Sustainability Through Green Manufacturing System: An Applied Approach

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Lecture – 11
Life Cycle Assessment Continued

Good morning, welcome back to the course sustainability through green manufacturing and an applied approach. So, this is week 3, lecture 4 and I am Doctor Amandeep Singh. So, till now what is covered in this course, Doctor Deepu Philip has introduced the sustainability framework to you and systems approach was taught and also he went through certain simulation techniques and like how to conduct; how to conduct simulation in analysis for sustainable environment and certain other concepts of facility and unit perception process and flow line those all were discussed and I took life cycle assessment.

Life cycle assessment; we will continue in this lecture as well. I will start with an example here. So, in this session I will cover materials flow and we will then discuss; what are benefits of LCA or what is your take away from learning life cycle assessment then we will take an example of automobile LCA.

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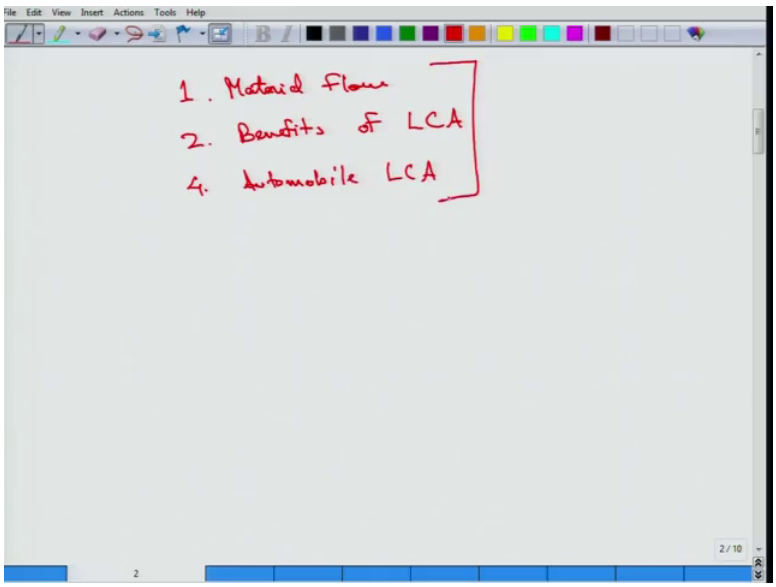

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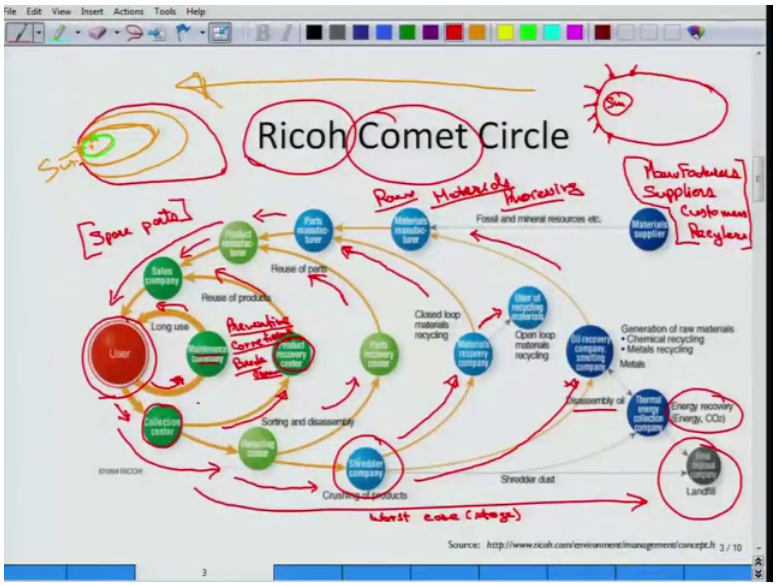

So, I just start with this one this is known as Ricoh Comet circle; Ricoh is a company that manufactures printers and some other electrical stationary electrical electronic stationary instruments like paper shrewdness printers and products like that right Ricoh came up with this; Comet circle in which they represent the various flow of the material from the user why the what Comet is used here actually what is Comet? Comet is a heavenly body that revolves around the sun the orbit of the Comet is like this one. This is sun and the Comets has an orbit like this an elliptical orbit is this right and Comets have tails like this if it is travelling the tails will be wanting away from the sun right these Comets has tails.

