Plastic Waste Management
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Lecture - 35
How to Quantify Something is Green

So as you know in this week we are focusing on alternatives to plastics. So, this is week 7 this would be the last video, last module for this week 7 as you know every week we have 5 videos of approximately 30 minutes each. So, this is the last video and as the topic for this week is focused on alternatives to plastic, the greener material to plastic we are so in this last video and we I showed you we went over several examples of alternatives to plastic.

So, will kind of a discuss a little bit on that in terms of when this plastic alternative plastic will end up in the environment what are the issues associated with that and then we will also look at how to quantify something is green, when I say green product or green plastic better to better for environment how to quantify that? And that is discussion will be done in this particular video and then that will kind of conclude the content for week 7.

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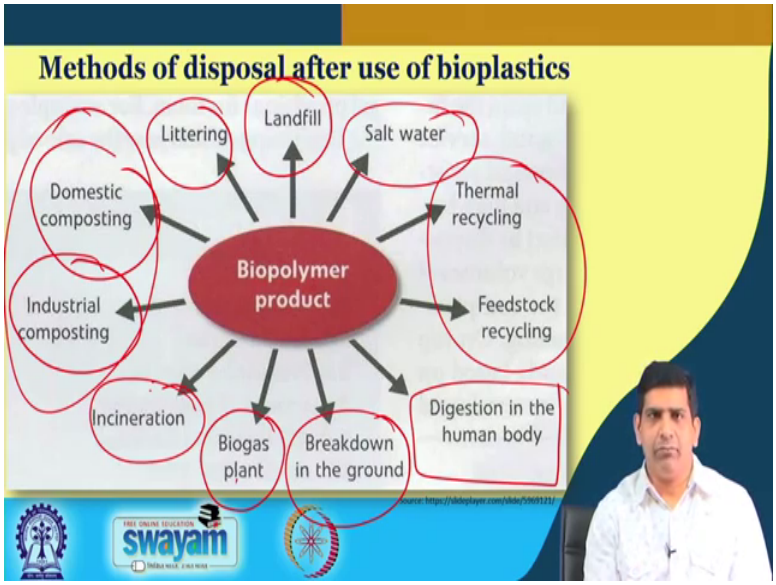

So, let us get started and look at the details, so we were at this particular slide in the last towards the end of last video we were looking at any of these bio plastic products, when

they will be disposed into the environment after it's use like traditional plastic as well. So, there are different ways you can do it, essentially it will be passed of your municipal solid waste stream. So, when you look at these waste product coming out you will have you will have either it if you do not collect it properly it will be littered.

If you collect it and take it to a landfill or a dump side if you do not collect then, if it gets into the surface water it may end up finally, to the sea, if you do the recycling you may go for thermal or feedstock recycling part of it if it gets into our body because of the micro plastics getting into our water or air or salt which we talked about earlier in the last week it can get digested into the body as well.

Do nothing in terms of littering also it can breakdown in the ground if it goes anaerobic digestion biogas plant, waste way energy plant you can go for industrial composter or domestic composter. So, these two together is basically composting, waste to energy as a incineration, waste to energy from a biological point of use, so this is where these can be end up.

And since these are biodegradable they will they will get most of it will like a end up converted to CO 2 methane and those other gas gaseous products which can be used which can be used as a energy source most like a methane can be used as a energy source.

But we do not want these gases to be just gone into the environment like that because these gases also have a negative environmental impact, they are green house gases, so they create problem in terms of green house gas impact.

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So, major disposal environments we talked about composting facilities, anaerobic digestion, you can go to the waste water treatment plant, it can go to plastic recyclers, landfill dump sides, marine and fresh environments or general open environment as later which we just talked about. So, this is just a kind of again summary of this of the previous slide.

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So, in terms of emerging application areas it has been used in many; many different areas like this is has been used in coated paper, agricultural mulch, shopping bags, food waste

film, consumer packaging, landfill cover film, bait, bags fishing line, silage wrap, body bags and coffin liners, nappy backing sheet, various sanitary products, cling wrap.

