Life Cycle Assessment
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Lecture - 37
Summary and Case Studies (Contd.)

As I said in the previous towards the end of the previous video we now I will be looking at several examples of how whatever we have learnt over last 7 weeks and in the last video can I summarize that how that is applied in real world situation.

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So, let us look at the first example. This project is it was a project it was a funded project which we were at that particular time it is not that old it is almost 2 and half to 3 years old project I was in working in southern Ontario as a faculty at university of gulf and this is a master's thesis of one of my student. So, that is this is a from a funded project.

So, in this project there was as we have talked about earlier composting is used as a means of treating organic waste. So, when you do compost if you do it hundred percent composting is an aerobic process, but if you when you do the composting what happens is there will be pockets of an aerobic activity going on, and that an aerobic activity leads to some fall gases being produced and then creates order problem that creates the smell problem. So, in this particular project we were looking at what are the different in terms of the different order control technologies which is out there, how they compare from the technological perspective as well as from the life cycle perspective.

So, there were 2 parts one was the technological perspective other is the life cycle. The life cycle is which is kind of relevant for this particular course, but I did not I also left the technological part there will kind of go over the little bit quicker kind of an it will give you a good idea of how you select a technology say, if you have to make a selection of a technology how you go about that. So, let us look at this particular example.

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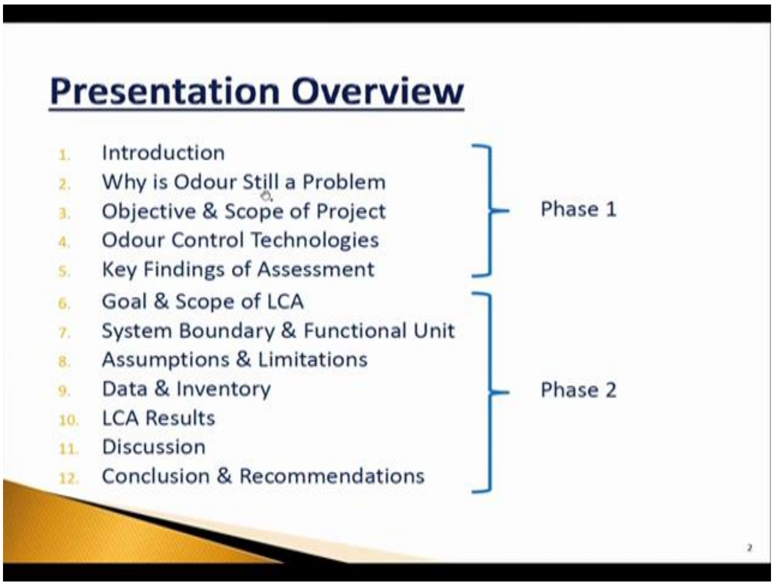

So, we look at the technological and lifecycle. So, here there were in this particular we were kind of talk about the introduction which we already kind of did. Then why odor is a still a problem what is this issue with the order what is the objective and scope of the project what the technologies out there, then we will have the key findings of the technological assessment then we go into this LCA part, if you remember from that LCA if you look at from the steps 7 unto 6, 7 to 10 6 to 10 if you goal and scope system boundary assumption limitations data inventory LCA result.

So, these were the core of LCA steps that we mentioned earlier several times in the course and then we will have the discussion in conclusion and recommendation.

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So, municipal solid waste as in India, also we have been trying to if you look at the new msw and management rules of 2016 the government is asking a is suggesting that we should have a source separation of at least food like a wet and dry wet. When we say wet it is mostly organics it is a food waste and other organic component of that this project was done in Canada in southern (Refer Time: 03:16) of Canada. So, they are there were doing a wet and dry separation where food waste was collected separately. So, here in terms of the food waste they were all nearly forty percent of the municipal or residential waste stream and they were having an organic waste processing facility either using composting or anaerobic digestion

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So, there has been composting when we do the composting the odor is a problem of same with a d facility. And mean they have been cases where complaints from this compose facilities had let to certain law suit is or London Ontario which is around you can say around you can say on 3 hours' drive from Toronto. And there they had an issue of they had to pay actually if we spent 700 dollars several hundred several thousand dollars sorry several thousand dollars like hundred couple of hundred thousand dollars to fix their order control system because of the complaint from the nearby facility and some also leads to the closer of the facility. So, this order control is very being one of the important aspect in organic waste management and it is most it is expensive and also environmental impact full components.

So, we wanted to look at environmental impact in terms of from the LCA perspective. So, we need to have a good understanding for order control.

