Sustainability Through Green Manufacturing System: An Applied Approach

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Lecture – 10
Life Cycle Assessment Procedure

Good morning, welcome back to a module 3 of this course, in this module we are discussing life cycle assessment and we have covered 2 lecturers previously in this regard. So, in this case in this specific lecture I will cover the procedure for life cycle assessment which we have which we have discussed in the previous lecture I will come up with some examples and some new term should be there right. So, I am Doctor Amandeep Singh.

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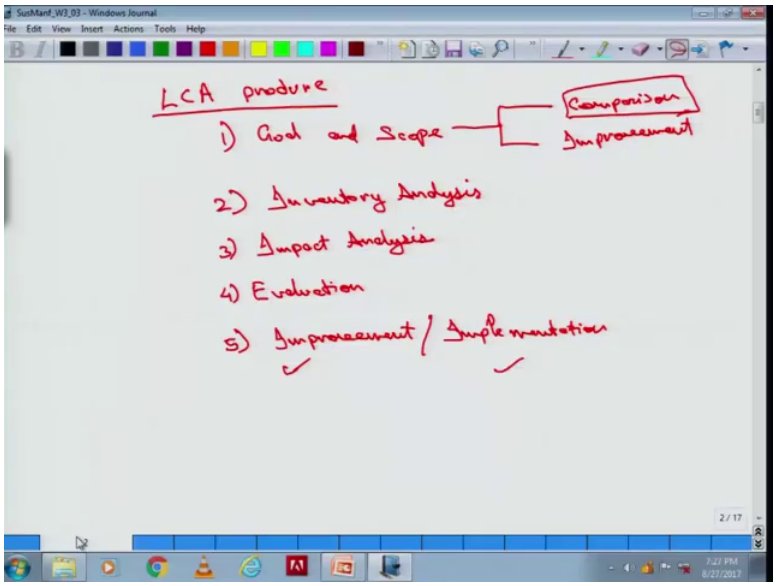

Let us quickly recall the procedure for life cycle assessment, now LCA procedure included goal and scope definition, then we had inventory analysis and we have here is impact analysis right during various stages of manufacturing.

Then evaluation and improvement or implementation just rewinding it again this improvement and implementation comes into play when we have the scope is improvement the scope might be comparison or maybe improvement. So, even during

comparison as well, we can up we can if we compare few products for example, if we compare one kind of bike with other kind of motorbike, we can select the bike that is it coefficient that also that we have it life settle assessment can also be use in that case as well.

So, in that case this implementation would be selecting that bike right.

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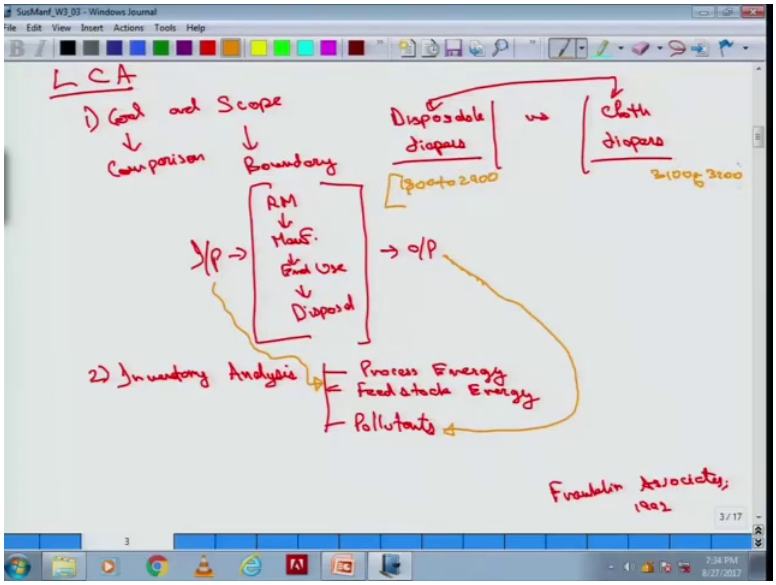

So, to understand this procedure in more detail I will try to explain this with few examples, first of all I will take an example of comparison between disposable diapers dispose disposable versus cloth diapers right. So, this example was developed by Franklin associates at 1992 2 right. So, we there are 2 kinds of diapers available in the market disposable diaper or we generally use cloth right.

