Life Cycle Assessment
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Lecture – 18
LCA Benefits and Drawbacks

Welcome back. So, we will continue with that exercise that we were looking at the light bulbs.

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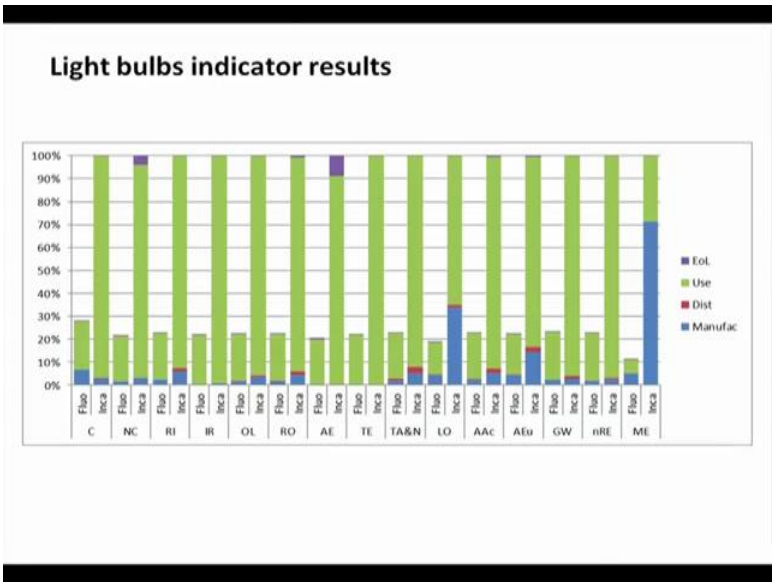

So, earlier we a kind of showed you those how we go from LCI inventory to the midpoint to the endpoint. So, now, let us look at some of the results that we got based on again this results is coming from a particular software and I will introduce you to that software later in the class we use a life cycle analysis software to come up with this particular graph. So, here as you can see those again those abbreviations at the bottom that you see those are our midpoint indicators. So, like a cut those impact on different categories if you remember.

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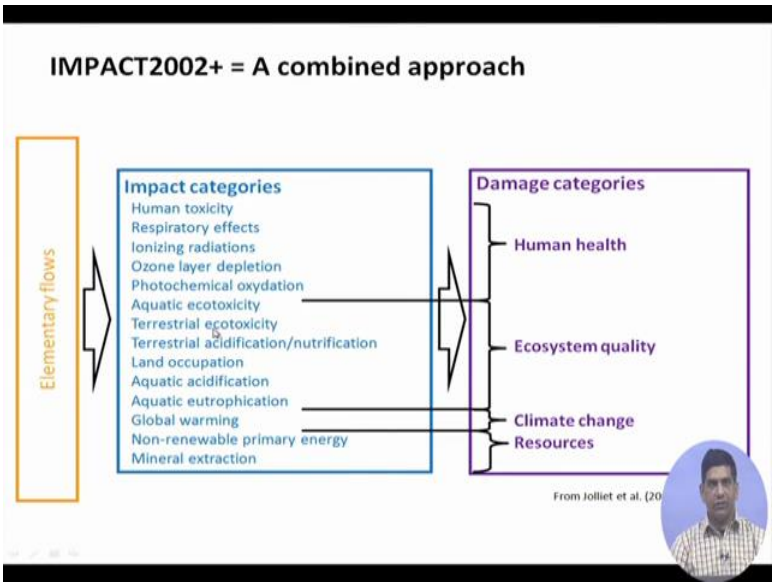

We looked at all these different categories human toxicity respiratory ozone layer photochemical aquatic toxicity terrestrial ecosystem. So, these are the different categories that I am using over these are the categories over here. So, that is how the different categories we have at the bottom those are and then for fluorescence and in conditions both are plotted at the same time the first a bar is for the fluorescent and the second one is for incandescent. So, usually what we do the way we this is a standard way of actually producing these graphs and this is how if we look at any literature or any book on life cycle analysis you will find that most of them actually report along this line.

So, as you can see that second of this column they are all at 100 percent. So, what does that means so, they are all at 100 percent they cannot be all at 100 percent for each and every category. So, what does that mean is this data has been normalized the data has been normalized where what they do is they take the category which is which comes out to be like a highest; higher impact the highest impact among the group we make that particular data as 100 percent and with respect to that 100 percent we present the second data.