So, as you saw there are several application is there and based on all the examples that we have seen in this particular week many of those were already we have this bio plastics coming into those applications. So, from all these after from all these applications one it's discorded it will come to the disposal stream.

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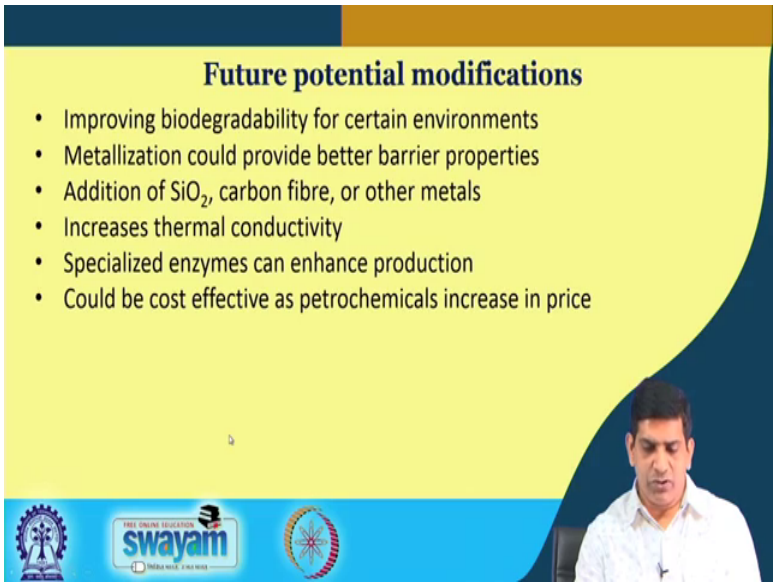

And there are some modifications are also happening in terms of improving biodegradability of for certain environment. Metallization could provide some barrier properties; they are adding some silicon oxide, carbon dioxide. Increase thermal conductivity based on usage, specialized enzyme can enhance production, cost effective as petrochemical increase in price again if it's petrol price goes up it becomes sometimes it becomes cost effective if the petrol price goes down these product does not or not cost effective, so that is always a problem.

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So, there are always some adverse effect as well pollution in water waste due to high BOD because now you have biodegradable plastic. So, if degrade once from the higher molecular organics, it becomes to lower molecular organics to be BOD numbers goes up. And migration of plastic degradation such as residual pigment, this run off leachate from land fill compost facilities that can contaminate ground water surface water.

And from in terms of biodegradable plastic in the marine environment if it's 100 percent biodegradable if most of it is biodegradable it is good, but if it is only partially biodegradable or show slow degradation again that causes trauma and death of marine species as well. So, that is not that area as well I said earlier, since now there are very few products out there now which is 100 percent biodegradable.

Since there are mostly blended products, so this blended products creates like a half degradability half no degradable and they all is still become an issue for marine environment.

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So, and then some other possible increase in incidence of littering because one people think that oh this is biodegradable even if I just throw it away on the side of the road it will get decomposed in few days of few, but many times that is not true. Even if it's biodegradable it needs a composting facility, it needs an anaerobic digestion facility to degrade if you just throw it away it may not it will take very very long time to degrade.

And then you compost which is has this biodegradable plastic, if it's if they have some contamination or they have a it's blended with traditional plastic with certain pigments and other stuff which may create, which may have some heavy metals, which may have certain organics. And then in that case they soil and crop gets exposed to it from those compost because of additives and modifiers like coupling agents, plasticizers, fillers, catalysts, dyes, pigments all those things which is there in the plastic because it is needed for it's use.

But when you make like compost out of that and these chemicals are still there and that gets bio accumulated in the crop in and then it may lead to adverse health impact as well. So, those those are issues associated with this plastic biodegradable plastic waste management.