So, while comparing these 2 kind of products right of similar segment, the goal and scope here would be goal and scope goal here is comparison. Now this is first step in are LCA right goal is comparison and scope is are boundary of like what extent we need to career assessment here. So, here we will start from the raw material, then manufacturing, then end use and disposal and all the inputs and outputs would be considered here.

Right. So, next step is inventory analysis. So, typically when this disposable diapers and cloth diapers are compare then multiple factors we are contribute to determing the prefer diaper, the franklin associates here used for the analysis part they used the process

energy, process energy here is the fuels that I used to manufactured diaper then feedstock energy feedstock is the actual material that is present in a diaper right and then is the pollutants that are produced.

Right. So, this is actually the input here besides the inventory you also have inputs and outputs are here right. So, regarding some information about diapers the disposable diaper is are generally the Franklin associate they said that you 5 times a day and a child can in a year use anywhere between 31 into 3700 cloths diapers 31 into to 3700 pieces and the same number in case of disposable diapers is come to be eightee1800 to 2900 right.

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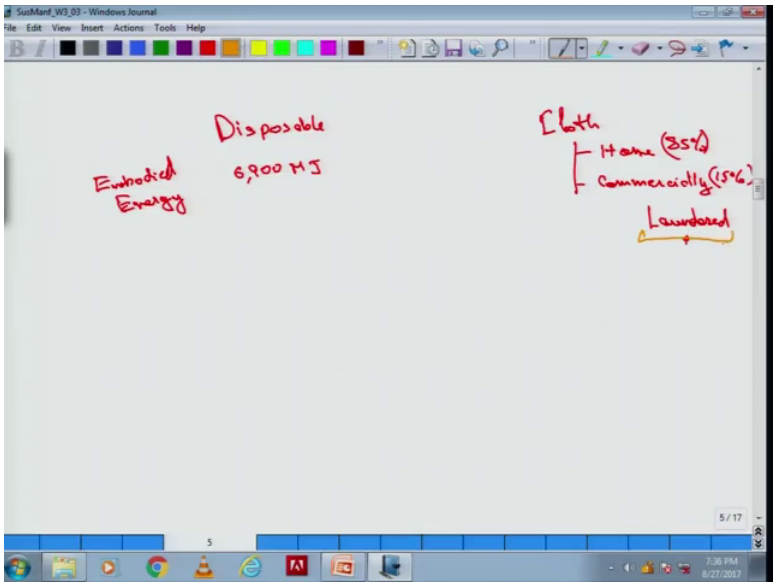

So, this is the total usage here. So, when other categories are compared here disposable versus cloth diaper. So, the cloth diaper 2 kinds of diapers work compared one is that is home laundered, another is commercially laundered. Now they found that 85 percent of diapers are washed at home and remaining 50 percent 15 percent are washed commercially and see the see look at the way the information that is being procured here like what is in home what is commercially like laundering then how much energies induced why laundering that we will also welcome up the numbers here.

Then net use of energy that is important and disposable diapers comes about to be embodied energy right that was 6900 mega joules right out of which about 86 point percent of energy was from feeds stock only and remaining of the by 50 percent was for

packaging and process energy and this feeds stock energy why it is 5o, high 86 percent because the petroleum based products were primarily used and in cloths diaper the energy that is important in cloth diaper is actually form laundering process main this laundering process was contributing this contributes right.

