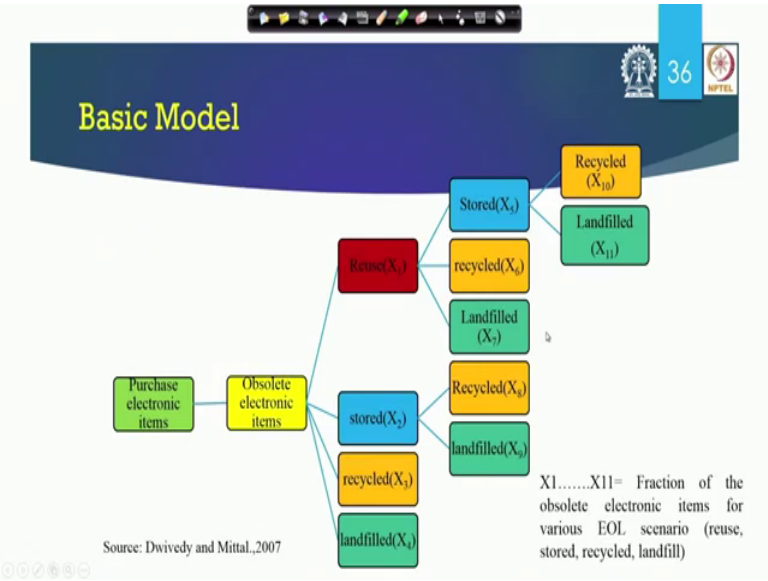

So, that is these are the four major analysis methods that is used factor model use, determine factors for correlation, input output is this is used mostly for multiple model variation you try to generate E-Waste generation for the regional scale or the country study we try to do that.

So, just wanted to introduce you to these four concepts so that you can try to get some more information about these different methods, I will encourage you to read say again this is a specialized course. This course is a specialized force focused I would say it is

mostly for high which is fourth year undergraduate students taking it as elective or masters PhD student or some people working in the professional. So, I do expect you to do some of the reading on your own as well. So, certain topics would be introduced here, but we mean we do not have time to get in great detail on those topics, and you can those of you who are interested can research today with the help of Google, you can actually find a lot of information good information.

So, all these different four methods of estimation, and this is not only for E-Waste it is let us say it is done for other scenarios as well. So, I would encourage you to look at those four methods. So, that when in the next video when we used to look at the next video, you are a bit more familiar. So, we will about these four method and then will discuss it in more detail.

So, with that let us close this will continue our estimation of E-Waste in the next and then we will have a case study for the city of Kolkata of how we can do a E-Waste estimation there. So, for again keep your questions active on discussion forum, we will definitely answer that and we look forward to having your discussion. Give your feedback along as the course is going on if you want certain things to be more discussed; put it there, will try to do it and anyway we can help you to learn better that is always will be our pleasure.

Thank you.