Electronic Waste Management - Issues and Challenges
Prof. Brajesh Kumar Dubey
Department of Civil Engineering
Indian Institute of Technology, Kharagpur

Lecture - 18
E-waste Management (Contd.)

So, let us get started from where we left in the previous video if you remember I was we were looking at this particular example where I asked you to kind of think about the process in which a lifecycle analysis is carried out.

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So, for we were looking at this particular example, we were talking about this function and the functional unit. What materials and resource are used for that? What does it take to produce these? We are talking about those aspect, what are the impact of the environment waste and all that kind of stuff, so will continue our discussion along the same line by giving some more examples in a minute or so.

So before we do that, let us look at say if you have once you have this LCA, like a the information what we do with this? What we do? Like what are what we say will collect all these environmental data in terms of I will collect all this inventory data, we got the emissions number, but then what? Then after collecting this information, emissions in terms of solid waste, what are the stuff present in solid waste? What is the BOD number,

COD number so, if they have a benzene arsenic lead or all those heavy metals stuff or organics in terms of air pollution SOX, NOX particulate matter.

So, all these data we need to calculate in, we need to collect in terms of the process that is happening in the industrial process during the production and after the industrial production is done during the transportation, the vehicle emissions, then during it is usage and finally, when it is disposed. So, all those things has to be captured in the inventory analysis. So, after getting the data what is the next step? Next step is we try to put it into a category of what is known as the environmental impact category.

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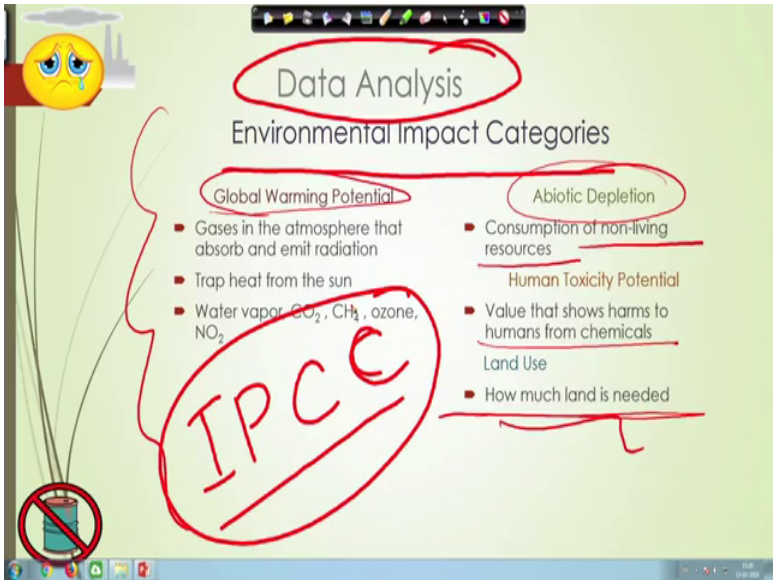

So, we do have to do the data analysis, where we look at the environmental impact category. So, when we say environmental impact categories what do you mean? If you have looked at these are all done as per the IPCC document if you are international protocol for climate change, if you remember that, that was done all most at the beginning of this decade; so we can do the like the data analysis, we can look at the different environmental impact categories. So, what are the different impact categories?

We look at the global warming potential; this is one like the global warming potential a biotic depletion now, what is the meaning of a biotic depletion? A biotic depletion is a consumption of nonliving resource. So, it is a like a renewable non renewable resource or nonliving resources in terms of usage of heavy metals, usage of organics and all those stuff. Human toxicity potential, making values, that shows harm to humans from the

chemicals land use, changes in the land use, how much land is needed? So, all these stuff is we need to categorize it and it is not only for these are some example impact categories, there are a lot of other categories that we look at.

So, our encourage if you are interested in this particular area; of course, we have a course going on right now, I do not think the registration is the no more illustration is over it to start it on fifth of February, but of course, the course similar course will be offered in the future and at the same time you can go and download this IPCC document and read about it, there are and the videos from the previous like a NPTEL courses are always available online.

So, you can always look at those courses as well, but this is what we, when we say looking at the life cycle impact, it is essentially looking at the different impact categories, but the global warming that is to get the most air we always get the most attention to global warming climate change, but there are a lot of other impact categories too, like a biotic depletion, human toxicity, potential, then we are talked about there are we talk about eutrophication, acidification is what is the and there are they as it says there are many more.

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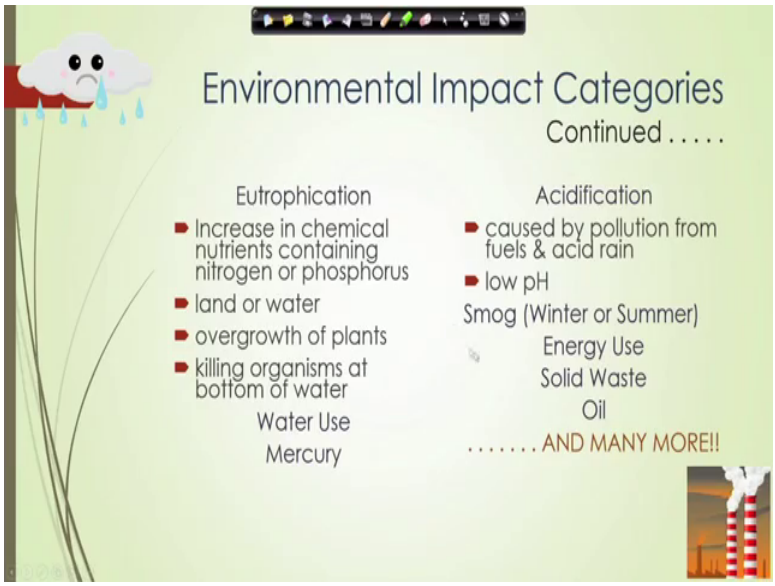

So, there is a lot of others out there as well, which we need to, we talk about that as well. Eutrophication increases in chemical nutrients land or water overgrowth of plants killing

of organisms at the bottom of the water, so that is the eutrophication part, acidification is low pH smog and word like caused a pollution from fuel and acid rain.