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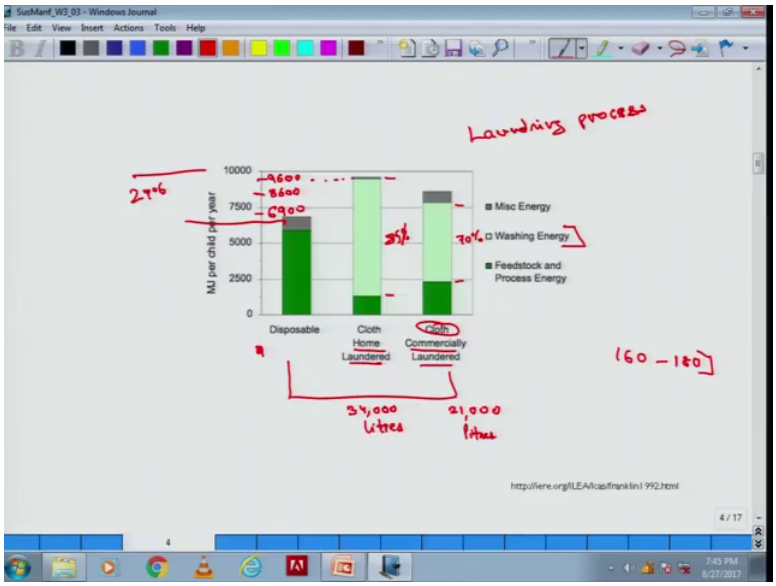

So, regarding the embodied energies of the diapers that are being compared here the disposable diapers used 6900 mega joules of energy here, this is 6900 right and the cloths diapers used the total of 9600 mega joules and these are cloth diapers at are home laundered and cloth diapers that are commercially laundered used 8600 mega joules. So, we can see the embodied in the energies that is the energy that is induced during manufacturing from the very like of planning of this stock 2 final manufacturing and reaching and the end user.

This one was higher for cloth the diaper that is home laundered. Actually this is the main laundering process here that is culprit right; in this case cloth laundered we can say this washing energy is very high, in this case about 85 percent of energy is washing and in this case I will also about 70 percent of energies here in washing now what is this energy? This is actually the washing the water disposal the energy this is induced in there as well now if we compare this. So, we can see. So, we can see the disposable diaper uses about 29 percent less energy, in comparison to clothe home laundered diapers and the diaper is actually used 160 to one180 times before being turn out this cloth diapered.

Like cloth diapers they have being used in this way. So, another difference between these 2 kinds of dog diaper was the amount of water that is used the clothes diaper that is home laundered used about 34000 liters of water and the commercially laundered diaper used twenty one thousand liters of diaper of water sorry. So, not only the commercially laundered diaper used one third less water through laundering they also use thirty percent less energy.

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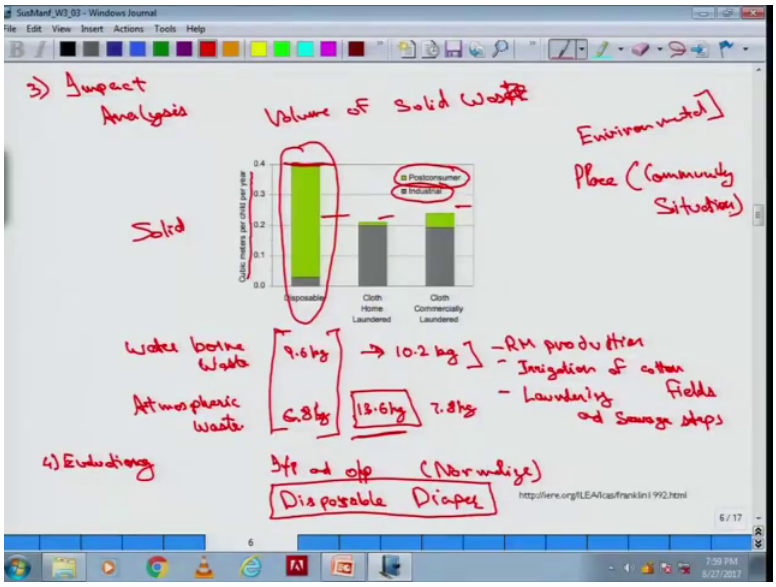

So, also we have here is volume of solid waste right now industrial waste here waste here includes the waste that is used to produce diaper such as raw material production process manufacturing trimmings as home electricity and post con consumer waste as well that refers to substances that are thrown out like diaper itself or the soil diapers child waste and packaging the win the packets in which diapers come.