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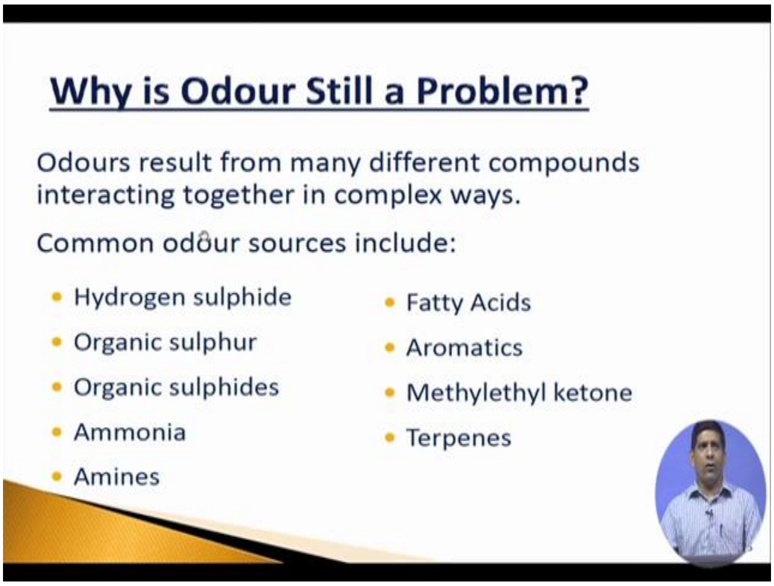

So, there are what the source of order hydrogen sulphide, again if it is a reducing condition you will hydrogen sulphide organic Sulphur organic sulphide ammonium amine fatty acids aromatics methylethuyl ketone terpenes. So, these are major once which causes some sort of order some sort of a smell. So, this is because of the reactions taking place.

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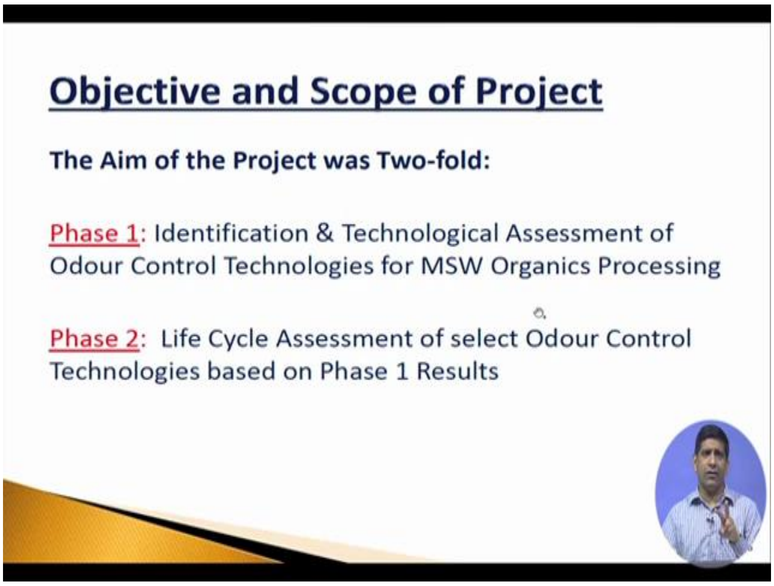

So, the aim of this project was 2 fold as I said earlier identification and technology assessment of the order control technology, and then life cycle assessment and based on the phase one results, I have done the life cycle assessment of the selected order control technology

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So, in terms of the technological assessment what we did there are several order several order control technology methods are the bio filter activated carbon packed bed wet scrubber fine mist thermal oxidization chemical masking agent. So, there are lots of order control at things around their, but we cannot we cannot like a I cannot to go over each one of them in great detail in this particular class.

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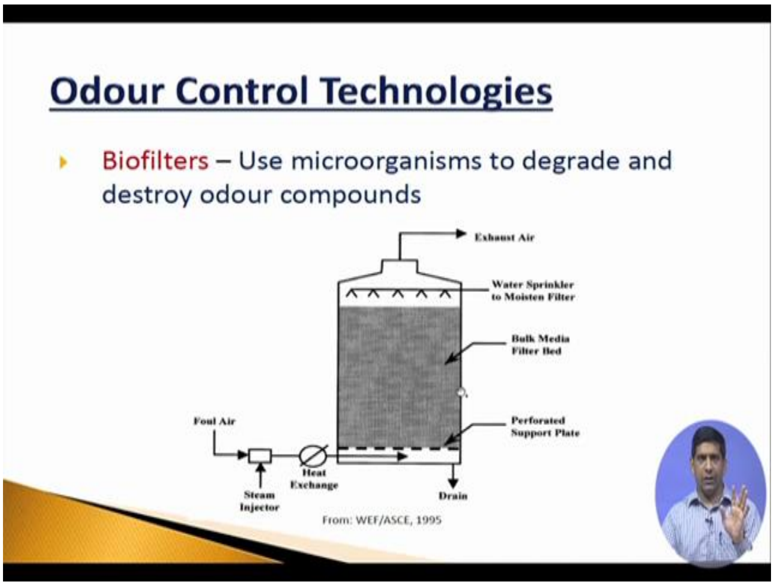

But will give you send a brief overview. So, bio filter what it does it use microorganisms to degrade and destroy order compounds. So, it uses certain microorganisms and so here you have a for air coming in passes through this that is the bulk media filter bed. So, here we have perforated support plate. So, this it will go up and then we have the water sprinkler to moisture the filter. So, because as you know any microorganism they likely little bit most environment. And then you have this exhaust air which should be clean and then even after this it will go to the chimney and then it will go out at a higher level.