So, here for incandescent as you can see for most of I think for all of them we see that the incandescent has been shown at 100 percent; that means, for each and every category incandescent has actually better incandescent is like having a bigger impact. So, it is at 100 percent. So, based on that 100 percent what is the impact of this fluorescent. So, that

is what has been shown in the other column next to it. So, that is one thing the other thing on this one is you can see on the right hand side this different nomenclature we have different colors per different face.

So, we have purple for end of life and we do see some purple here purple like end of life impact and then use face is the blue, sorry, green; green is a use face and the maroon or red whatever you call it is a distribution face and the blue one is the manufacturing face. So, as you can see for in fact all of them other than your metal like depletion for all of them we see that it is that use face has the biggest impact. So, the use face is the use of the energy so; that means, it will have a lot of impact on what kind of energy is being used is it a coal based thermal power plant or it is your hydro nuclear. So, based on different types of a energy sources these will vary in terms of their impact so, but that is the that is the end of life as sorry, sorry that is the used part that is the green one a manufacturing in some cases manufacturing has an impact significant impact as you can see a land use a change of land use or in terms of the metals a we have we see a big impact on manufacturing then distribution has some impact as well.

So, but here most predominant one the predominant the one is our use face. So, energy mix will have a big impact in terms of how this like a light bulbs results will show up.

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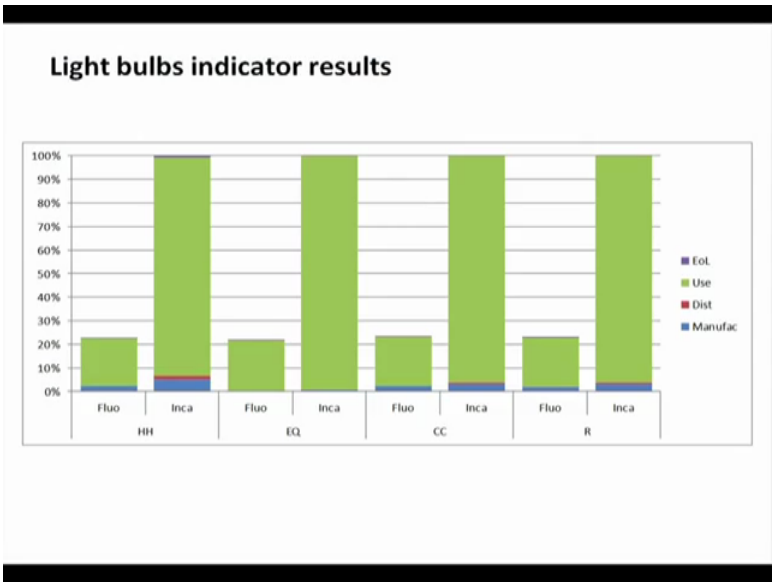

Same graph just now here if you look at the bottom here what we have done we have taken the end point impact. So, it is a like a human health impact ecosystem quality

climate change and resource depletion those 4 big in end point categories. So, here again you can see incandescent bulb actually shows up to be a much higher impact as supposed to fluorescent bulb and it different categories for end of life use this distribution manufacturing has been shown here.

So, for most part it is the use face which is the dominating. So, again is a same thing. So, if this graph and the previous graph is the same information here the previous graph was individual impact categories and in this graph we have taken the impact those are the human health ecosystem quality climate change and resource depletion and these 4 essentially this these are these bars are summation of some of these bars on the previous slide. So, this is summation of some of these bars is showing up over here based on which category comes what. So, I hope I made that clear. So, this again it is a same data point as what we saw in the previous slide.

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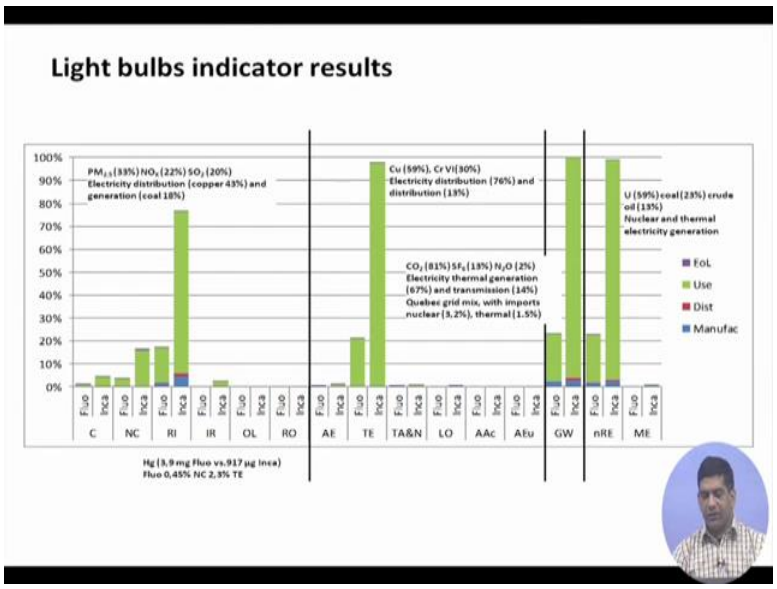