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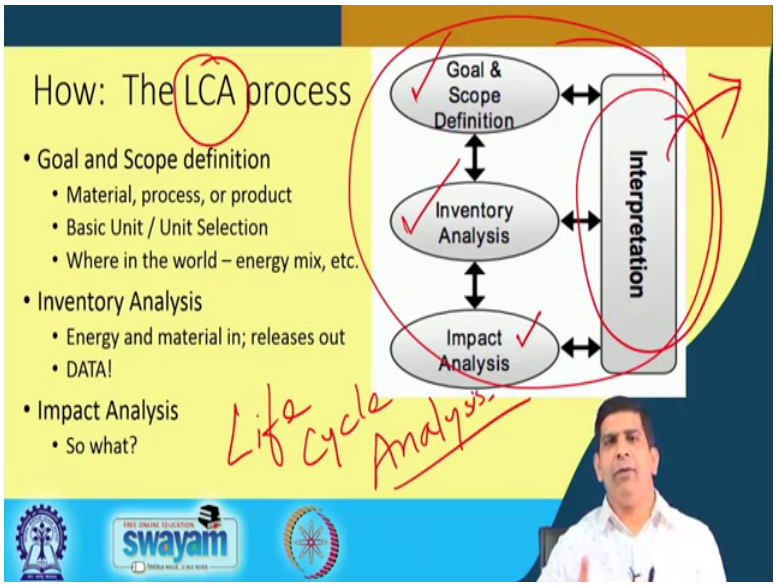

So, being said that we wanted to also discuss a little bit, I wanted to have a little bit of discussion in this particular segment on when we say something is green. How do you really quantify that? So, because just saying something green is like this is greener than that may be, but how much, what is the numbers? because as an engineer or a scientist or in general like if you go to a any legal place as well they always want some evidence.

So, what is the evidence that this is green? Yes your raw materials are seems to be better based on our past experience, we think that your product should be greener, but how much greener? Because anything new when we do we have new processes coming, every process as their own environmental foot print as well. So, this whole process whole concept of quantifying the greening of certain product process is what is known as this LCA Life Cycle Analysis, which is LCA the full form is the Life Cycle Analysis.

Now, what is this life cycle analysis means? You are looking at from cradle to grave, sometime even from cradle to cradle, now we will explain that in a minute. Cradle to grave means any product process is from the very beginning cradle is jula in Hindi; that means, one baby is born you put it in cradle and grave is when somebody dies you put it grave because this concept has come from the Western world where they use the grave a lot, so that is where it's it is coming from. So, it is a cradle to grave from the very beginning to the end.

Now that is the and you look at the whole environmental impact associated with different things that is happening there. So, when you go for this LCA you have to look at the material process, you have to find out what should be your functional, what should be your system boundary? And to do all that there is the ISO methodology and this sketch that is the diagram that you see right above is on this is based on the ISO method, for LCA the for which is you start with goal and scope definition.

You find out what is the goal of doing LCA, what is the scope you do a inventory analysis to find out, what are all the inventory like energy material in releases out? So, collect lots and lots of data and then you do the impact analysis like after doing that, what does it mean? And looking after for impact you can make sense out of this LCA and then you take this for the product improvement, so process improvement and all that.

So, will discuss it little bit, so that even for a bio plastic point of view a whenever we are proposing that will replace this traditional plastic with this bio plastic product, now how much real environmental benefit we are getting. So, that is always very important to justify to quantify. Similar like many many educational campuses many cities in India are banning this single use plastic and they are asking a replacement. So, based on the replacement that is coming into the market that will decide whether we have really made a significant environmental benefit or it is more or less just a incremental benefit with some token is some happening there. So, that is very very important.

Similar say for example, I am talking to you sitting in IIT Kharagpur campus, in our campus we have there is a huge drive happened and right now if you go to the market you do not see the single use plastic within IIT Kharagpur market. You go outside still because Bengal has not banned single use plastic say you see those showing up in the grocery shops or in when you go for vegetables or bread and all those, but within the campus single use plastic has been banned.