So, in this case it was found that is solid waste is high for disposable diaper right and actually the disposable diaper the waste how is evaluated, how it is considered here the waste is bio volume not biomass. Actually the waste fills in the landfills it is the volume that is considered whatever the mass is for example, we throw steel and or a cotton product right, it does it is not the bio weighted it is bio volume that how much space out it consume in in my landfill.

So, that was considered here. So, cubic matrix per child per year this much volume for disposable diapers and for cloth and home laundered diposite was less right; now this is

industrial weight and this is post consumer weight. So, it can be seen here that the solid waste that is produced by the disposable diapers is about 2 times in comparison to the cloths diapers here, also there are water bone waste right these was only solid waste, now also we have atmospheric waste what actually we are doing here? We are typically doing the impact analysis that is the third step and also we are evaluating that will do here. So, regarding the water bone water bone waste here cloth diaper produced typically 10.2 k g of waste and this disposable diapers produced about 9.6 k g.

This waste actually come from the raw material production right and irrigation of cotton fields from which cloth and the feed stock is produced and laundering and sewage steps sewage treatment right. So, in this case we can see the cloth diaper has higher waste then regarding atmospheric waste the greatest quantity was observed by the home laundered systems right. Now what is the amount here what is the value? They produced 13.6 kg per child per year and commercially laundered diapers produced 7.8 now disposable diapers produced 6.8 k g.

So, why is this value so high? So, home laundered diapers are essentially produced more atmospheric waste because of the washing of diapers at home, energy is intense is energy intensive and laundering process indirectly increases the at more is pheric atmospheric emissions that are from electricity generation this increases. So, significant that the home laundered diapers produced more atmospheric waste through laundering then the exhaust that is produced from transporting vehicles commercial vehicles for the disposable diapers. So, we can see here that in this case this in case of waste the disposable diapers are winning here.

So, suddenly when we compare finally, when we evaluate the input and output and we normalize that into single scale, it was recommended that disposable diaper is the winner right. So, when determining the best diaper trough and energy analysis are disposable diaper is preferred; however, they produced substantially more solid waste. So, this is life cycle assessment there is only not only one criteria solid waste is high or maybe in some cases energy is high that is not the only criteria all the factors need to be considered they need to be summed up or they need to become about to a single scale through normalization then the final decision is to be made and in case of diapers I can also say that it all depends upon the environmental conditions.

This is not our Mother Nature environment, this is the product environment environmental condition means the types of customer or maybe affordability of the customer or maybe the demographic area for example, in drought areas where there are where is it is drought where water is not much available. So, only disposable diaper is the option, and the basis where there is a lot of water available cloth diaper can be one of the option it all depends upon the place at which we have we need to be we are like going to by this diapers and if air pollution problems are there then resort to disposable diapers.

Best diaper ultimately depends upon the community situation as well right. So, this is an example of life cycle assessment.

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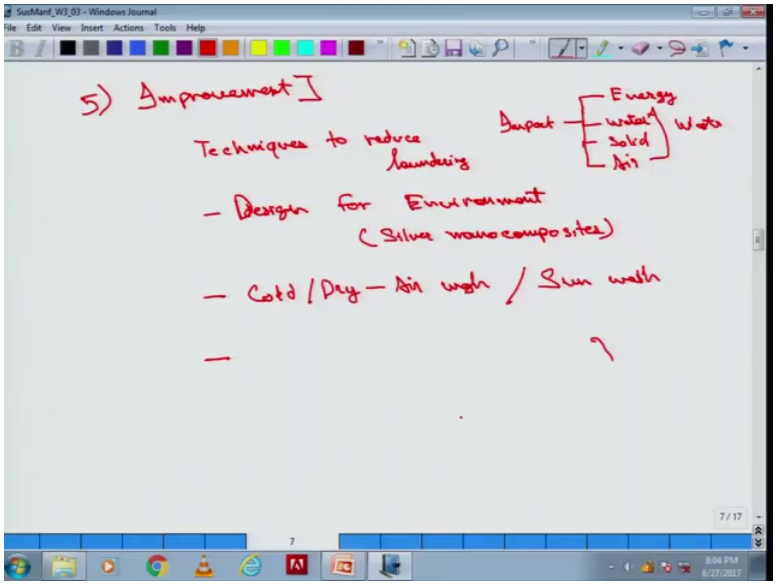