So, this is actually one Comet this is it is it tail for this one. So, finally, what happens if one Comet it is keep on coming closer to the sun here right then one day this Comet has to vanish there is a life for the Comet may be from hundreds to thousands of years that this is the life of the Comet and finally, it totally vanish, right. So, this concept of Comet revolving around the sun is used to explain the degree of impact at each stage of the product right; for example, this is a user here, right and user gets his product he purchase maintained by the company that he gets after sales service and he kept on getting the maintenance and repair and keep on using that for long time. For example, I took the example of bikes in life cycle costing you which is the bike right then you keep on getting it maintains just the service first service you did you the company asked to do; it

in first 2500 kilo meters, then in 5000 kilo meters, then every 2500 kilo meters or in 3 months may be in 6 months you get it serviced.

So, this is known as preventive maintenance that is prevention of any breakdown or stopping of bike, right. So, this is preventive maintenance you keep on getting it through the company. Then next is even corrective maintenance is there, sometimes, you do that corrective maintenance is what rend some small issue come up in the bike for example, your bike brakes stopped stop working or the brakes are not working well or your clutch plates got deregulated your kick is slipping.

Right, then what you get you get that part replaced that is your corrective maintenance and sometimes it happens that the your bike totally stops moving right some part is totally break down that is known as break down maintenance for these kind of maintenance the customers keep on doing and keep using the product right now second Comet circle is the product when you saled is collected by the collection center like they purchase second hand bikes they do some maintenance and give it to the second hand user. So, in this case what they are doing they are repairing the bike or maybe engine overhauling and a product is recovered here right engine overhauling or maybe is some components are changed and sales company would again send to another user.

Who would like to purchase a used bike right then third circle is third stage or circle here is when the product is sent to recycling center now what does this recycling center do they sort and they disassemble various kinds of parts in our product and lead differentiate variant categories. For example, plastic products rubber products and no product sorry components here and metal components different types of metals that if in aluminum, if I say like carburetor or pistons are hard aluminum they are melted at little high temperature and various other kinds of products like steel, aluminum, manganese, all these thing language in electronic equipment, right. So, these are all segregated and they sent it to part recovery center who could re use the parts re use the parts and it is sent to sales company sales company can use this as spare parts that are reusable.

So, the next is the parts are sent to the shredder company this is next cycle here the shredder company totally crushes the products they shredder into spies and extract the components extracts I would say not components state converted into total land fill able position right. Shredder company would send some of the portion material to recovery

company material recovery company can again sent to the parts manufacturer here right parts manufacturer puts again send to product manufacture which can again go to sales and the user.

So, some of the parts the users user of recycling materials used some of the parts here for example, recycled plastic is used is generally purchased by the customers that is lower cost recycled plastics have certain bad effects induced into them for example, the plastics becomes smelly after sometime and in food grade plastics it is never recycled that is for dustbins or the bins or the dry things that we may be have only those places recycled plastics could be used. So, the next is this shredder company set it to the order recovery company or smelting company right who would send it to the materials manufacturer this is now materials processing right actually this is raw material processing only.

They could even extract some thermal energy form this oil and generation of certain raw materials like a chemical recycling material recycling that happens then energy recovery is here and finally, we have disposer. So, this is this case is the worst case worst case or note or no I will note say case here I would even add here stage minutes goes to length field. So, the purpose of sustainable approach here is to keep this Comet circle smaller the more we had towards the left side the more we are towards the left side or most small is the circle or like I would say smaller is the sign of size of this Comet circle for this path this is more sustainable this. For example, I would say if I grad it or if I would like to give them colors I would give this as green color this as orange color and the last one as this one as red color. So, this is how the material flow happens. So, it could have been noticed here that all the players all the stakeholders from manufacturers suppliers customers then customers who is left here the recycling companies.