So, here again if you want to kind of go into a little bit detail and here things have not been plotted 200 percent. So, it is the raw data. So, if you look at the previous 2 graphs we had the things at 100 percent for the highest impact, but here they are not. So, we have up kind of raw data. So, this is non-normalize data that we got from different indicated result. So, here again you can see the distribution in terms of the different types of a categories and this is just for kind of comparison purposes that is what and in terms

of how what is the like real actually the actual values that is that shows up in terms of the impact.

So, here this some data has been provided. So, for example, pm 2.533 percent n y x 22 percent socks is twenty percent electricity distribution if the copper is there 43 percent and then the generation coal is eighteen percent. So, those values are there as well in terms of some of the impact here we have the copper chromium 6 electric distribution electric distribution like supply and distribution and then we have curve this is the emissions coming out of that then we have some of these end of life there is some uranium issues. So, radioactive issues are there 2 nuclear and thermal. So, those are a different category that has been shown up over here. So, that is in terms of this indicator results.

So, this is how you will get that you will get your results out from the day from that software. So, software does help you prevent present some of these graphs some of these standard formats of graph they may not be they may not be they may not be able to produce you the way you exactly want in terms of your research or thesis, but they do a decent job in terms of a most of these software now has a liquid graphing software already also part of that and it helps you make the graph of the categories. So, otherwise what you can get which you will see in one of the examples later on in the later on in this particular course you can also get this raw data.

So, you can take the raw data and the plot at the way you want to plot it and then put it in a in a context that you want to put it in a context. So, some many companies do that and they will not use these graphs they will come up with their own graphs taking the raw data and that is as long as they do not try to tweak the data the way they want the their story to be told which is also happening a lot. So, we need to be a careful in terms of a when you look at some of this sustainability results.

So, that that was an example of an LCA that was how the LCA is done I hope it made it clear in terms of the different components that goes there you need to again if you in a like a quick one minute I will do a recap of what you did for this incandescent bulb and CFL bulb first of all you need to find out the golden scope you have to find out what is the system boundary typical LCA is cradle to grave. So, you did the system boundary

you come with your functional unit what is the both for both of them the function is to provide the lighting. So, we have to find how much functional unit.

So, we take seven 100 lumens for ten thousand hours and that was to give ten bulbs of incandescent and one CFL bulb and then for one ten bulbs and one bulb we did that LCI life cycle inventory we look at the impact categories we look at the midpoint impact midpoint impact midpoint impact categories and also the endpoint and then we also looked at in terms of their how what is the which face it has the most impact and then we found that during its use face is where we see the most of the impact.

So, those were and some of the graphs associated with that that was presented. So, that is kind of gives you an idea of how LCA exercises done and later on in the semester later on in this particular course I will I will again give you more like applied examples from some of the projects that we have done or some of this stuff from the books as well, in terms of the benefits and drawbacks of life cycle. So, we if we know now how to do life cycle and we should have a kind of got some idea by this time what are benefits and what is the drawbacks, but let us look at them what are the what is the benefit and what is the drawback.

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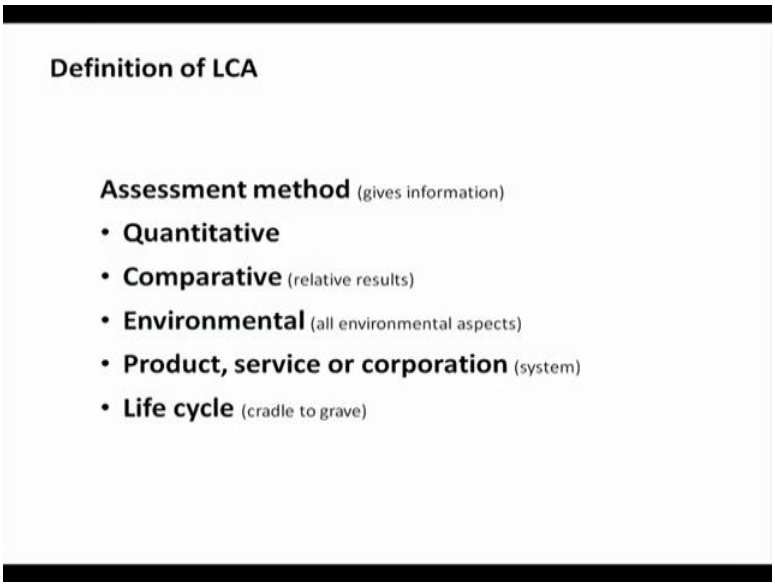