So, next I will come to the fifth step here that is improvement. So, I extended by scope here by scope earlier was just comparison. So, what was our take from this diaper controversy here? So, impact that is be considered is the energy right then water, solid and air waste then when conclusion of LCA study are easily reversed it is a closed call and we can we may considered the alternate is as about equivalent patting the one involvement most LCA is overed do lead a definite conclusions.

Now, regarding the improvement here we need some techniques to reduce laundering here, if I select cloth diaper let because cloth diaper is not selected here. So, I will work on that disposable diaper is selected. So, I will in this case I chose to work on cloth

diaper. So, techniques to reduce laundering here may be design the fabric in a way that no laundering is required design for environment here. How could this be done may be using silver nano composites, then what else we can do we can cold wash or dry wash we can is dry wash means air wash right or may be sun wash right.

Then if we need to choose washing machine, there washing machine maybe front loaded washing machine can be chosen because that consumes less energy. So, this is one of the example here.

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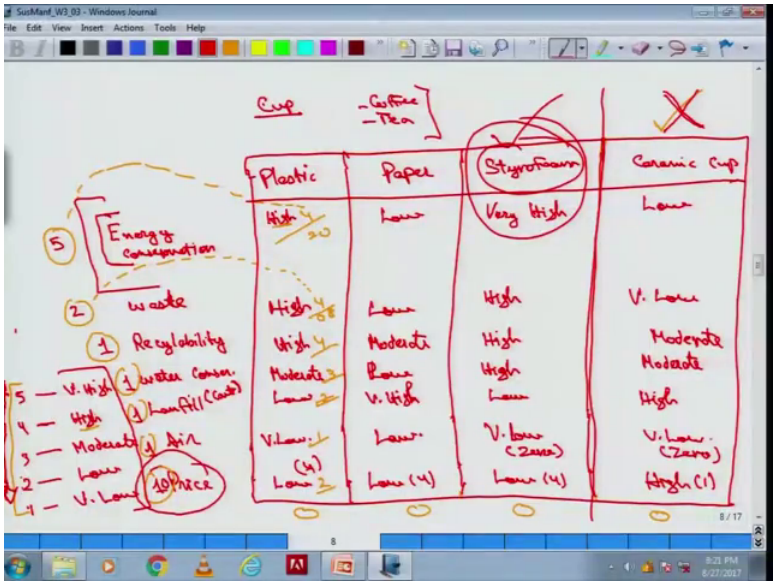

So, I come up with another example here that is the kind of cup he choose for coffee or tea right. So, I have brought some kinds of cups here. So, I have current me various kinds of products here, this is a plastic cup right this is a disposable cup and it is made of a very thin plastic here and second is this is a paper cup this is made of a paper and a led is there.

So, that is does not bent. So, easily and this is a Styrofoam cup that these 3 product were all disposable and this is a regular ceramic up that we can wash and deduce. So, I will not do the factual analysis here I not put up all the figures just qualitative analysis I will take into account here. So, when I say I have plastic and paper and Styrofoam and a ceramic cup right, now this 4 categories as I will told you for evaluation we will make a table we make a table here and compare this. So, I can choose certain parameters here

energy conservation, energy conservation remains the a boded energy that is and used in manufacturing of this product right.

So, embodied energy is essentially the energy that is consumed by all the process is associated I am repeating all the process is associated with the production of a product from the very mining and processing of natural resources to manufacturing to transport and product delivery. It does not include the operational disposable energy the operational disposable energy comes into manufacturing only. So, when we think about the life cycle impact the embodied energies upstream and front end component here.