So, these are the different impact categories which we look at in terms of when we talk, when we try to quantify the environmental impact from different industrial process in terms of when we talk about lifecycle assessment or any environmental impact for that matter.

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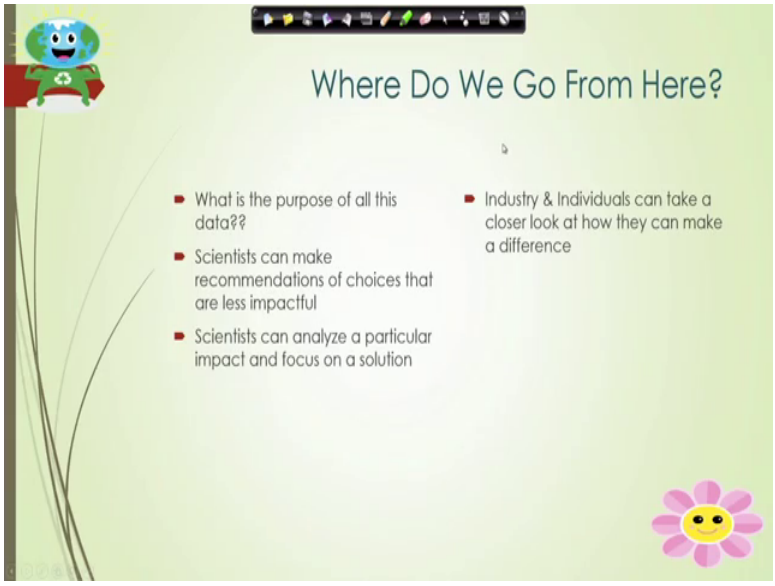

So, once we get that information, what, where, how, what is the way forward? What we can do with this information? So, number thing is that what is the purpose of all this data? What we are really want to achieve with all this data? As a scientist say if I am a environmental scientist, I want to so that what are we can show the choices, we can recommend the choices which are less impactful; which has less impact on the environment.

So, scientists can make a recommendation of choices was less impact. We can analyze a particular impact and focus on a solution, say if you even if you think about do you have a cell phone and you are going to you are looking at the process of how this meant, how the cell phone is formed and from this smart phone looking at the each and every environmental pro sorry, each and every unit process which goes through in making of this a smart phone, we can identify what is known as the hotspot, what is hotspot? Hotspot is that unit process because say if this cell phone has n number of unit process,

within that n number of unit process there could be 1 or 2 which has the higher environmental footprint.

So, we can pinpoint on those 2, 3 unit process and try to modify it, make it more greener. So, that the newer version of this phone from the same company will be much bit environmental friendly. So, they and these things are coming in, where people are trying to sell their product, selling that I am more environmental, it is a my product is better from environmental point of view than the other products out there in the in the market.

So, how they can say that, they have to do these LCA exercise. So, this sustainability report, lifecycle assessment these are becoming very popular day by day and it is kind of a bigger version of ELA, many of you may be familiar with environmental impact assessment, many are like almost all the projects in India now require CIAA, same thing in abroad, like in U.S and in some of the world bank related projects Asian development bank, united nations project like UNEP, UNDP they have also started looking at going beyond environmental impact assessment and going to this what is known as the lifecycle assessment.

What is that? If you look at we will not go into great detail about because that says this course is not an LCA, this of course on application of LCA to e-waste like electronics and electronics e-waste, but will just for kind of putting a little bit of context say there is EIAA is mostly local, EIA is the environmental impact assessment you are focusing on the local consideration, wood LCA is the lifecycle assessment it looks at the global picture. So, LCA is a much bigger perspective than the EIA, EIA looks at a very focused local impact, LCA looks at a global impact.

So, that is that is the difference between the 2 and try to captures the all their processes along with that and EIA as you most of you may be already aware with or it is kind of you start with a baseline, any new construction, any new project, new construction you see what could be the other impact coming because of that. So, scientists analyze a particular impact and can focus on a solution that industry and individuals can take closer look. So, they can try to come up with a better product as I was starting to tell you they can for the smart phone or in any product for that matter, they can look at how they can make a difference in terms of like a environmental performance of their product.

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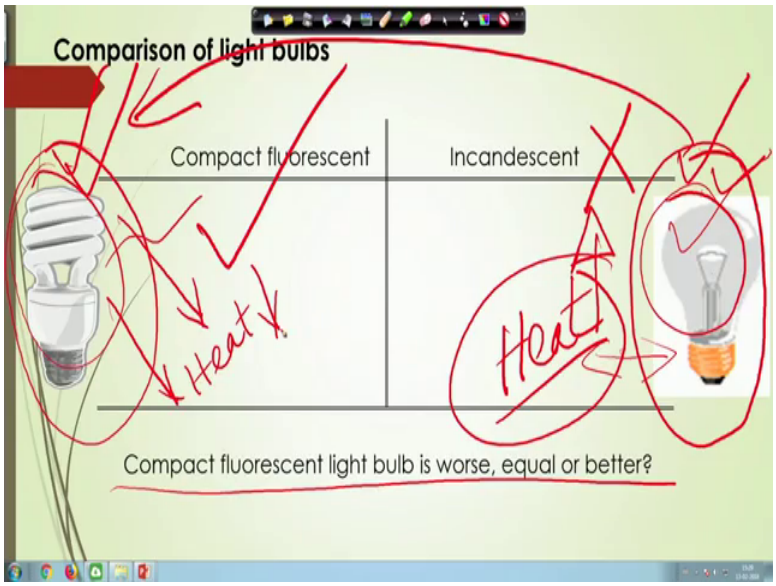

So, let us look at some other like another example, we will look at this example of a comparison of a light bulb, this is it is again kind of electronic waste, you have compact fluorescent and Indian incandescent bulb. These are the 2 bulbs which is, this was this particular type of bulb is being phased out, in many places you do not see this bulb anymore, but some places you still see that, then we had this compact fluorescent lamp.