And so, and there are some alternatives which is come up some cloth bags have come up some of those cloth bags also have a very thin layer of plastic inside. So, those needs to be studied with those needs to be studied to find out is it really a environmental benefit, which it seems to be and, but what is how much, what is the quantification of that? Because there is lot of resources also went into making this process making this single band effective. So, that also requires lot of energy lot of. So, whether it's really going to

give us the benefit and how much benefit? So, those things can be quantified using this LCA process.

So, will discuss like a little bit in the background of this LCA process the detailed is there are several you tube videos there was a course on lifecycle analysis on this on this NPTEL platform, which is happened 2 years ago it was redone again last year and I hope it will again probably be run in the coming future.

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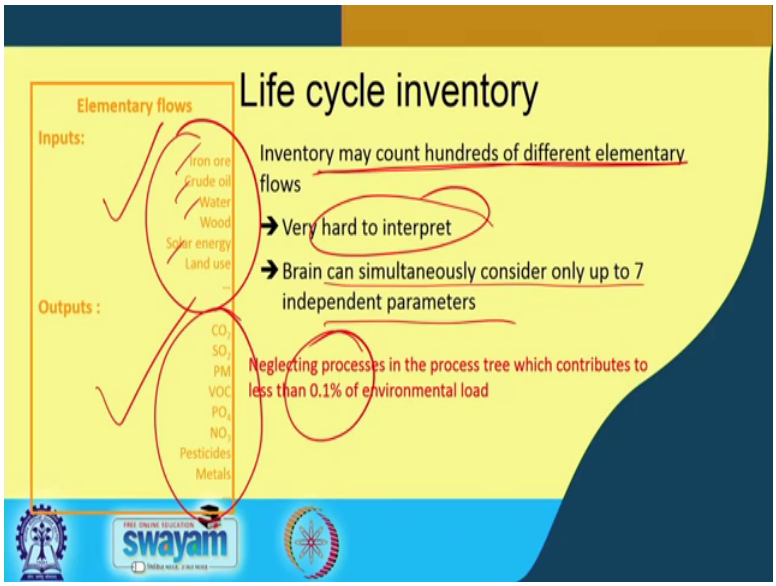

But this is just a small discussion on that for us to put in prospective for what does it mean? So, in terms of lifecycle inventory has you saw for the ISO methodology there is an input, there is an output for every process that you do for which you are making a new bio plastic. So, what are the input goes into making those bio plastic? Here this terminology these is this stuff is just for example, they are not do not think that this is what is needed for bio plastic, this is just a illustration example here and there will be certain emissions coming out.

So, what we do is we try to quantify take all the input, take all the output and then try to quantify what is the impact coming out of it? And many times for very very small product also you can have hundreds and hundreds of different elementary flows in terms of input and output which gets very hard to interpret. Brain cannot consider more than 7independent parameter at a one time, so what we do? We try to neglect something

which is less than 0.1 percent. So, that make our life little bit simpler. So, that is that is that is done to do that.

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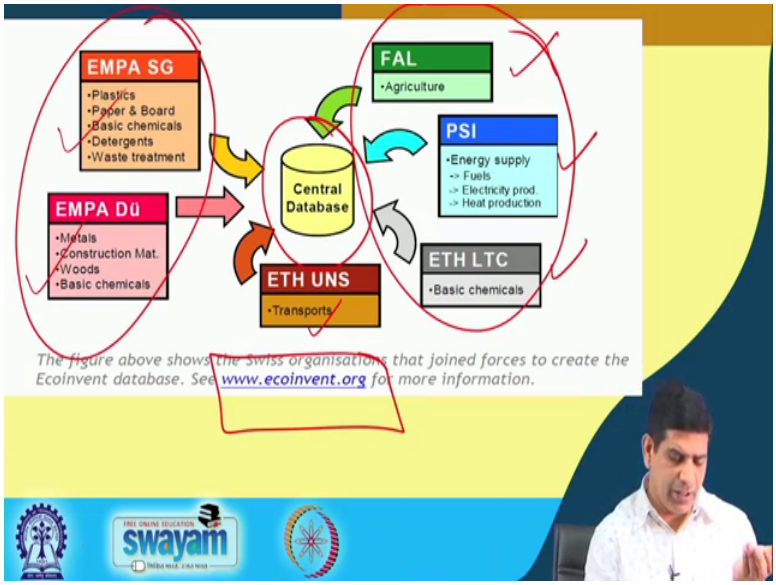

And with all these data that you set with the inventory you have for making something you need lots and lots of data. So, data you essentially is coming from a central database these days and that central database is coming from eco invent dot org and that is where it's data is coming and this is from a different sector agriculture and energy supply, basic chemical transport, metals construction, some plastic paper boat all those things are there.