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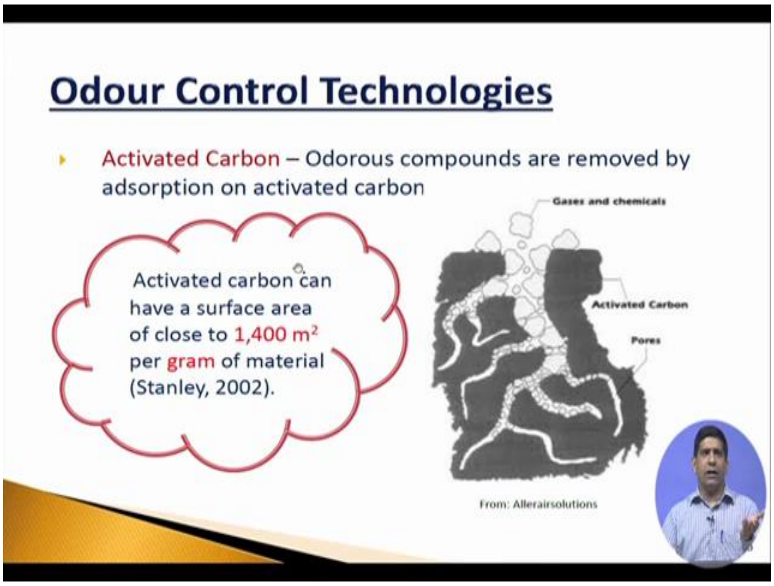

Activated carbon it is removed by adsorption activated carbon used a lot in. So, that can be used adsorption activated carbon can have a surface area flows to 1400 meter cube per gram. So, that is how we used for activated carbon. So, that is also used for removing a powder chemical.

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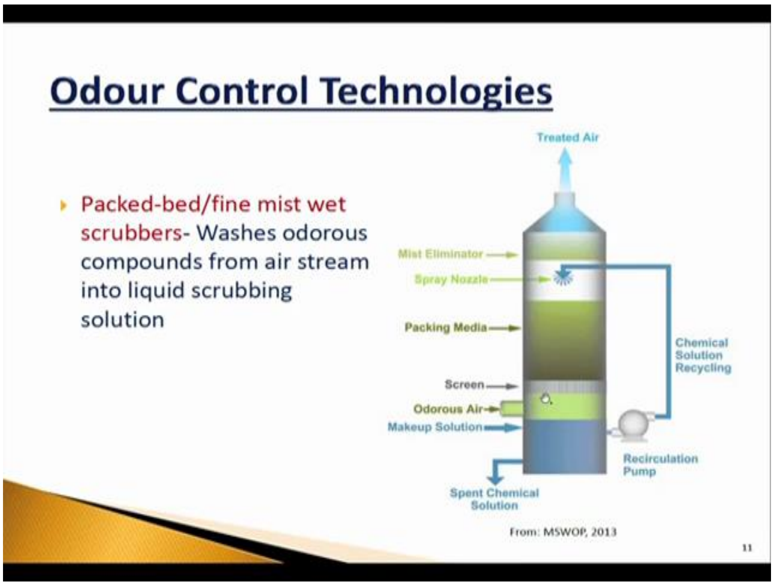

Packed bed fine wist wet scrubber what it does it washes odorous compound from air stream into liquid scrubbing solution. So, here you have like a makeup this is your spray here chemical solutions are coming in packing media, and make makeup solution is spent chemicals screen is over there, this is the recirculation pump this is the packing media. So, you have this order as like a fall order carrying gas into the system and then it goes through all these different steps and then you have treated air coming out.

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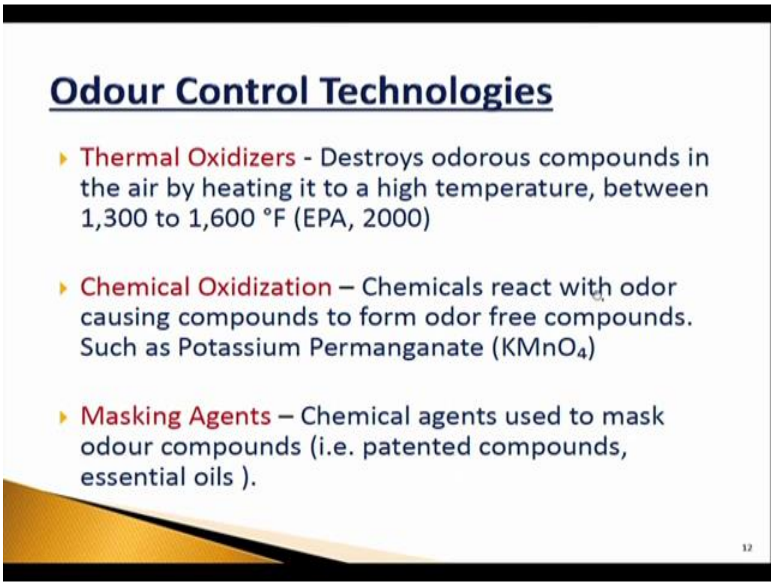

So, there are thermal other systems are out there thermal oxidizer chemical oxidation masking agents. So, there are lots of different chemicals out there which works on different principles. If you are if you end up doing some research in this area you will you can go and learn more about it or if you are interested to learn about it, you are always you can find information about that.