Now, if we have to compare, that which bulb is greater with the CFL is bulb is worse, equal or better? How will we do that in terms of the environmental performance? When I say environmental performance, I am trying to find out in terms of it is a what like it is a in terms of the lifecycle analysis, will look at the lifecycle impact between the 2 bulbs.

If you from a common like a we do know, like if you are; if you all go and ask anyone, which we bulb is better, of course, people will say this one is better, most of the people who are aware of the bulbs they will say CFL is better, because it gives you more light, the light quality is better, then we have it said to use as less wattage. So, it should be good for the environment because the less wattage is required, but that is true it is, it should it is good for the environment, but how much better?

Say if you have to tell, that between this bulb and this bulb what is in terms of the quantity; in terms of the quantification how much when we moved from here to here, how much really the environmental benefit we are getting, because here the materials are different.

So, this may have a material here, we have not sure we have to look at the list of material, this may contain some material which is more harmful than the material which is present here, this may have some elements or some metals present here which was not here and this element has no toxicity than this, what potentially yes; of course, the wattage, the use of power is much less in this case, the power was higher in this case.

So, power coming from the thermal power plant and coal and other stuff it this, this was and this, this was coming out to be actually worse then, this guy and that is why many places we moved from this place to this place.

Now, if we have to compare will it be fair to compare one of these versus one of that, is it fair to do that? What is the function of these bulbs? The bulbs function is to provide light is not it. So, it is a provide light, you it is a we are getting light, I am sitting in this room, I have some bulbs on top of me coming here that is why you see the bright colour like a video showing up on your screen because the lights are replicating that the light the sorry, the bulbs are creating those lights which is it makes it illuminated and we can see things much clearly.

So, of course, one thing is a do provide light both bulbs do provide light, of course, the wattage will be different, we can have the same wattage from both bulbs as well they provide pretty much similar life. Other thing is that, that type of light some of that this bulb has little bit of yellowish kind of feeling here. So, it is many times the bulb is not the, although the light is coming out it is not as bright for the same wattage.

Here, it because of the CFL, it looks a little bit brighter and that is why you see that when you go to these days any of these I would say, any of these mall or shops or especially in those if you go to the bangle shops and they put lots of lights, lots of CFLs and other things will be there, where they are trying to sell those artificial jewellery, bangles and all that or even for the sarees.

So, for example, you see lots of lights are there and it things looks very bright and it is can, so it what I am trying to say it also does create an ambience. So, it is very difficult to quantify that, is not it; that what is the ambience created by this CFL bulb. Of course, that is also one of the function that is used, but that is called a secondary function. So, there is a primary function and a secondary function, will not get into a secondary function in this particular video or a lecture, I will talk only about the primary function,

but you should be aware because when just for your information in if there is a there could be a secondary function and sometimes you have to divide the environmental load to primary function as well as to the secondary function. Here for the incandescent bulb, minute in a paltry form and other places these bulb has a tendency to produce more heat, so you get a better heat here.

Now, if you get better heat, sometimes our chicken when they are growing they require better heat, so especially during the winter months. So, you go for, you will, may prefer to go for this bulb is still because this bulb does not produce that much of a heat. So, heat production is actually low here compared to that for the same wattage. So, that is why these are there is a pros and cons of using these bulbs. So, being said that, if you have to compare, you have to first go through the 4 is steps.

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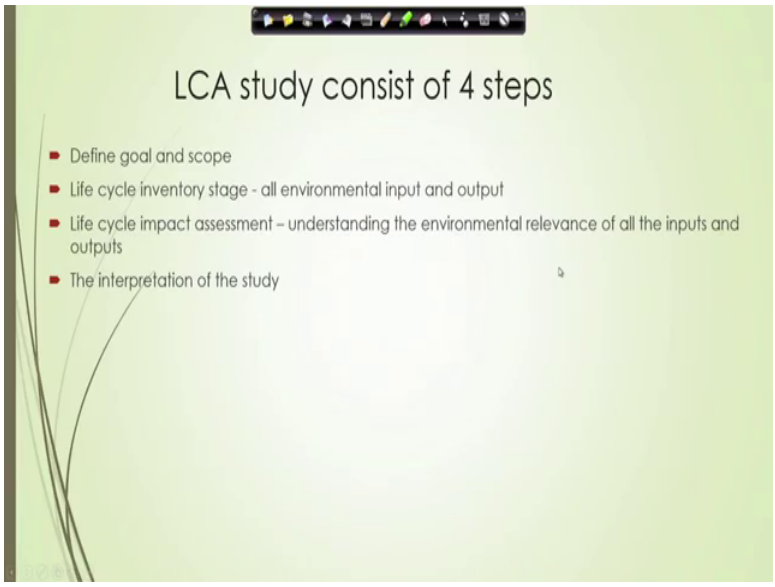

When you do any LCA exercise you go for 4 is step, first of all you define the goal and scope, what is the goal of this study? What is the scope of this study? And what is the audience? What is; who is the intended audience? What we are really trying to get out of this study? What is the ultimate objective of this study? We need to be clear about that, then we looked at life cycle like all environmental input and output that we talked about, we need to have a life cycle inventory stage, then we talk about in the life cycle impact assessment, login in the in the impact assessment, we have to have understanding the environmental relevance of all input and output, then finally, we have to interpret this

study, we have to make sense out of this study that we are, that we have come up with, so that is. So, lifecycle of a product we try to have all processes output, all processes associated with the product wherever and whenever they might occur.