So, all these data are mostly say for what how much? What is the input and output that you saw in the previous slide say for making 1 k g of like 1 meter cube of concrete or 1 this particular this self or even this marker, how much if I what is the unit process ? What are the different materials here? Plastic some may be a circuit board, sometimes it is there some depends if it works as a slight changer probably it has some sort of relay or something and so that may have some circuit board.

So, all those things we need to look at and all the different parameter all the different components we need to look at and how they came and how much it takes to make those as per the unit process and that unit process data comes from all these different databases which is already has been developed. And these are these databases initially when it developed was mostly European based, but now we are getting Indian based databases

coming in as well. So, that is also becoming we will have more and more data on Indian base, so to do the LCA in India we can use Indian based data, we do not have to rely on European data to do that.

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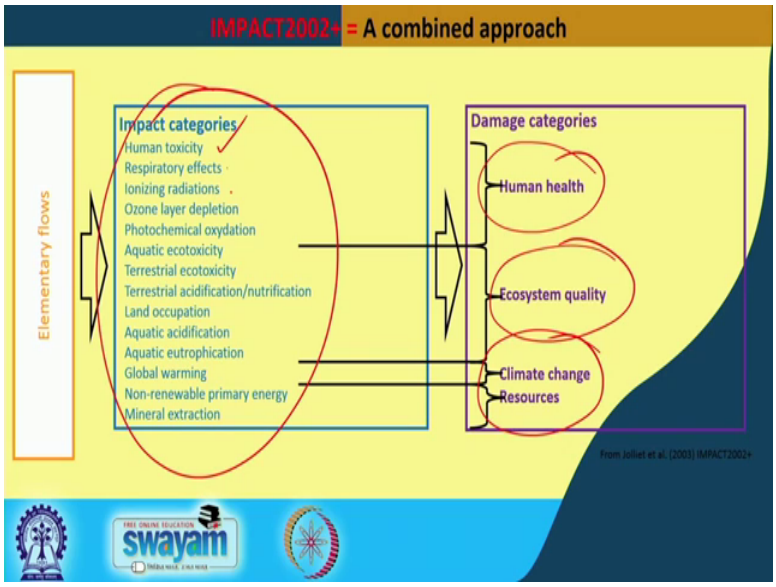

So, once you have this elementary flow which you got all the data you look at based on the emissions, what are the impact in different categories? Again do not worry too much about this categories and all that this is not what we are going to quiz you or ask you questions in the final exam because this is something which is much broader topic just wanted to give you a snap shot, so that you get an idea that whenever we say something greener we have to really quantify that.

If you are really interested to learn more about how this LCA and sustainable engineering and all that, you can look at the YouTube videos on like if you just go on YouTube and say lifecycle analysis with my name you will find all those NPTEL videos showing up there. So, but these are the different impact categories human toxicity respiratory ionizing or ozone layer, photochemical and all that.

And then from the impact categories you can kind of club them into human health, ecosystem impact, climate change impact and resource depletion. So, that is becomes your kind of damage categories in terms of what will happen with all these emissions and those emissions are coming up part of the process of a making those bio plastic for

example, here or it could be also part of the raw material which you are used to make those bio plastic or even the traditional plastic if you want to do a comprehension.

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So, once we have the LCI result we have these what we saw was the midpoint different impact categories, then we have a endpoint which was also you saw that respiratory level, extension species, reduced space. So, this is how we kind of a do that environmental mechanism we try to come up with the what is the potential impact to the environment. And then when it we have we cannot really take these kind of information and go to our policy makers to our leaders and present to them because it gets to technical we can, so what we do we try to come up with some simplification of that.