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So, in terms of technology assessment when we say technological assessment what actually we are trying to assess. How to do this technological assessment any anything when you try to do you, of course, you look at the what is what will be the cost what is the capital cost what is the operational cost what is the maintaining cost what will be the volume of air flow that we can it can treat. So, what is the capacity what it can treat for. And what how much order removal efficiency of how much order can be removed reliability long term performance, the space requirement chemical and media usage how much energy will be required how much water will be required. So, all these different factors you can look at.

So, this is exactly what we did. So, for this.

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Technology	Odour Units Removal	Capital Cost	O&M Cost	Reliability	Space Requir.	Energy Usage	Chemical/ Media Use	Water Usage	References
Biofilters	Can be >90%	Mod	Low	Good	High	High	Low	Mod	(NMB, 2005) (EPA, 2000) (Burgess, 2001)
Activated Carbon	Can be >99%	Mod	High	Excellent	Low	Low	High (depends on air concentration)	None	(NMB, 2005) (Burgess, 2001) (RWSA, 2008)
Packed Tower Wet Scrubbers	>90%	Mod	High	Good	Mod	Mod	High	Mod	(NMB, 2005) (EPA, 2000) (Corey, 2000)
Fine Mist Wet Scrubbers	80-99%	High	High	Mod	Mod	Mod	Very High	Mod	(NMB, 2005) (EPA, 2000) (Corey, 2000)
Thermal Oxidizers	Can be >95%	Very High	High	Mod	Low	Very High	High	None	(NMB, 2005)
Oxidization chemicals	Up to 99%	Mod	High	Mod	Mod	Low	Very High	None	(EPA, 2000)
Masking Agents	N/A	Low	Mod	Excellent	Low	Low	High	None	(NMB, 2005) (EPA, 2000)

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As you can see in the table we looked at for different types of technology bio filter activated carbons. So, all this thing that we listed we look at the order unit removal capital cost operation cost reliability space energy chemical water usage. And these all these data were basically from different reports and literatures and other things out there, because we had to kind of rely on that and we come up with this particular comparison table where you can look at different categories different types of technology based on their different categories how they are behaving.

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Key Findings of Assessment

- From a technological, efficiency, usability and cost perspective biofilters are preferred option.
- Packed-bed wet scrubbers also function well in composting and A.D facilities, especially for more concentrated air streams.
- Fine mist wet scrubbers are not a preferred choice due to higher capital and operating costs.
- Carbon adsorption can be useful, but its applicability is limited to odour streams where ammonia is not produced.
- Thermal oxidizers are not practical due to high cost, use of fossil fuels and potential production of SO_x and NO_x.
- Oxidizing agents and masking agents can be used as part of odour management plan but not effective as individual methods

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So, based on this from a technological perspective if you look at the table again, bio filter came out to be the preferred option. So, that bio filter was as an if based on technological efficiency usability cost perspective bio filter came out to be better. Packed bed wet scrubbers also function well in the composting system especially for more concentrated air streams fine mist wet scrubbers are not a preferred choice due to higher capital and operating costs carbon adsorption can be useful, but it is applicability is limited to odor streams where ammonia is not produced since ammonia is produced it can does not work very well with ammonia.

Thermal oxidizer is not practical because of high cost use of fossil fuel sox and NOx production. Oxidizing agents and masking agent can be uses the part of, but they are not effective as individual methods. So, you can just have a kind of a combination with others. So, based on this we looked at this packed bed wet scrubber and the bio filter. So, those we chose to go for LCA.

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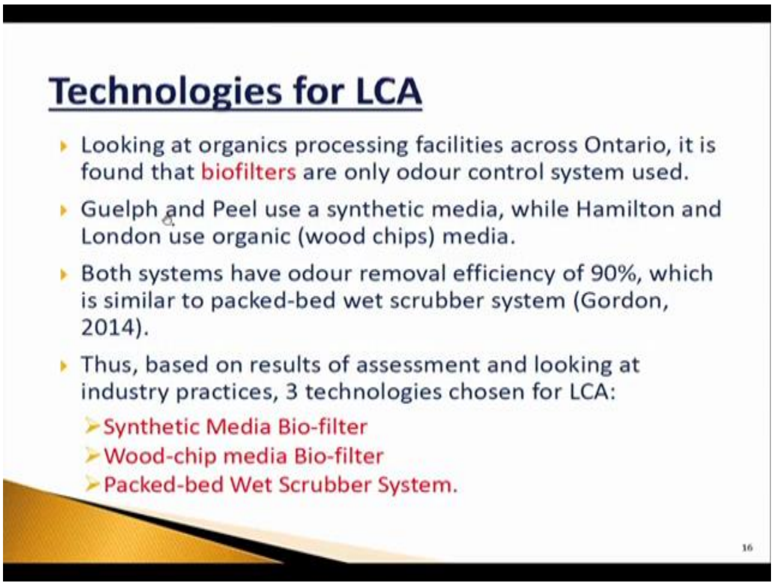

So, we viewed as in terms of bio filter we had 2 types of bio filter which is a synthetic media bio filter. And I wood chip media bio filter and then we compared and then we have the packed bed wet scrubber systems. So, we tip these 3 technologies the reason for taking these 3 technologies I was also because of the area that we are working with the funds, the funding agency who as funded the project there was they wanted us to look at synthetic media bio filter and wood chip bio filter, because the way the system works over there the basically the different municipality is that they have they give some money for research, which goes to a big pull of money and from the big pull of money the research project is funded, but the research project should be kind of an applied research should help this municipalities.