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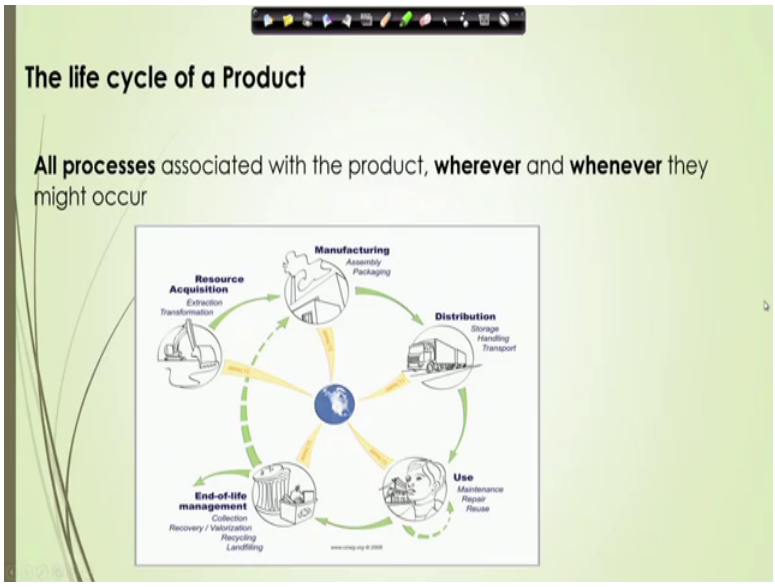

So, we try to have all the process included in there. So, if you look at this is our mother earth in the middle, we have resource acquisition there, extraction transformation, then it goes to the manufacturing, distribution, use, end of life management. So, that the entire heat during each of these we have an impact, as you can see little written here impacts, impacts, impacts, for each of these there is an impact on the mother earth. So, in LCA we try to capture everything, so all the environmental input and output. So, there are lots of data, that is why there are databases, there are software's, which will talk about in a minute.

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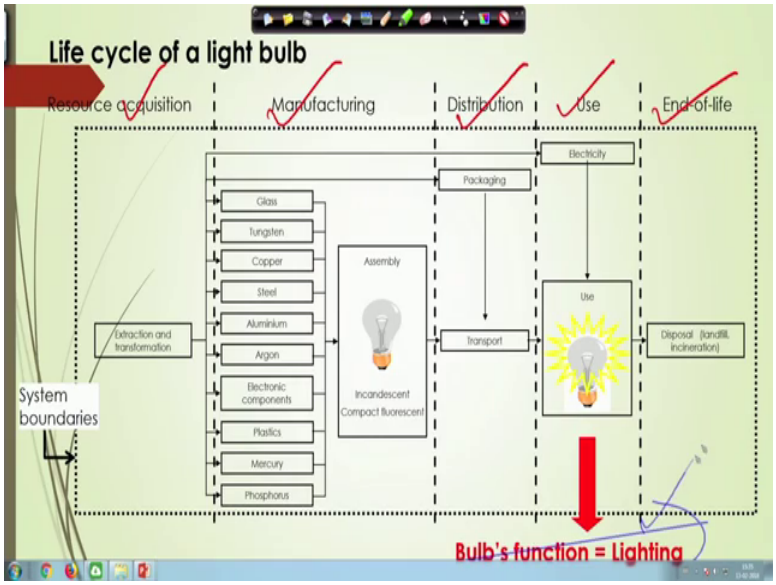

So, if you talk about the life cycle of a light bulb, so that is your in condition or compact fluorescent bulb. So, if it is a bulb there, bulb has to be made, so we have glass, tungsten, copper, steel, aluminium, argon, electronic components, plastics, mercury, phosphorous all these goes into just making a simple bulb and the list could be even much longer if you try to include everything.

Then, these things have to come from somewhere, so there is a step called resource acquisition. So, you see over here the resource acquisition has to be done, then extraction and transformation, then the manufacturing will happen to make those bulb, then after the bulb; then your bulb has to be packaged, transported, then it would be used and it will be using electricity to do that, then finally, end of live disposal, so that is the different stages.

So, first is the resource acquisition stage, manufacturing stage, distribution is stage, use a stage and end of life stage. So, we are looking at 5 stages here, resource acquisition, manufacturing, distribution, use, end of life. So, these are the 5 stages that we have. So, all together these 5 stages we can solve, all together that so we were talking about these different stages, so we have resource acquisition, we have this resource acquisition, we have manufacturing, we have distribution, we have used and we have end of life.

So, these are the different 5 stages of any product, we are just using bulb as an example, but this is for any particular product you will see these and then when all these things

together is this dotted line that you see all around it, that is known as the system boundary. So, in this system boundary we are taking all these 5 stages, we are starting with resource acquisition, then the manufacturing, then distribution, use and end of life. So, this entire thing is your system boundary and it is a cradle to grave, so you are going from very beginning to the very end. Now, we have to do a lifecycle analysis for that, so as I said earlier we need to identify a function in the functional unit, so bulb function is to provide lighting. So, to in terms of the function we it is say we have to provide lighting. So, that is your bulbs function that is their providing lighting, so we have that. So, once you have.