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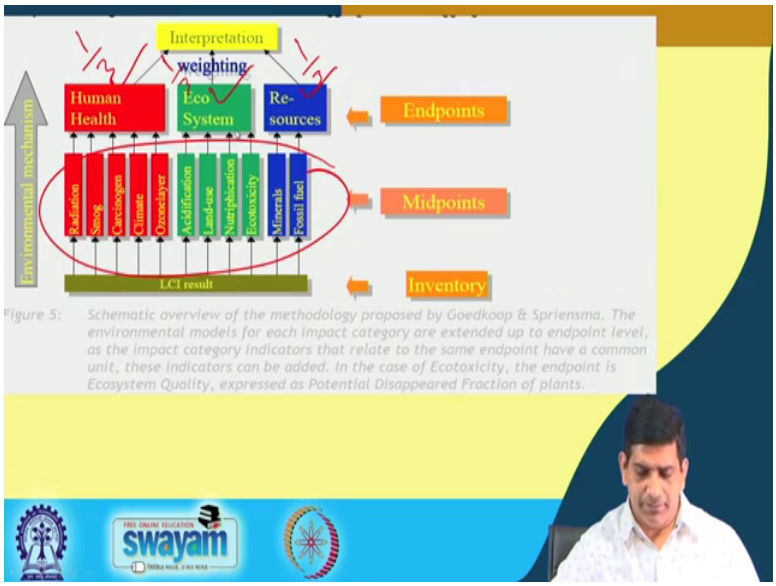

And that simplification require certain interpretation, so certain waiting because if you have these three say impact categories after from this midpoint categories. Now, when we try to look at the impact should we take one third one third, are we going to do one third one third of each one of them or are we going to take put a different like 40 percent may be 30; 30 or 60, 20; 20 that depends on where you are.

Say in your region if this certain ecosystem or resources depletion is of higher into higher kind of concern you will use a different weightage, if it's a equal you can use equal weightage to, but if you think that human health is what is the major concern that will get the most weightage. So, that is as a practitioner that is your call and that is what you come up with in terms of how to how to do those like interpretation.

So, you start with your ICI result come up get all the emissions number, from emissions number you come up with this midpoint like a impact categories, then you take that a midpoint impact to come up with the endpoint impact categories and once you have the endpoint impact categories, you have to use certain weightage factor to put everything together and come up with an interpretation.

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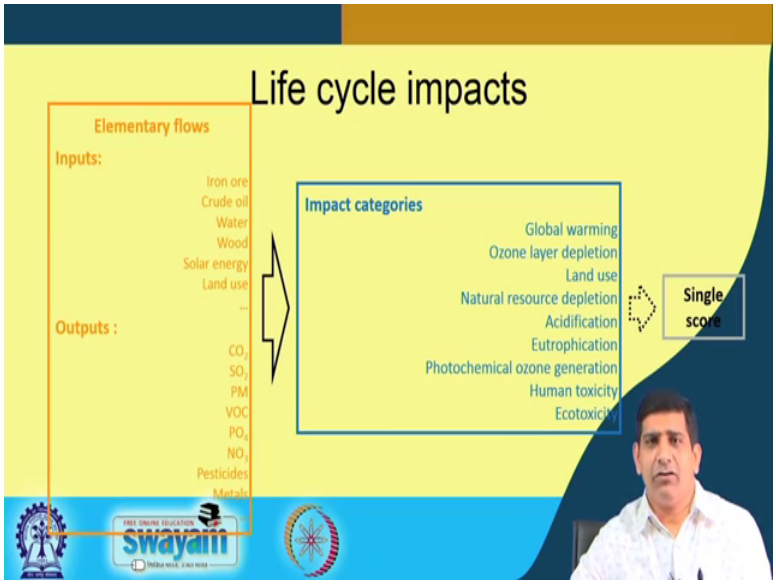

So, that is what is it's done, so it's to come up with some making some sense out of that. So, again from if you look at from the beginning you get all the input and output for the process, you go to the impact categories and from impact categories you get into the damage categories and you finally, you come up with the single score. And this single score is very similar to what you see for water quality index or air quality index or even for Bombay stock exchange index.