So, we had this Guelph which was the city of Guelph and the peel region. They were using synthetic media. Well Hamilton London were using organic wood chips median all these are in southwest Ontario in Canada in on province of Ontario. So, both system as similar power outer removal efficiency, which is packed by wet scrubber system. So, based on that we use these 3 technologies for comparison.

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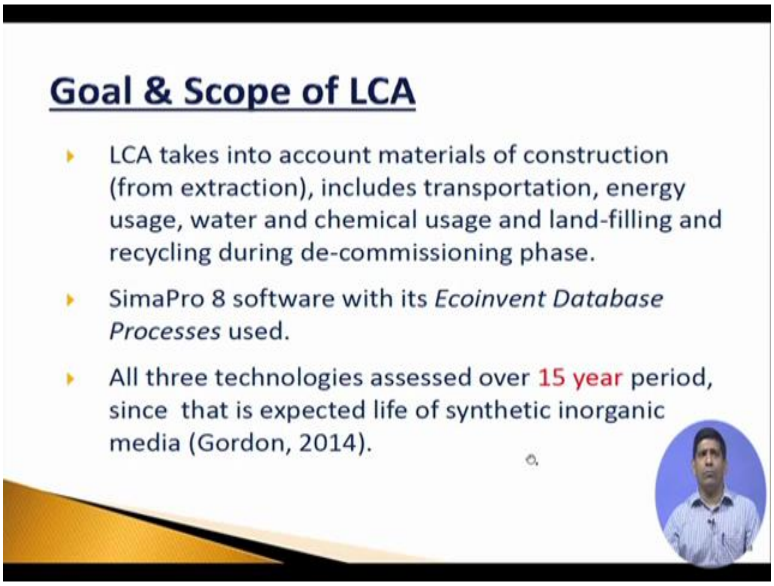

So, in terms of lifecycle we started from the goal and scope the LCA we take in the construction transportation energy usage water in chemical usage landfill and recycling, whatever we need for the decommissioning phase we use the simapro 8 software you do not have to use the software, but this is one of a software which is very commonly used and ecoinvent, database one thing I would like to let you know that as a non country India.

In India if you are working on LCA, exercise ecoinvent databases actually available to us for free in academic year in academic city. So, you should be able you can be able be able to get the ecoinvent database. And even if you are not using simapro there are some open LCA. So, there is another one which is open LCA, you can open use that open LCA software which ecoinvent database. So, the simapro is a bit expensive, but it is not that bad either it is a very good software. So, all these 3 technologies they looked at over a 15-year period which is a kind of a life of a synthetic inorganic media based on the talk we had.

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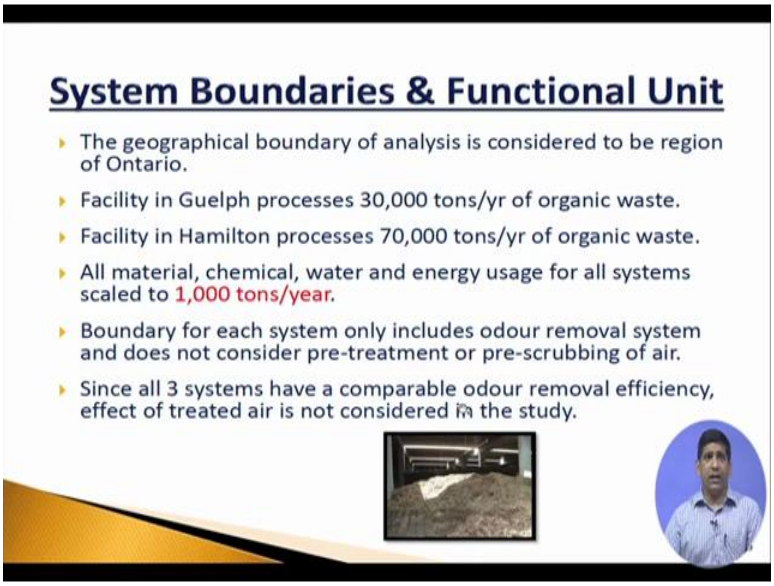

So, then we had to remember what we said we have you have to have to a system boundary and a functional unit. So, the system boundary is considered to be the region of Ontario that is why we are. So, sorry geographical boundary and the facility is boundary of each system only includes the order removal system.

So, we do not consider pretreatment of prescrubbing of air because our goal was to look at the environmental performance of this order removal system and sense 3 system have a comparable order removal efficiency effect of treated air is not considered, we assume that there for the 3 will have similar and facility in Guelph (Refer Time: 12:59) 30,000 tons per year for organic waste facility in Hamilton process 70,000 tons per year for organic all material chemical and water energy usage for all system is a scale to 1000 tons per year. So, what does that mean our functional unit is treatment of 1000 tons of organic waste per year. So, and we collect data from Guelph and Hamilton. So, it was a real data. So, the real data was collected and then we scale it down to 1000 tons per year. So, that is how it has been done.