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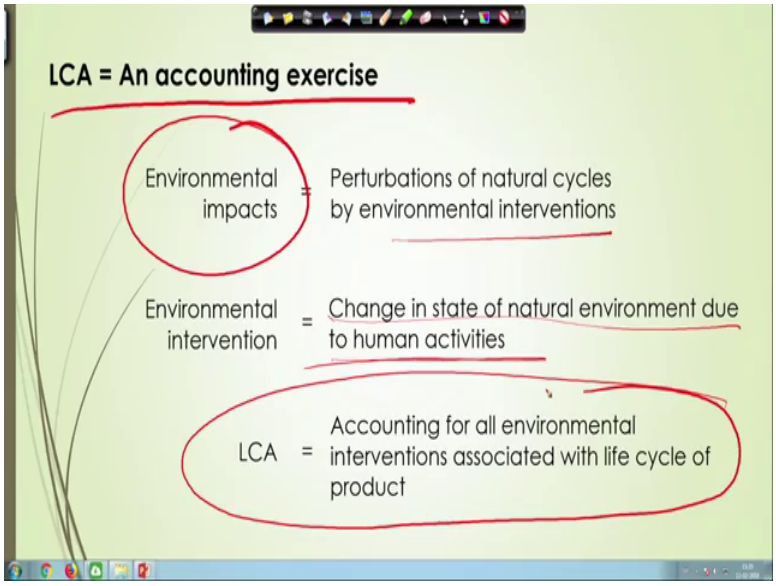

So, in terms of the LCA what will do? Will it is an LCA is an and as a environmental accounting exercise, it is an accounting exercise essentially. So, we will try to have the environmental impact, so whatever the disturbance of natural cycles by environmental intervention. So, what is environmental intervention it is changes in the state of natural environment due to human activities, what is that? So, LCA essentially we are doing an accounting for all environmental intervention associated with life cycle of product. So, we are trying to account for all environmental interventions, which is happening associated with a life cycle of that particular product and we that is what we try to capture, so will try to see an example here.

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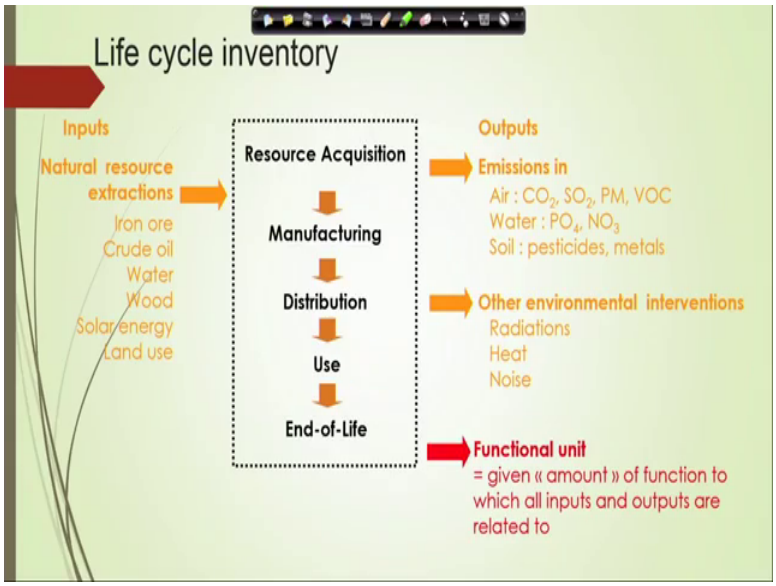

So, in terms of the inventory resource acquisition, manufacturing, distribution, use and end of life remember we were looking at these 5 stages, this dotted line is showing as dotted line that you see here is showing as the that is the dotted line all along is that is the dotted line that you have I am just trying to draw along just to highlight that point. So, this is showing us the system boundary.

So, that is our system boundary and under which we are working for this particular product, we have the input which is the natural resource extraction, iron crude this is again not an exhaustive list just to some example iron ore, crude oil, water wood and solar energy, land use, so all these are input and then output is their emissions air emissions, water emission, soil emissions and then also some other environmental interventions in terms of radiation, heat, noise all these are our output. So, as part of LCA exercise we need to quantify all these numbers and try to relate it to in terms of the environmental impact. So, that is what I will show you how it is done for this.

So, will for all these we use a functional unit, which is we put a function for which all inputs and outputs are related to. So in terms of for example, if the function is to provide light, so we can take a functional unit of how much light? As I was telling you earlier if you have a mechanical pencil versus a wooden pencil and if you have to compare, in the previous video towards the end of previous video I asked you to think about it.

So, if you have a mechanical pencil versus a regular pencil and if you have to compare you cannot just compare 1 mechanical pencil versus 1 regular pencil because they last at it they had their lives life is stage like their life is much different, mechanical pencil can last for a longer period of time as long as you keep on replacing the lead and, but the this regular pencil you keep on sharpening it and after usage for a month or 2 months or 3 months, it will die out you will not have anything left it.

So, for mechanical pencil if you use it properly can last for at least few years, as long as you are using it in a responsible way. So, it is, so, that is we cannot really compare one mechanical one a like a regular pencil, what we can compare is certain amount of writing. So, that is becomes your functional unit, so you have to choose functional unit in such a way so that you can put both the products that you are trying to compare, multiple products that you are trying to compare on a similar footing, they should not be undue advantage to one product versus one product and when I am saying product I am using it as a general term, even it is true for process or systems.

So, even one process versus another process it should have similar function, so then only you can compare. So, in terms of the functional unit that we have it is a we have, so functional unit will be having 10 pages of writing for the pencils in terms of this bulb, we can have certain amount of light that needs to be we say we can put a x unit of light from either this bulb versus the other bulb and that will be a fair comparison rather than taking one (Refer Time: 21:32) versus one CFL because that will not be a proper conversion.