So, they have a single score and that is score is used to present a certain information. So, because whenever the sensex is going up we say that market is doing good; market is doing good that does not mean that each and every company for which it helps it impacts on senses they are doing good some companies are doing good, some companies might be doing bad.

Similarly, when sensex goes down same way observation some may have gone bad, some may have; some may have good performed badly, but some may have performed good as well, but this single score helps us to make it easier to understand how the economy is if you based on, if you look at stock exchange as one of the indicator for economic performance that also itself is debatable will not go there we will leave it for our economics professors to do that but it, but that is the other way to look at.

Similarly air quality index every time during this winter or during certain time you heat you get the news that oh air quality in this area is getting bad because air quality number

has gone above 400 above 450, now it is in danger level. Now what is this 450 400? The they are combinations of different parameters which has given that number.

Similarly, water quality index is there, so similar concept is you take all these impact categories and put them in a single score because when you go and talk to a regulator you say that I have a traditional plastic which has that is score of this much, in terms of environmental performance I have this bio plastic which has a number of this much in terms of informal type performance.

So, bio plastic is better and it is better by this fraction or this number, by this time or this percentage. So, that gives a quantification number becomes easy for regulators or leaders and secretaries ministers to understand what we are trying to say. You can be expert in LCA and you come up with a very beautiful graphs, but then it becomes too technically technical and then people cannot really understand.

So, you always in your presentations you always have to see who your audiences and then based on the audience you tell your presentation and that is true for all the presentation that you will take in your life, you should always be aware or who the audience are and you try to tell it based on the audience. So, that is similarly here when you go for a LCA audience to for our ministers or regulators another places we have to make sure, that it has to be scientifically sound, but not too technical it should not people should not get lost on what is happening here.

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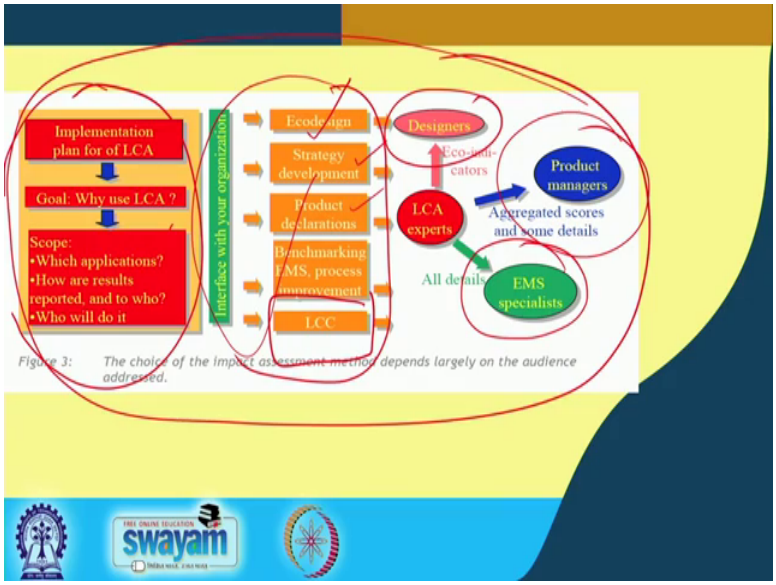

So, so this whole concept of quantifying green it's make it is very very important concept and this is the whole the concept of LCA, some of you may have heard about EIA which is the Environmental Impact Assessment. So, this LCA is kind of a much broader version of EIA; EIA usually we look at localized impact, in LCA we looking at global impact. And were we are trying to capture all the possible impact that is happening from the process and we go from cradle from the very beginning to grave which is to the very end, so, that is the whole concept of lifecycle analysis.