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So, data for bio filter was collected from facility in Guelph which uses synthetic media Hamilton uses woodchip. So, we got the data from there. So, for packet bed wet scrubber we could not find a system nearby where we could go and collect the data. So, we collect the literature data and previous studies whatever the previous studies out there and again you scale it down to thousand tons per year.

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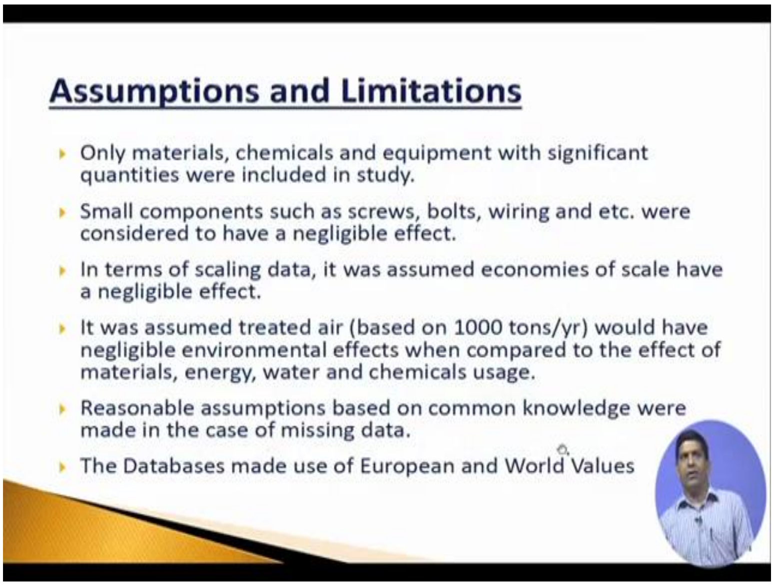

So, just to. So, there are certain assumptions as I said as well you may have to make certain assumptions because otherwise your LCA becomes. So, big that you cannot deal with that. So, all the material chemicals and equipment where significant quantities were included in the study a small component such as screws nuts bolts wiring etcetera, where assumed to be negligible effect in terms of a scaling data is we it was assumed that economy of scale have limited impact. So, our negligible impact.

So, that is what basically linear relationship it for assume that the treated air based on thousand tons per year would have negligible environmental effects which compare to the effect of material energy water and chemical usage reasonable assumption based on knowledge where made in terms of any missing data the database made use of European and world values we didn't had the Canadian values although we did change the energy mix and we use the energy mix of the Ontario southwest Ontario.

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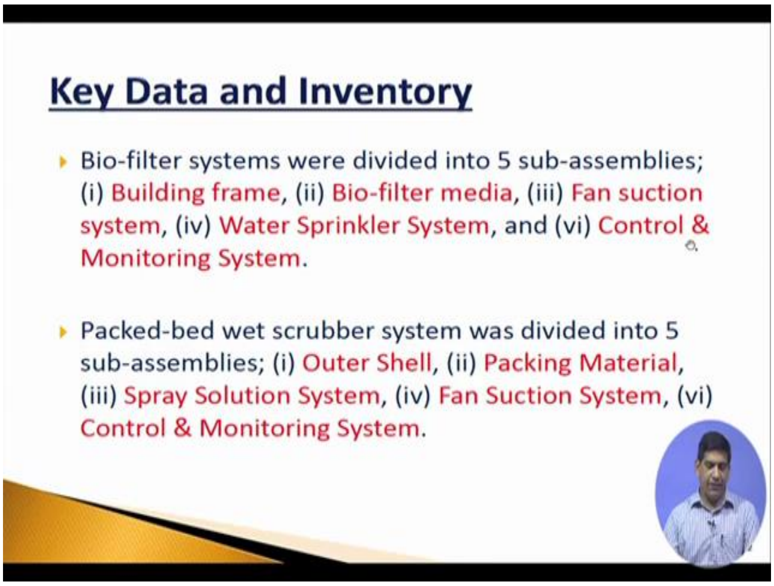

So, key data and inventory will bio filter system we divided into 5 sub-assemblies building frame bio filter media fan suction system, water sprinkler system, control and monitoring system. Similarly, packed bed we have to outer shell packing material spray solution system fan suction system control and monitoring system.