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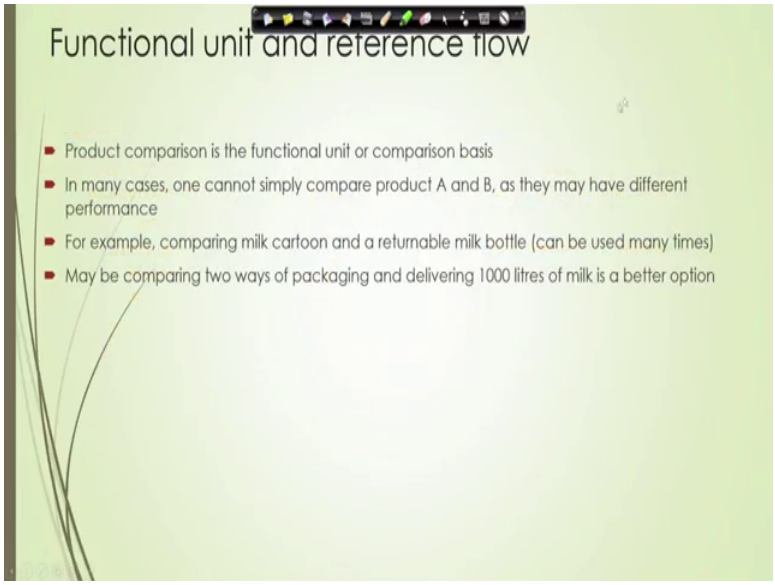

So, product comparison is the functional unit or comparison basis in many cases, one cannot simply compare product A and B, as I was trying to explain for example, comparing milk carton and returnable milk bottle, returnable milk bottle can be used many times, milk carton only used one time. So, how will you compare that, better way will be to packaging and delivering of thousand litres of milk.

So, you can choose because they for both the cases you are packaging and delivering milk, is not it. So, you can say comparing 2 ways of packaging and delivering thousand litres of milk. So, that becomes more as a more realistic by more like a you are putting the both options on similar footing. So, it becomes you are being fair to both the options that is what it is all about, you need to give for both options the same chance, you cannot give a biasness to one.

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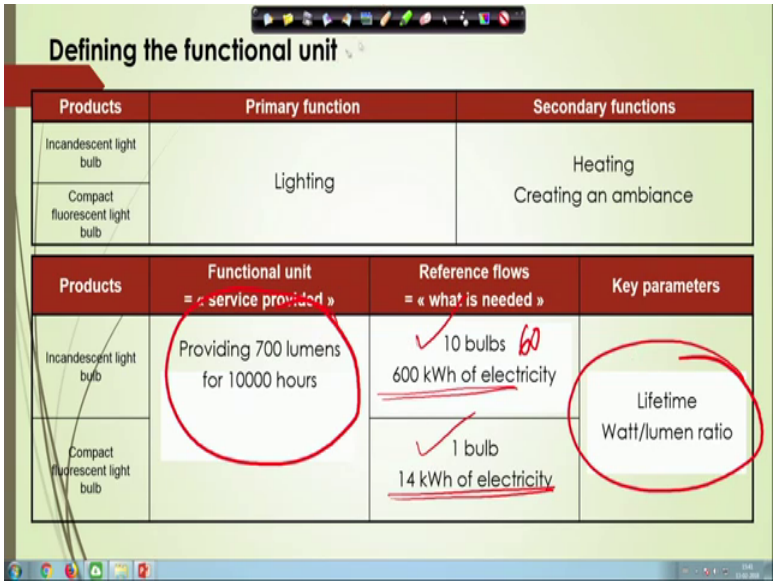

So, in terms of coming back to this bulb, now if you have to do this and let us like work with me on this you also try to understand where like if you again if you have any questions concern feel free to put it on discussion forum will be more than happy to respond to, but if you looking at this 2 types of bulb and we are trying to compare in condition bulb versus CFL bulb. So, for both this bulb the primary function is what is to provide the light that is the primary function.

Now, the secondary function is of course, heating and creating an ambience which we talked about that is the secondary function, but the primary function is to provide light. Now, as I said to why we have to choose a functional unit, so let us take 700 lumens for 10000 hours.

Now, why we have taken this number, it would be clear in a minute because if you take 700 lumens for 10000 hours, it gives you 10 bulbs of incandescent light and your it gives you 1 bulb of CFL. So, it becomes much easier 1 and 10, it becomes much easier to work with those numbers. So, this how much what functional unit will you will choose it all depends on you sorry, how, what functional unit you will choose it all depends on you, you can decide what functional unit you want to choose, but taking 700 lumens for 10000 hours gives me very nice 10 bulbs in 1 bulb, where 10 bulbs each of 60 watt 60 kilo watt, so it becomes 600 kilowatt hour of electricity and 1 bulb of 14 kilowatt hour of electricity gives the same light. So, that is why it comes out to be much environmental

friendly and then you can look at the lifetime watt per lumen ratio that is kind of just to compare. So, in, so that is gives us, so how.

So, once we have this again if you go back to that particular slide you have system boundary. So, along the system boundary we will try to collect all the information for resource acquisition, manufacturing, distribution, use and end of life, for the bulb function which is lightning and for 1 bulb versus 10 bulb, for 700 lumens for 10000 hours. So, we come up with these calculation, so these kind of calculations we do.

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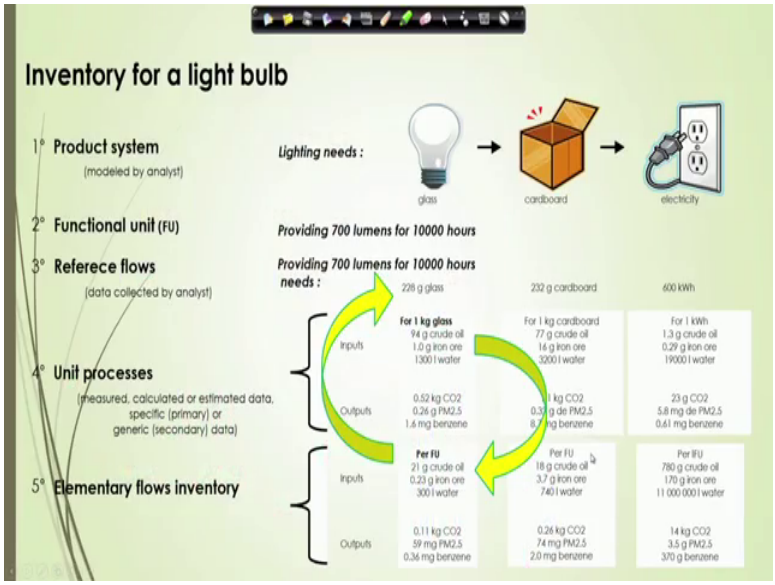