So, in terms of lifecycle analysis say, in terms of the plastic industries we can use this first of all you need to come up with why you need to do LCA? What is the plan? What is the goal, which application what were how you will going to use the results how it will be reported who will do the stuff? And the you interfere a interface with your organization for say plastic manufacturing and once you have you can use it for eco design, making a better design you can come up with a strategy product declaration, that is also important as I said earlier that people are ready to buy greener product if it is really green.

So, you can make so product declaration, but doing at the LCI kind of exercise and you show like a summary graph as a some sort of flair or whatever you do in terms of your marketing, where you see that this is actually is greener because we have done it using a you have done the quantification of this particular product as compared to the traditional product. And you can use it for bench marking; you can use it for life cycle costing, so there are different application.

So, once it's done that LCA experts can work with the designers of products, can work with the product managers, can work with environment management and safety specialists and then look at the whole stuff and come up with a better product design.

And this the whole process helps us to quantify the real environmental benefit and to come up with a better environmental product. So, in this week when we were trying to talk about the greener alternatives, bio based alternatives to traditional plastic, at some point of time we have to do this kind of exercise and to come up with whether it's really green whether and how much green the product is. So, that is kind of important thing to do.

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So, with that we are kind of towards the end of this particular weeks is material. So, what we saw so far is over all plastic bio plastic has generally more expensive than regular plastic, but there are variety of uses and benefits if you look at the whole lifecycle this plastics. So that is why the lifecycle analysis is important because traditional plastic may be cheaper, but they have a very huge environmental load, huge environmental negative impact and, but in this bio plastic may be expensive to start with, but when you look at from a lifecycle perspective, since the from the end of life in terms of managing it is a waste is will be much simpler, it may out way you we may get a better result.

So, so any anything we should not just look at in a silos we should have a look at in a systems prospective. So, were you things the things in a systems way rather than looking just part by parts, so if you have a huge, if you have a unit process. So, each and every individual unit is important, but the whole units together, the whole system is very very important as well that is called systems approach.

Then bio plastic will cut down the municipal solid waste because it mostly biodegradable, so it non non biodegradable waste will be reduced and if we if we take that and manage it properly, we can reduce the green house gas impact it is a environmental friendly. How much friendly? You can do LCA and find out and that is what I would encourage some of you who wants to do your projects and other stuff you should do those kind of projects. A look at all these variety of environment plastic

alternatives that are coming in and try to get their process information and do a quick lifecycle analysis on it.

There are several software's out there which you can download and use it for free for certain days. So you can use it for student projects and that is allowed. Then with developing technologies we it has the technologies developing, the products will improve and the cost will also get competitive in the market. And to and finally, we need to quantify the environmental benefit because just saying something is greener is not good enough, we have to quantify, we have to show how green it is and that can be done using the tool of LCA which we just talked about.

So, over all this particular week our focus was on greener material, better alternative material and look at what are coming up in the market, what are the different types of material coming in the market and we also looked at how to really distinguish between greener material versus non greener material how to avoid doing the green washing. So, that is that is also very very important.

So, with that thank you for this attending all these videos and I hope you are enjoying the course the 7th this is the last video for week 7. So, next will move into week 8 which will which have a nice transition, we just talked about lifecycle analysis and this whole systems perspective, in the next week will talk about a concept which is a brand new concept which is applied in waste management sector in general that is called the circular economy concept where and we will talk about that what is circular economy and all that which will be interesting and we will also see how the plastic industry and the plastic waste fits into this whole circular economy a discussion.

So, again do not forget to take your quiz one time and you should take all week quiz although I know you are being allowed to skip few of them, but we will take I think 6 out of best; best 6 out of 8if I remember correctly. So, that is, but and if you; if you should if you I think you must have registered for the exam because that is that is also important, that is always better to get the certificate because if you are putting all these effort and rest and the exam fee is not that too much either it is just I think 1200 or 13 1300 rupees. So, with that thank you again and I will see you in the next week content, which will be on circular economy and this whole plastics around the circular economy.

Thanks take care.