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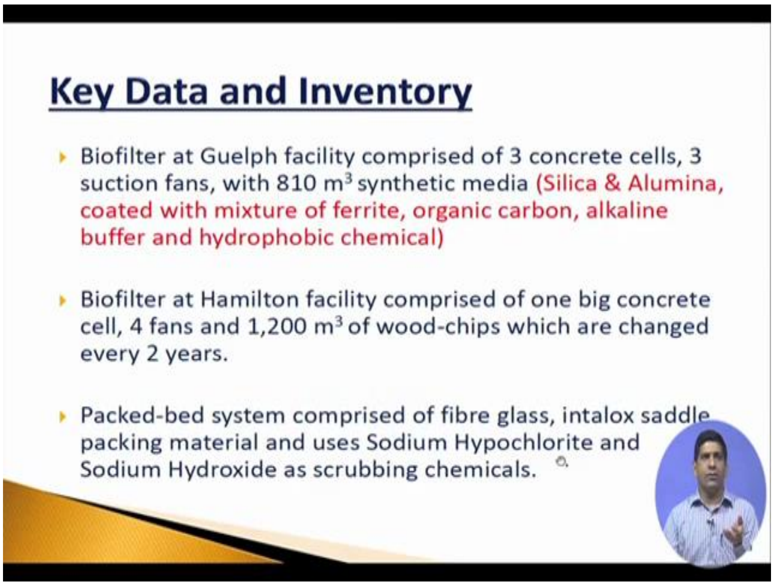

So, from there we had looked at the facilities that we saw qualifies a 3 concrete cell 3 suction fan with 800 10 meter cube of synthetic media which is silica and alumina coated in mixture of ferrite organic carbon alkaline and buffer and hydrophobic chemical in Hamilton we had one bit concrete cell 4 fan 1000, 200 meter cube of woodchips which are changed every 2 year and packed bed system, fiber glass intalox saddle packing material sodium hypochlorite sodium hydroxide was used as a scrubbing chemical.

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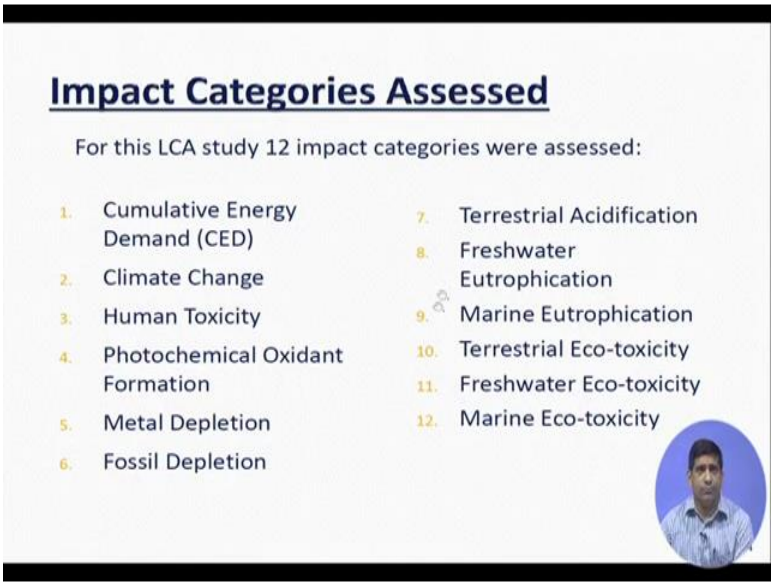

So, and we used all impact categories rather than the other impact categories out there, as well, but we use the 12 impact categories cumulative energy demand climate change human toxicity photochemical metal depletion fossil terrestrial acidification freshwater marine eutrophication terrestrial eco toxicity freshwater eco toxicity marine eco toxicity. So, there are all these impact categories we used.

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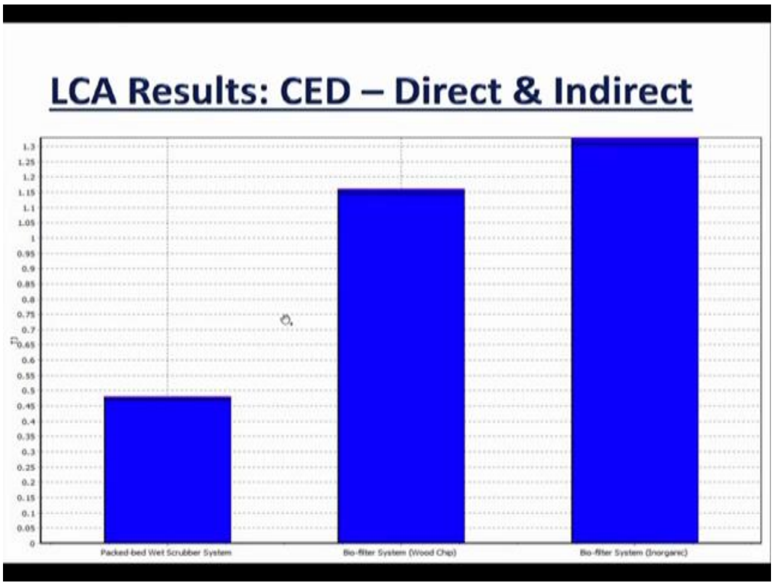

So, if you look at the LCA result for in terms of a cumulative energy demand direct and indirect what you see is the on the this is the packed bed wet scrubber system this is the bio filter system woodchip this is the bio filter system in organic. So, more energy is needed there, and in these graphs what happens is whatever is needed the most is made as hundred. So, whichever as the highest kind of impact we take it as a hundred and based on that hundred, we put these values the other 2 values are shown based on that particular hundred. So, that is why. So, you will see always one graph kind of goes all the way to the top.