Definition of LCA it is an assessment method. So, we are assessing something life cycle assessment. So, it is an assessment method. So, it gives you in some information. So, it

gives you some information how good is that information depends on how good was all the like a ingredient that went into making this particular assessment is it not.

So, better data you have better will be your results when you do when you come up with the analysis if you have a dataset which is very poor very sketchy does not make sense then there is a very good chance that were you do the LCA exercise again this exercise is LCA exercise may not makes some sense as well. So, we have to be careful on that. So, it is an assessment method it is a assessment method means it gives some information it is quantitative.

So, that is very very important it is a quantitative stuff it is not qualitative it is quantitative; quantitative means that you need to like you need to have numbers that is what I was talking to you earlier you need numbers because that is what we are interested in especially the we engineers we want to have numbers and the numbers are important here because we have to compare we have to compare to different process or to different product or whatever. So, in the because most of the LCA are in kind of comparison those which are stand alone is also used for comparisons later on.

So, that is we need to have a like a quantitative like we can have numbers there then it is has to be comparative (Refer Time: 11:58) relative results comparative to what is kind of expected environmental all environmental if FX aspect is considered product service or corporation we can do it even for system and we have cradle to grave that is the life cycle we are looking at we are doing a cradle to grave LCA.

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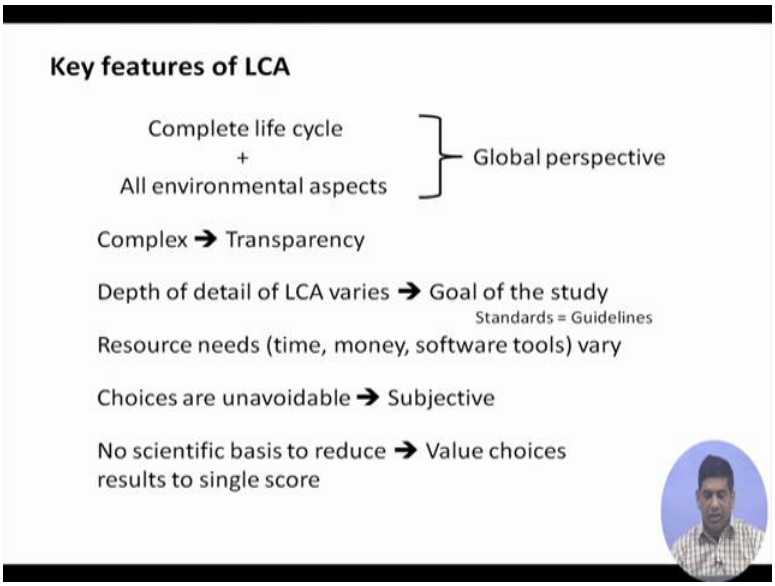

So, key future of key features of LCA it is a complete life cycle. So, we do take care of all environmental aspects. So, at least we try to we try to take care of all environmental aspects in terms of when we do the life cycle analysis.

So, it becomes it becomes kind of a it gives you the output in much of the global perspective. So, you get a most global perspective in terms of the output that you get out of that its complex it s not an easy thing to do it is a complex exercise you need a transparency in the system to do it much better depth of detail of LCA will vary that depends on the goal of the study what is the goal what is the standard the guide line then there are some resource needs in terms of the time money software tools and they also vary sometimes your choices are unavoidable all though you may want to make a every time like a correct choice, but choices are unavoidable sometimes and there are no scientific basis to reduce you waste choices results from results to single score.

So, there is no scientific base is to reduce the choices. So, basically there is a there is a method this recipe 2002 plus or sorry recipe 2009 impact 2002 plus these are the different methods out there which one can use, but there is no hard and fast value choice how to go from this data to a single score. So, that is that is really gets subjective sometimes.