So, energy conservation if I say now plastic cup needs relatively little less energy to make. So, I would say it energy conservation is high and Styrofoam is also compatible it is also here actually energy conservation is very little energies I will put it very high. So, I am using the qualitative scale here very high like 5 stages are here high moderate low and very low so, for paper requires high energy to run mills. So, energy conservation is low here and for producing china glass needs high energy to run kills and washing for re user etcetera.

So, all here energy conservation is low for this energy conservation includes the embodied energy and energy in manufacturing as well in this case right. So, next is waste conservation right. So, in case of this foam plastic foam Styrofoam here it is high, right then in case of china glass because not disposable I will say very low and in case of paper it is again low and for this plastic it is again high because these are not via degradable products. If I say biodegradable everything is actually decade the thing is that plastics do not decay in days or months or weeks right one years it takes millions of years for this to decade.

So, anything that is decade within a specified time, that is within a few months that can be satisfied decodable right. So, in this case this waste is high in plastics and in Styrofoam and if I say recyclability recycle, what do you think recyclability of plastic is high and for the ceramic it is maybe moderate, for the this paper cup the recyclability is again moderate and for Styrofoam it is again high right. So, next is water conservation; water conservation it is excellent in case of is plastic or sorry if you have Styrofoam here.

So, very little conserve water is required for any manufacturing this. So, it is high and for paper it is poor because paper manufacturing is water intensive process it is low here and for ceramics it is again no water is required very low, and for plastic it is moderate right. So, similarly I can choose other like parameters here like landfill and air pollutants and impact on ozone layer or like relatively may be may be price can be one of the factor here right.

These all price are equivalent I would say this is low low low and high this 3 process are equal, but this is a high price right. So, regarding air pollution there is no air pollution here, very low air pollution regarding ceramic cups and also no air pollution in this Styrofoam it is to be noted I am talking about air pollution only not landfill air pollution is very low or maybe none like zero pollution. In this cases and in plastics also if we landfill that it is very low, but papers also they said some amount of some amount of skin of the paper, but I can say, but that is still low right.

So, landfill that it is like. So, when I talk about landfill, if I say landfill contribution here contribution to landfill that is the what is the positive impact. So, the impact is low in case of plastic and low in case of Styrofoam, and this actually turns into the land will I make sand itself ceramic cup and this actually contribute the paper actually contribute to methane gas. So, it is very high. So, next is I have made the comparison chart here, now I could give weights here right.

For example I have be 5 units to this 2 units to this one unit and maybe one unit one unit one unit and one unit and all these categories are also given some numbers here it is from fi5 4 3 2 1. So, how could I decided finally, which product I need to choose here. So, I have given certain weights here and certain values here as well. So, therefore, high the weight is 4 this is 4 this is 4 this is 3 this is the low is 2 1 2.

The score 4 this point is 4 into this 4 in to 5 that is 20 the score 4 this point is 4 into 2 that is 8 right. Similarly I can calculate all this scores here right and come up with my final ranking here based on these scores. So, when I do this I will find it all depends on these values which I am given it all depends I will find that ceramic cup is the winner here. So, ceramic cup it can be reused we can re watch that again and keep using that only thing is that the water conservation here is little high when we keep on using it.

So, I will change this water conservations from low to very low to low, this was very low I have change to low or maybe I will put it more direct here. So, that now is taken into our mind that water is consumed in washing here as well. So, I will keep it moderate right. So, it all depends the values which we are putting here is it in this water 1 2 3 4 5 or maybe in reverse order as well right. So, ceramic cup is one that is chosen here. So, one thing is there if we consider price as the criteria that is if I need to keep this as the criteria I can even give this as value 10 may be right.

So, this value is 10 here. So, when price is criteria this ceramic cup for ceramic cup the price is too high. So, in this case actually the weight would be one it this is low the weight would be 4 here, it may be 4 here it may be 4 here that is this weight categories reversed. So, be careful while assigning these things. So, in that case this ceramic cup is crossed in that case this Styrofoam cup is the winner right. So, this is Styrofoam cup that is winner. So, generally what is the perception here the Styrofoam it looks like the landfill cost is high it does not like degrade by degrade so, easily.