Now, here we prepare what is the inventory of a light bulb. So, the product system is we have the bulb, we have the lightening needs, we have the functional unit providing 700 lumens for 10000 hours. So, that is what you see over here 700 lumens for 10000 hours, then the reference flow, so for this we need 1 bulb versus 10 bulb remember, that so if you think about just 1 type of like a incandescent bulb, we will need something around 228 gram of glass to make 10 bulbs 232 grams of cardboard 2 picks to put it in there for the packaging 600 kilowatt hour of electricity for usage. So, this is broad category these things.

So, now for the bulb we need glass, we need for the just again these are not complete if you remember from the previous slide, we had several item which goes into making this particular bulb, I am just showing you an example of 1 item and so there are lot of other

items out there, which needs to be incorporated too, that is why we need a software, we have a database, we need a software, which will talk about in a minute.

So, for the 200 and we for the unit process say for 1 k g of glass we know it requires 94 gram of crude oil, 1 gram of iron ore, 300 litters of water, that is that goes to make 1 kg of glass and it releases 0.52 k g of CO 2 0.26 of PM 2.5, 1.6 milligrams of benzene, so that is the emissions coming out. So, this is for 230 to 220 we that is for 1 k g, we have to know for 228 grams. So, if for 1 k g it is this much, how much it will be for 228? So, we can using these values, we can calculate these values for 228, similarly here for cardboard and the kilowatt hour, if you look at for this is for 1 kilowatt hour 19000 litters of water, so it is lots and lots of water is needed.

So, 19000 litres of water for 1 kilowatt hour, we have to calculate for 600 kilowatt hours, so look at the amount of water that is needed for that. So, lots of water goes in into for that is why it has a bigger environmental footprint. So, for cardboard 1 k 1 kg of cardboard 3200 litres of water and of course, you have the other emissions.

So, just these are not the complete list these are just an example that suggest a snapshot. So, if you start putting every bases data together in an excel spread 5 spreadsheet it will get a bigger and bigger and bigger. So, and then you need to collect these all these data, so what we try to do is, we try to get the information in a database there is a eco invent database that we use and from that database we try to extract information and use it in our LCA exercise.

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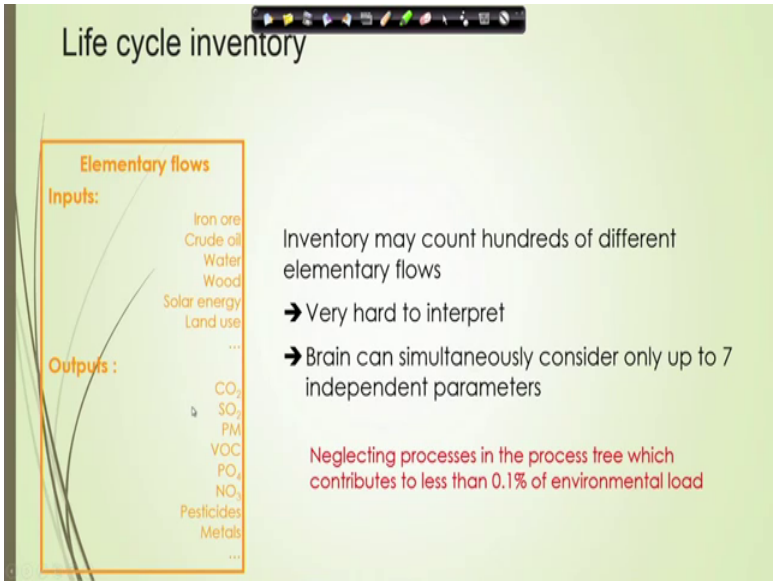

So, once you have the life cycle inventory you get the data, but it is sometimes it gets very hard to interpret brain can only simultaneously consider 7 data points. So, anything which has less than point 1 percent, impact we try to ignore that, anything which is less than 1.1 percent we ignore it, in terms of input you have all these iron ore crude oil output all these emissions coming out and so that is why I was saying there is a database out there, which is it started an eco invent it is a Swiss organization.

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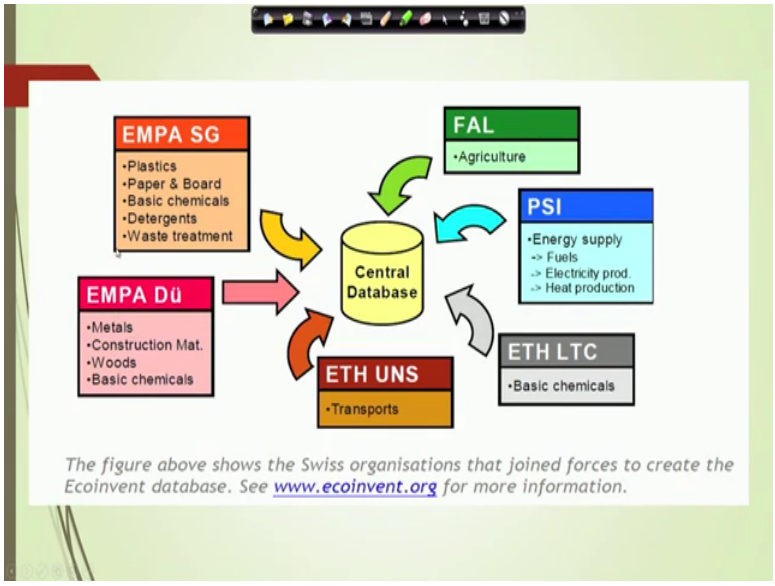

So, they have taken the all are different, these were all different organizations collecting data for different stuff like plastics, agriculture, energy supply, basic chemicals, transport, metals. So, everything was brought together under 1 umbrella and that is the eco invent umbrella.