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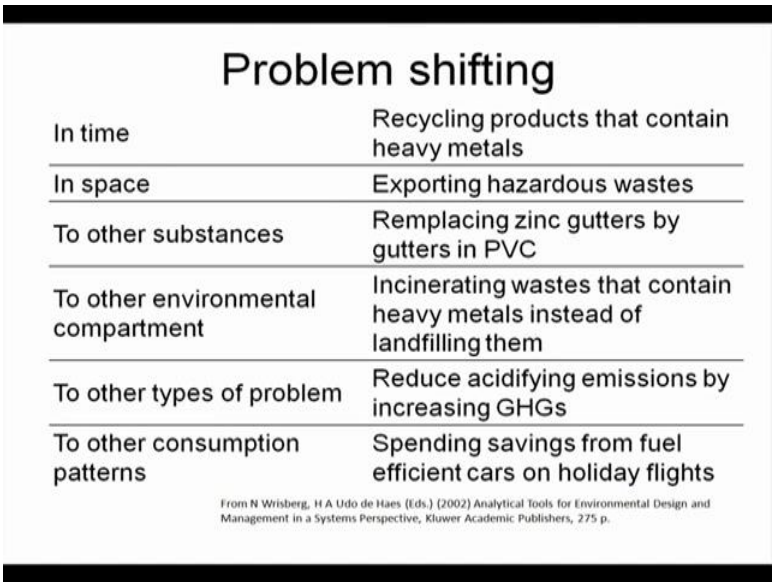

It may have a also there is a you may see some of these LCA reports were things are have been put where problem has been shifted. So, when we say problem shifting you have problem shifting in time where the recycle products for example, if you are saying that I will recycle I will recycle most of our; my waste material coming up.

Now, this recycle product that you have has lot of heavy metals now you can recycle it once you can recycle it twice for its then at some point of time you will have to stop recycling it and then it will it will make no it will a loose like a it will probably take much more energy and effort to recycle then to get a new material. So, you may stop recycling it and then that heavy metal will come into the disposal stream

So, there are there will be cases of problems shifting were things are shifted like we say recycle and then a things get shifted all though we may not count its environmental impact, but there is a environmental impact which we may happen say ten years down the line not right now and then there are in terms of problems shifting in terms of the space were we can exporting the hazardous waste for like if you are doing a life cycle analysis on hazardous waste related stuff and then you see that in Australia or us or may be Canada wherever a from Canada you do not see that much of u s being exported, but there are several countries from where it does.

So, in terms of if it gets like you are you just do not want if you do not want this hazardous waste so, but if its hazardous waste is exported it does not get calculated

within the system boundary of the present problem and then if you if you do not do that you may you may see that certain things seems to be very good, but at the, but actually they are not because we have just shifted the problem in his space, to like for other, other, other area.

So, to like a problem is say before other substances like replacing zinc gutters by gutters in replacing zinc gutters by PVC gutters. So, that is another would be PVC polyvinyl chloride we do not know it may have some kind of health impact as well we see that things are problematic in terms of those plastics. So, those again we do not write now we do not consider the impact, but we may have any impact on associated with that to the other environment compartments say- if you incinerate waste that contains heavy metals instead of land filling them although it sounds really good that you are incinerating it, but incineration it is you may you are concentrating the ash the with heavy metals because they will be present there as most of the heavy metals they are not volatile and if they are volatile they will become part of air pollution control system there are supposed they should be captured in the air pollution control system and that should prevent them from getting into the atmosphere.

So, if it is captured over there it will come out as a part of the flash. So, things may just move from one involve mental compartment to the other environmental compartment that is why this LCA which looks at the whole big picture and with everything together is it is kind of a good; good tool to find out if we are making some mistake unknowingly today which will haunt as a five year down ten year down the line. So, and it becomes other type of problem, so example reducing acidic acidifying admissions by increasing GHGs.

So, you can reduce the emissions coming out and then there could be some other consumption like spending saving for fuel efficient cars. So, you buy a fuel efficient car and then you feel very good about it, but then you go on a holiday flight. So and kind of a used up all those good fuel that you saved now you have to use it on the plane, but there is an argument always an argument that even if you do not go on plane somebody will and then plane will go on full. So, it may not change much, but these are some of the examples of where we talk about this problems; softing problem shifting exercise.