I would say recyclers they all participate in this to reduce the degree of impact at each stage and they all have partnership right they need to have partnership to have better product right it is with respect to greenness. So, here at the smaller Comet circle even the economic value or the value of the product is higher here the value of the product is higher and as we move towards this side the value becomes lower this is value right and reuse can be by the customer only or maybe by the manufacturer and recycle is a this recycling is a multi tired recycling system reused is actually inner loops. Here after that only recycle happened and they need to establish partnership at each stage and the dealing with a systems approach here is important this understanding of the material flow

would help us to conduct life cycle assessment in a better way. Now I would come to certain take away from life cycle from LCA information that is being shared. So, what is LCA or what are the benefits I would say; what are benefits; if you say LCA helps in environmental labeling.

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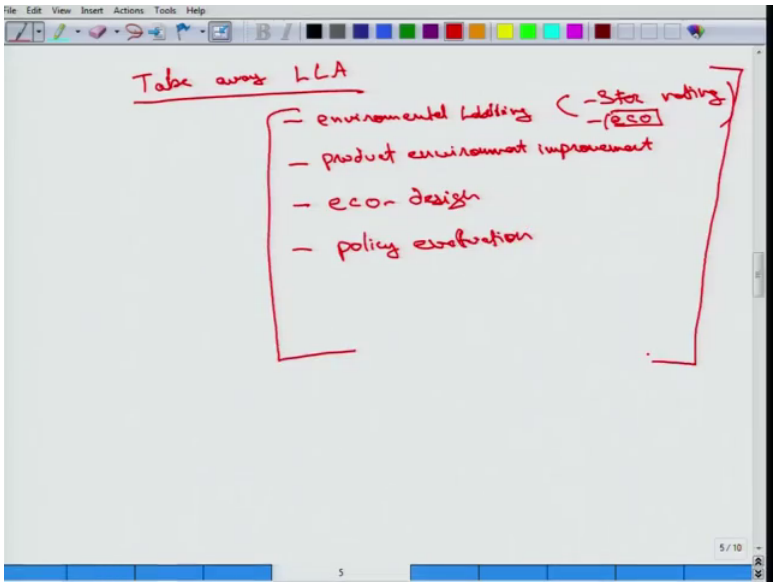

We have star radiating then we have certain echo labeling on the product right then LCA helps in total product environment improvement then we can even have eco design with LCA then maybe policy evaluation.

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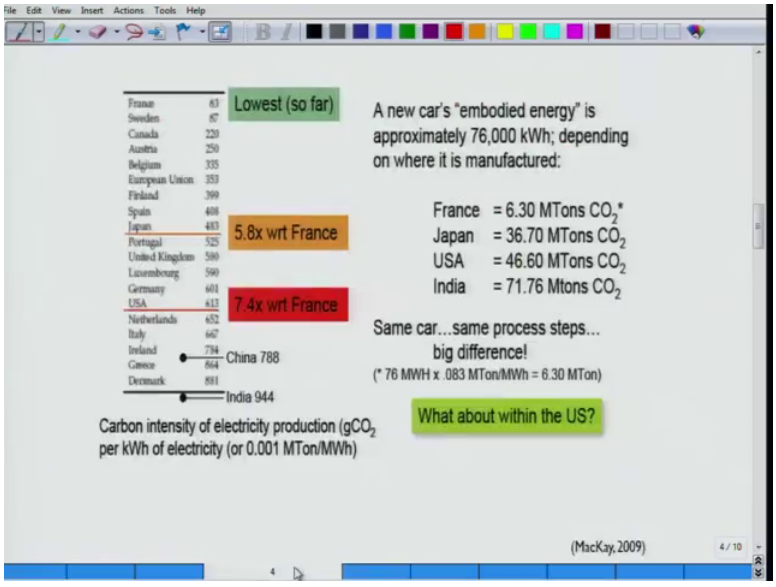