So, this should not be purchased in comparison to this paper cup, but when I do I will see a here I found that this is the winner because of certain other factors that are being considered here. So, in this case also I will tell you one thing it also inclusion led here right. So, its price of the paper cup is a bit higher than this one right for example, if I have by 2 cups led the 3 cups of Styrofoam, I can purchase 2 cups of this only so, but the price is not that high that they becomes the criteria here.

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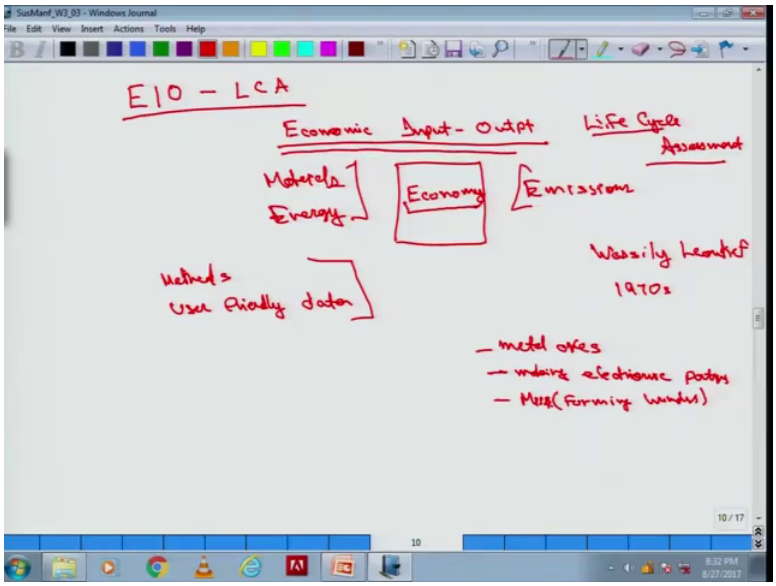

So, next is another life cycle assessment criteria that is EIO-LCA, this is one of the easiest way to assess the life cycle of the product when we consider the whole industries.

So, this EIO-LCA is an online database and they have models that have database is regarding the various factors that are in land company. For example, in India they will provide the number of workers that are in the factory and the number of right amount of energy that is being consumed per unit worker per unit product that is sold and the carbon emissions that are there embodied energy that is there. So, they maintain the data and provide this one. So, this data is most of us this this data is open source. So, EIO-LCA is actually economic input output life cycle assessment. So, economic input and output the waste at regenerated the carbon footprint of the in the transportation and the packaging waste all these kinds of things are there.

So, what does EIO-LCA does? It is actually a method that estimates the material and energy resources that are required materials and energy resources and the environmental emissions right of an activities in an economy. Please not I have no talking about a single factory here I am talking about a country right a specific sector of industry for example, water intensive industry, for leather industry or for steel industry or for automobile manufacturing or this data would be provided right is provided in by this software here. So, it was actually develop by an economist who is a normal rate his name is Wesley Leontief.

So, he developed this method in 1970es using his work that he did in about 1930s that was input output work for an economy. Now in the contain we have a website for EIO-LCA that provides methods and transforms methods for EIO-LCA life cycle assessment and transpose in into 2 user friendly data right transforms into a user friendly online tool to quickly and easily evaluate a commodity or a service as well as its supply chain.

Now, results from EIO-LCA model and this websiter free for commercial use and it is an online tool for example, a facility for a final resemble facility the impact on maybe metal ores like impact not on like impact from the metal ores right then making electronic parts right then maybe some miscellaneous things maybe forming miscellaneous that is forming a windows in automobile right or attaching some other miscellaneous accessories into automobile all these data is present here now.

So, this is economic input output LCA method. So, with this I will stop here in this lecture and would come up with a practice session on this EIO-LCA and others soft tools for life cycle assessment, I will choose one of the open source or maybe not of if open source maybe the student version of a tool and we will see how do we do life cycle assessment, how the data is put in what kind of data is available. So, see you in next lecture.

Thank you.