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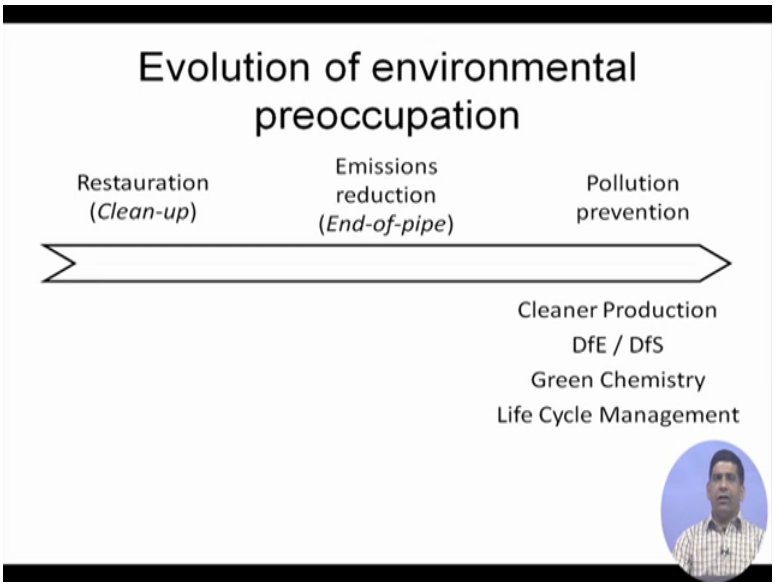

So, how this again why and how is again very very important. So, how this topic of life cycle assessment is started of course, the definition of sustainability started from the European union we already gave you the definition I think 2 times, but how this concept of life cycle is started in terms of civil engineers of the environmental engineers or say chemical engineers and other professional who are interested in that. So, here a they can usually what we have is what is known as the end of pipe approach.

So, we are not really we do not think much in terms of how the products are going to be made because that is not my job as a environmental engineer or as a waste management waste management engineer. So, that what we are focusing on is once the once the thing gets contaminated we will go and clean it up, but that is not a the focus right now the focus right now has been let us design things let design things in a way. So, that it is easy to recycle let us design things in a way. So, that it is a like a design for environment design for sustainability where it seems to be sustainable and. So, that is that is how the role of our engineers are also changing and we have becoming more and more involved in terms of this pollution prevention and all that.

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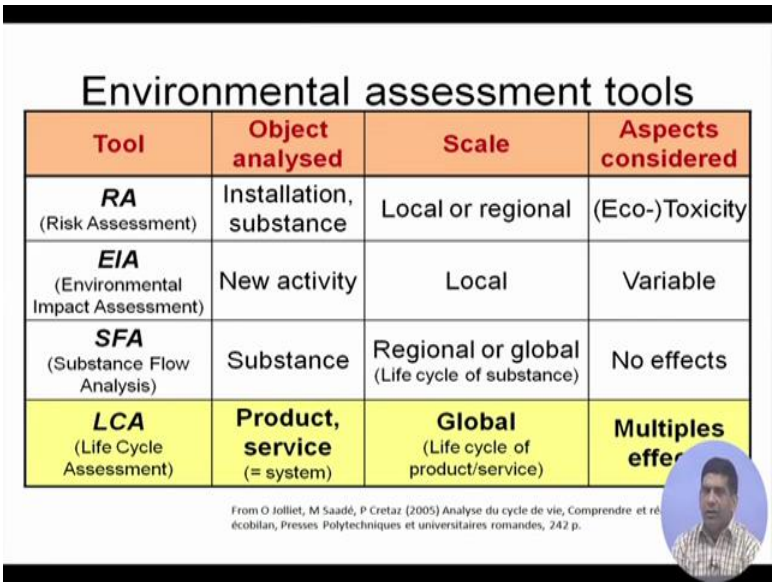

So, this is how this environmental occupation has been growing in terms of evaluation what are the different assessment tools LCA is one of them, but there are other tools out there and some of them we have been using and some of them you must have been using as well as part of your some course especially if you are a empty students. So, we had risk assessment and then which is a installation hence like a risk assessment is a one course which his like a can be potentially used with this particular program, but (Refer Time: 20:14) that is another risk assessment is a very a specific course its object analysis the installation or substances (Refer Time: 20:25) local regional and also I would say even international sometimes aspects is a ecotoxicity. So, that is the risk assessment.

Then we have this EIA environmental impact assessment EIA as you know as per the government of India directive for any new activity other than some which has been exempted for any new activities EIA has to be done and then EIA is done to find out what is the base line condition and first you find out the baseline condition and then you try to model that if you put a new plant in there what will be the impacts coming out of that.

So, that is your EIA which is a which is a local scale its aspect is variable we look at the different aspects in EIA then we have substance flow analysis which is again look at the substance it could be reasonal or global it is a it may not be just a regional stuff it could be a global scale too and a aspect again we just are consider we are just looking at

substance flow analysis. So, there is no effect as such then there is a LCA which we talked about which are talking about product and services and then scale is global and UA like there is are there we look at a multiple effects.