So, this is what LCA health helps us to do next I will come up with an example of automobile fracturing and discuss LCA that was conducted by a steady in a study for in a for in a automobile manufacturing. So, before that I like to discuss I will like to explain this illustration that is brought form and reference here reference from two thousand nine in this case what we are showing we are showing the embodied energy for a car for manufacturing a car, right. So, what it is showing that a car embodied energy is about this much 76000 kilo watt hour depending on where it is manufactured he is saying now we have various quality of energy; here, this is how electricity is produced. So, it depends upon whole electric ties produced right. So, in France it is 83 gram of carbon dioxide that is that is produced produce one kilo watt hour of electricity right. So, it becomes 0.001 mega ton per mega watt hour.

So, we multiply energy that is used for car into this it becomes this much of carbon dioxide is produced to manufacture a car in France and we can see the condition of India here. So, why is this difference here because that energy they are producing the electricity power they are producing is from different sources these are the countries the clean countries these countries were working on the screen technology produced from nuclear energy nuclear right and in India we use thermal plants primarily right which use coal that is why the pollution level is this much high. And if I say; if I even say that this much 76 kilo watt hour of energy is embodied in car that manufactured in India; this value of the carbon dioxide value that is produced would come close to 650 megaton, right. So, this is what I am talking about the quality of energy here I would like to tell you one more concept here that is energy ladder what is energy ladder an energy ladder tells us the quality of the energy.

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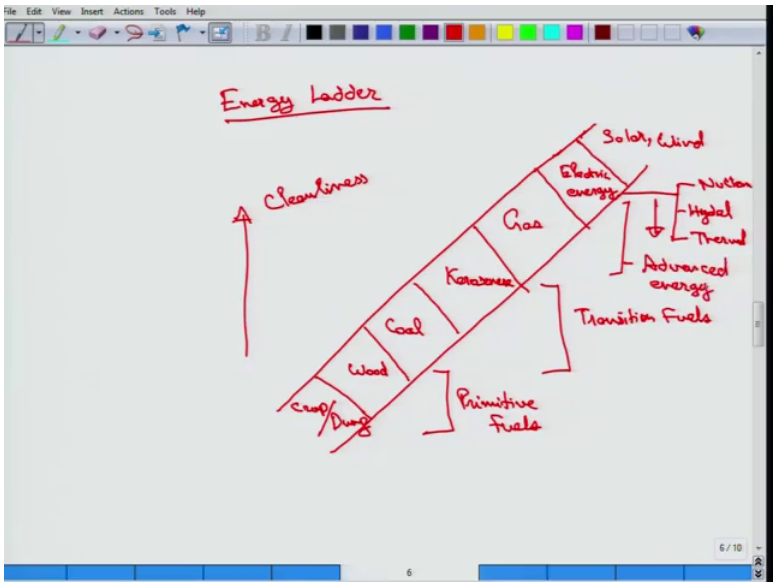

Based on its cost or cleanliness or the kind of fuels we are using. So, this is the ladder it is ten plus two claim bump. So, what we have here on this side it is cleanliness right and the most clean energy is renewable energy solar energy or maybe wind energy right then we have electric energy right and how is this electric energy produced that is another factor like I told about nuclear then maybe Hydel power plants may be thermal power plants. So, in this case also the quality is going down here. So, then we have gas, then maybe kerosene then comes coal then wood or then comes down what is used in the rural areas or in India maybe the crop or animal dung this is the energy ladder those these are primitive fuels here primitive fuels and these are transition fuels transition means they helps to produce our the better or advanced fuels I would say advanced energy, right.

I would like to share one more thing we are like to moving back to that example which we shared regarding the diaper selection. So, in that case we what we found that laundering was the processed that was material getting the environment very badly. So, in laundering we also dry the clothes like the industry industrial ordering people also dry because in home also they are also various kinds of drier used electricity like the spinner is there that rotates and dry the clothes some of the drum machines even heater is available.