So, we eco invent is now the one of the biggest database in terms of the lifecycle analysis collecting all these basic life cycle inventory data as a I think we are non OECD countries always get confused between OECD and non OECD, but I think we are non OECD country, whatever as a like an in India if you are in an academic organization, academic institute you can request your professor whoever who you are working with or your department chair, they can go to eco invent website and request for eco interment databases for free and you do login and password for that. So, you can use that login and password to get all this data. So, that eco invent database can be available to you for free. Similarly, sim approved support some of the research for the students in terms of LCA.

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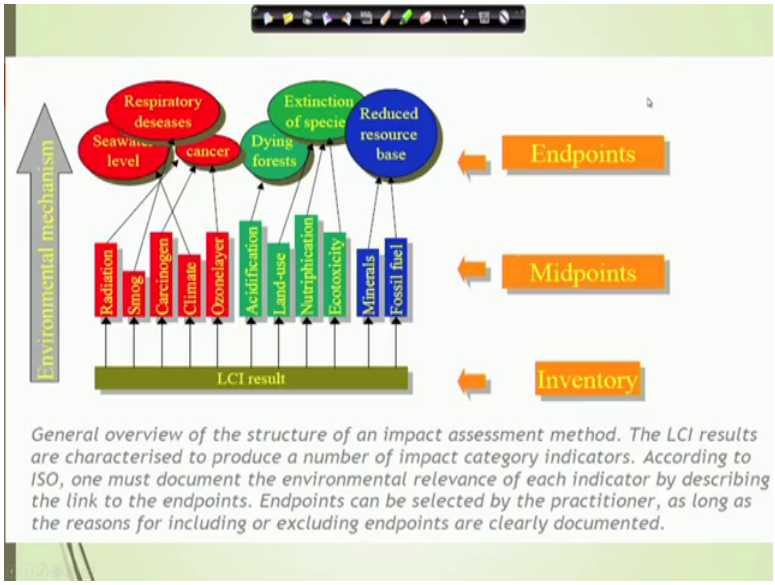

So, once we have this LCI result, so from the data that we have collected, we have this LCI result and this that it the emissions that is coming out, from there we can categorize that into different types of impact whether it is a radiation is more carcinogen, climate change, ozone layer, acidification and all that mineral depletion, so these are called midpoints. So, from the inventory we which is you saw all those data like SOX and NOX and particulate matters and all that. So, we can relate this to in terms of the impact that is

called midpoint impact, from the midpoint impact we can take it to the endpoint impact, which is you look at in terms of reduced resource base extension of a species, respiratory disease, sea water level and all those kind of stuff. So, that is your environmental kind of mechanism yet in terms of the endpoint.

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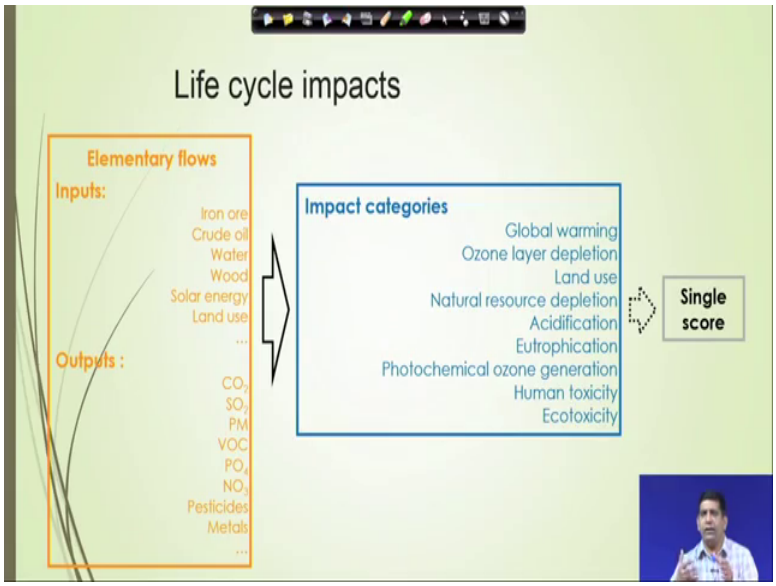

So, from the life cycle impact, you have the impact categories and from the impact categories you finally, you get a single score. So, what is the meaning of this single score? Say, when you go when you are going and presenting this to a so, very almost when usually when you go and present to regulator I would say bureaucrats or ministers or any of those type of forum, if you start talking about too technical it becomes a problem.

So, you have to put it in a big picture in a perspective. So, that is why this single is scored that is a concept very similar to the concept of a stock exchange SENSEX, so that you hear all the time or water quality index or air quality index. So, you come up with a single score, which is a weighted average of all these different parameters which is out there and that way how much weight which has to be given is up to you or for that also there are several protocols are available which you can use for that and then the single score is used to tell that this product is better than this product. So, it is easy for people to understand.

So, that is how a nutshell, how this lifecycle analysis is done, we still have to talk a little bit more about that in terms of interpretation and all that which will do in the beginning of the name video, but just one, so I hope that you really got an idea. Now, will quickly in the next video will do that little bit slightly more discussion on interpretation and then we get into an example, we already showed you an example of in bulb which is similar to an e-waste and now will go talk about some other examples related to electronic waste in terms of application of LCA in on electronic waste.

So, thank you keep learning, any questions feel free to contact us.