So, these are some of the different environmental assessment tools that are used in terms of making some decision making.

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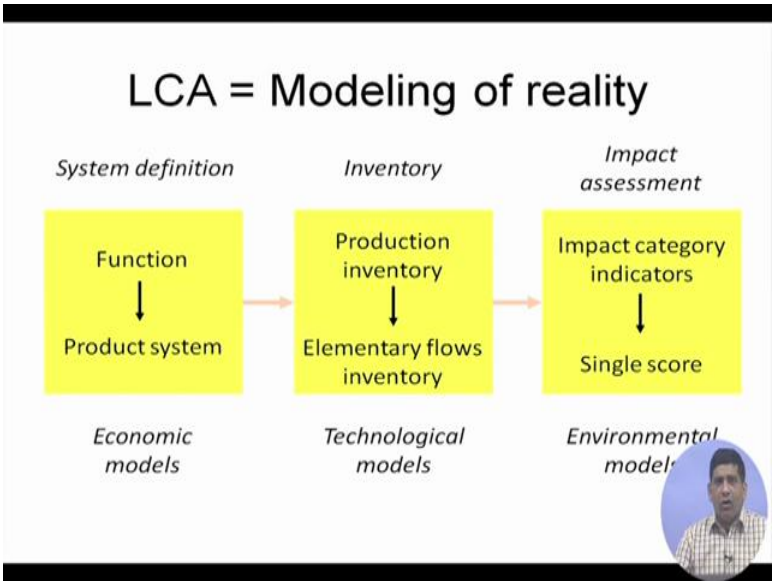

So, LCA is a modeling of reality here you have a system definition which you have your function and the product system that is your economic model and then you have your product inventory and the elementary flow inventory that is the technological model that is the inventory side and then impact assessment is due to impact category indicators in the single score that is the environmental model and that is the impact assessment part of it.

So, this is we are trying to model. So, whenever you try to model something there is always see when you when you say we are modeling we are already making some assumption is it not, we are because the complexity of the natural environment cannot be replicated in any model. So, you always take some sort of like some sort of you already have to make some sort of assumptions any way. So, that is, but at least you try to model as close to reality as possible. So, that is that is another thing you should you should be keep in mind. So, function and product system that is your economic model product

inventory elementary flow inventory that is your secondary model impact category indicators lead into single score that is the your environmental model.

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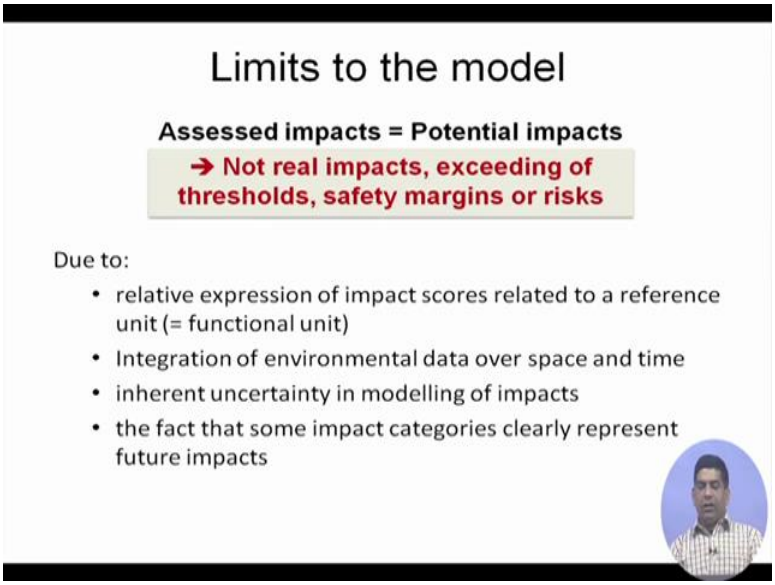

So, that is impact assessment model. So, it is an; since it is an model of course, there would be limits to the model there is an assessed impact and potential impact assessed impacts is they are not real impact they are exceeding thresholds safety margins or risk. So, they are due to relative like a impact like when we have a relative expression of impact score. So, there is an assessed impact and based on your like you look at a functional unit and then you do a relative expression of impact.