So, what we are using we are using electricity to drive the cloths. So, this is not a good idea with respect to our sustainability approach it is better to use solar energy or wind

energy to dry the clothes than to use electricity. So, this is called reduce. So, if you could recall this approach regarding before disposal we could recycle reuse and reduce the use reduce the consumption for in this case this solar energy would reduce our consumption also we had refuse here, right. So, what we are talking about is the energy that is embrowned in manufacturing a car in India, we are talking about see here we have concerned here about the quality of energy right energy quality.

And also we need to reduce this energy. So, what is happening in these days while the use of the car by end user I am talking about here by end use, right? So, the kinds of fuel that we that way that we are thinking about to use in future are clean fuels right we have clean fuels here like presently we have gasoline fuel.

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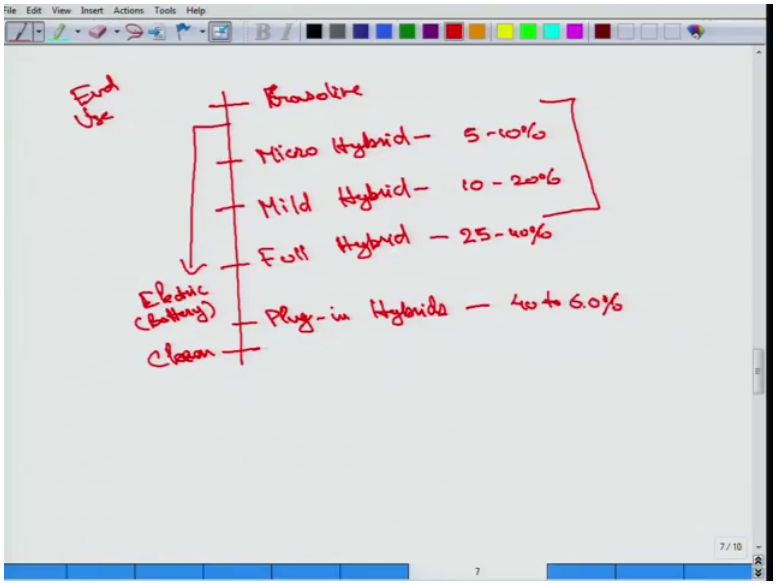

And the cars the concept is there even testing is done only thing is that mass production is not there micro hybrid cars what are this micro hybrid cars as this switch the gas engine off when the vehicle would normally be idling running the mechanical such as heater accelerator batteries etcetera efficiency grains are from 5 to 10 percentage in this case then we have mild hybrid cars.

Now, mild hybrid cars stops the engine during the idling and provide additional power from electric motor during acceleration that efficiency grains here increase from ten to twenty percent then we have full hybrid cars, now full hybrid car run completely on electricity completely on electrical part. So, in this case from gasoline we are going to

Electric Park that is on battery right; now full hybrid cars run totally on that an efficiency grains is from 25 to 40 percent here and there also plug in hybrids. So, plug in hybrids run the cars only on electric park for first may be 50 to 80 kilo meters then like full hybrids like full hybrids car function, right.

So, unlike the others they have to be unplugged or they need to be unplugged and then plugged into the recharge the efficiency grain here increases from 40 to 60 percent. So, if we could recall the various stages of material flow those where material extraction material processing then actual manufacturing end use and disposal the material flow happens from the very first step and keep to the final disposal here.

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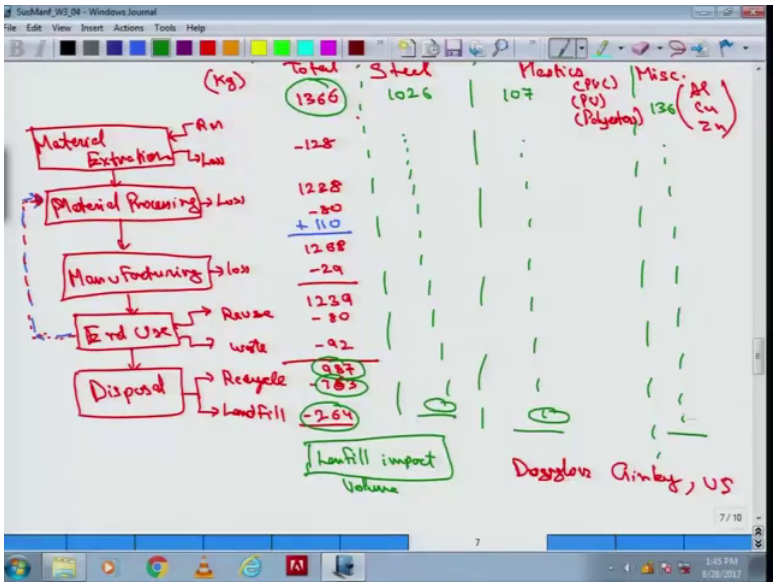

So, this study was conducted in nineteen hundred and ninety in which the weight of the material of flow was considering as a criteria right. So, in this the weights the kind of material that was considered was steel plastics and rest materials where there like aluminum copper zinc I will put this as miscellaneous, right.

Now, I have total weight here I will try to make a table here, right. So, we have raw material input into this and loss coming out raw material and loss is that is the waste that is produced and also in end use we have waste and reuse the weight that is transferred here and after end use we have some of material even going back to the process in here. So, what was observed in this study that the total weight of the automobile here was 1366 and this is kgs; kilo gram all weights are in kilo gram, right. So, total raw material

that entered into this stage into material extraction was 1306 kg out of which the loss during this raw material extraction process was 128 kg. So, material that went into material processing was this difference 11366 minus on 28 that is 1238 and in material processing; we also had loss at all stages we had loss and in this final disposal stage we had landfill and recycle.

Now in this case the loss was 80 kg of the weight the weight that entered into the next stage would be 1228 minus 80 kg and please note some weight is coming from end use as well. So, this weight I would put at different color here. So, this weight is plus 1, 1 0. So, the weight that entered into this stage. So, the weight that entered into manufacturing stage was 1268 kgs, right out of which 29 kg is the loss and we are left with 1239 kgs, right. So, the thing is that why I am talking about the kilo gram or the weight flow here remember in material flow the weight of the material this is also one of the way to conduct life cycle assessment. If we know what is the loss or how much is the weight of the material that is being transferred to the next process and what is the energy that is required to produced per unit of this material per unit of steel per unit of this specific plastics the plastics that will be used for are PVC polyvinyl chloride polyurethane and some polyesters right the miscellaneous materials are aluminum copper zinc. So, how much of energy is required to produce 1 kg of this one.

So, at each stage, we could do assessment that at what point the loss is higher or what kind of material is having higher loss and the kind of the weight of the material multiplied by the energy that is required to the produce 1 kg of that material would be the criteria here, right. So, so this was 1239. So, in this case reuse and waste were 80 kgs and 92 kgs and final disposal of the product when it happened; it was 97. Now this guy who conduct this study in 1990; his name is Ginlay Dogglous Ginlay and he is from US.

He actually observed these weights in the factory and finally, the recycling that was done was about 763 kg and remaining 264 kg were land filled. So, in this we it was even segregated what kind of material had what kind of weight. So, in case of steel the weight was of the order of 1026 and in case of plastics, it was of the order of 107 kgs and miscellaneous was 136 kgs. So, we had they had certain values here as well and final disposal was also there.

So, this kind of study can also be conducted to conduct life cycle assessment now in this case this is the total weight of the car that is input and this is this was the in the disposal stage this is the landfill here. So, what is the landfill impact here right this is actually weight. So, what is the volume for this material for volume for steel volume for plastic then volume for miscellaneous materials to do the landfill this is one of the parameter here. And what is the embodied energy to produce this material and at each stage this much loss is there, so what is energy associated with this one now this is one of the case. So, for more details you can read this study by Dogglous Ginlay that is present online right and in concluding weeks of this course, we will take this soft tools as well how to conduct life cycle assessment using soft tools and also we will conduct simulation analysis using soft tools.

Thank you.