So, that is that is your like a in terms of a limit to the model then how to integrate data of environmental data over a space and time that is again another challenges like a you can integrate the data over a space and time that is really a challenging stuff to do these days with this big data and lot of software and another stuff associated with that things may be things may get little better and then there are inherent uncertainty modeling of impacts when we are modeling the impact there is a uncertainty if you look at the IPCC document where this things first came in united nations they also have a when they try to suggesting some of these impact categories and all that they also is there is some uncertainty there as well say.

So, it is in when we are trying to model something especially something which is very new thing there will be iterations of model getting a. In fact, better as we make we make

progress. So, there will be there is a inherent uncertainty in modeling of impacts. So, we all talk about that the fact that some impact categories clearly represent future impacts. So, we have some like a impact categories where we are actually worried more about a future other than a right now.

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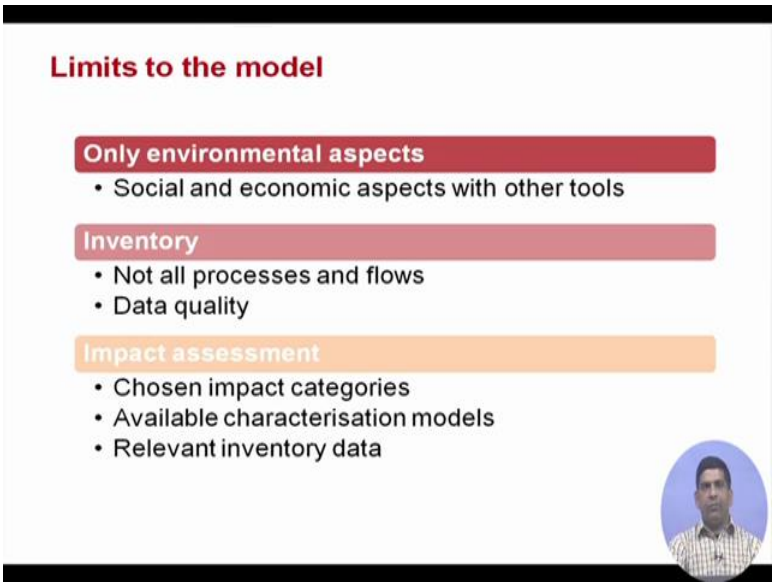

So, all the environmental aspect that is another limit to the model we are only focus on environmental aspect social and economic aspect is not considered in this particular one economic aspect typical is done what is with what is known as LCA life cycle costing analysis a social aspect we do it with social LCA which is again also is a getting popular now we are just recently social LCA guide line where formulated by C tech and UNEP which is C tech is the society of environmental toxic ecology and chemistry and it is a big organization and they were kind of instrumental behind getting this life cycle analysis things of the ground at the global scale.

So, we are looking at only environmental aspect that no social no economic which are again also important inventory we are not looking at all processes and flows because of we cannot really take care of all the processes and flow we do we do ignore certain things the one which has less than find one point one percent of impact. So, we ignore them and, but few of those can built up and have a like decently impact a level. So, not all process and flows are considered and many times data quality is a problem to get data

for each of these unit processes and flows then for impact assessment you its depends on your chosen impact categories.

So, there is some a subjectivity that does get into like if you if you chose certain type of impact categories you may get a certain kind of I would say answer and if you choose other set of impact categories your answers may be different. So, that is again. So, you have to choose choosing of impact categories have an impact on what kind of what kind of like end point you will see.

So, available characterization model how to like there is a we have we have to kind of look at some of these characterization models in more detail and then having to have relevant elementary data that is again it is a big issue in terms of having a data you can data that is always a that is the number one thing in terms of good LCA recently there was a meeting and in India there has been a in India the LCA is picking up now it has been there are people involved in LCA for quite some time every year there is a conference done on which is called Indian life cycle management conference and its organized by FICCI. So, this year also it was organized by FICCI in October and I was there we had some presentations there as well again they are one session was just focused on how to get good data for doing better LCA.

So, you can think about and once you do some research projects or some even some consulting projects or industry projects related to this LCA exercise you will find out that data quality is the major concern. So, those of you were doing lab experiments or pilot plant experiments you should think about doing when you design when you do your experimental design for your experiments make sure that you collect the data in a way so that we can use those data for LCA exercise. So, that is and then how to in terms of a new design your experiment get feedback if you are not sure get feedback from somebody who knows LCA stuff and by the end of this course you should know enough to make those decision by yourself to.

So, with that let us wrap up this model and then we will see the other model where we start looking at some of the like a benefits again we will continue this benefits and drawbacks of this life cycle analysis model.

Thank you and I will see you again in the next module.