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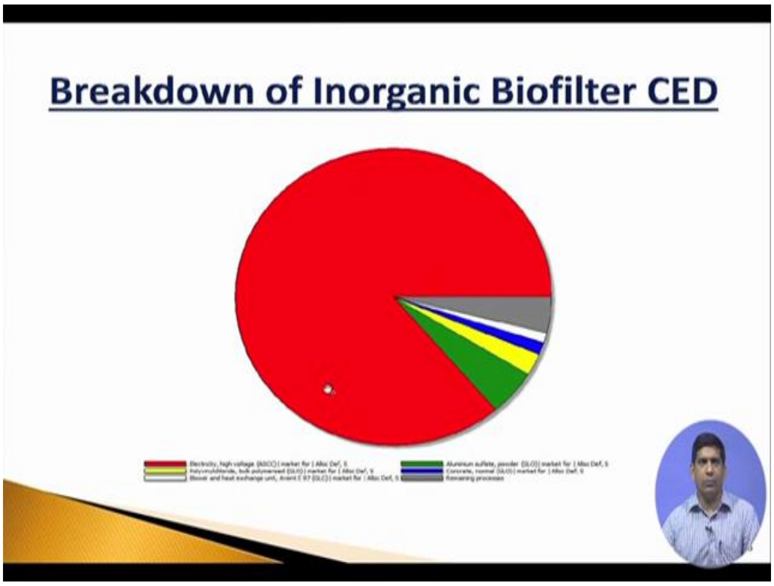

So, if you look at the breakdown of that bio in organic bio filter CED cumulative energy demand it is electricity high voltage electricity that is the major one, then the aluminum sulphate concrete which is the blue one, blower and heat exchanger polyvinyl chloride is a yellow one blower and heat exchanger is the white one. So, so this is all and this bottom one is actually green this green one is what we have is aluminum sulphate and this the top one which is the light grey is the remaining processes.

As. So, you can see the electricity the high voltages that is the one most dominating.

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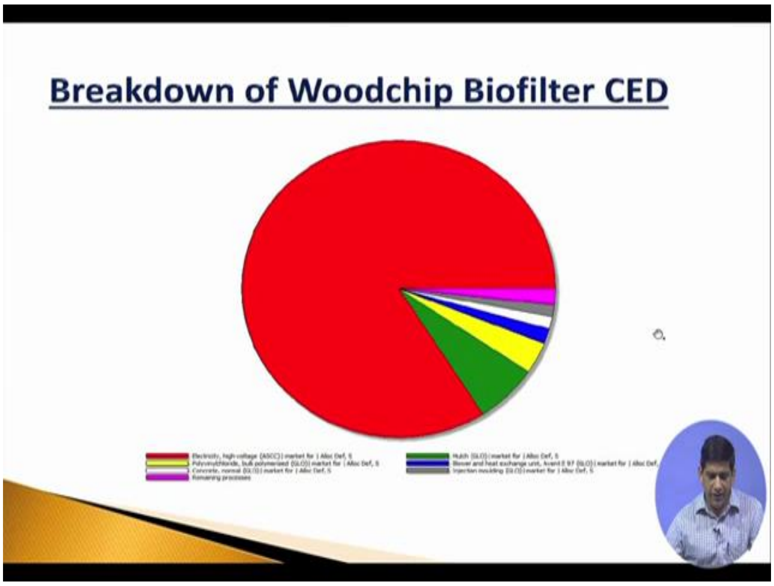

Same thing with a wood chips to this electricity is which is the most dominating in terms of it is cumulative energy demand.

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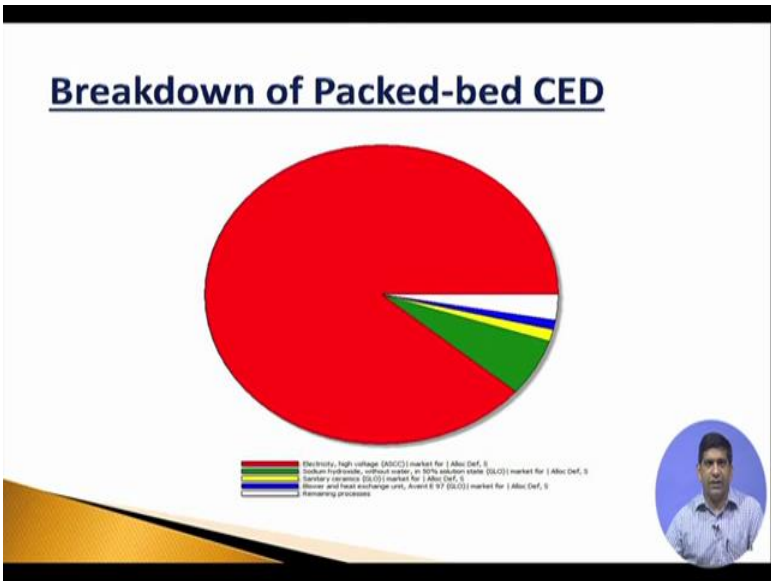

Breakdown a packed bed CO again the electricity the electricity usage is the number one kind of is number one like an impact.

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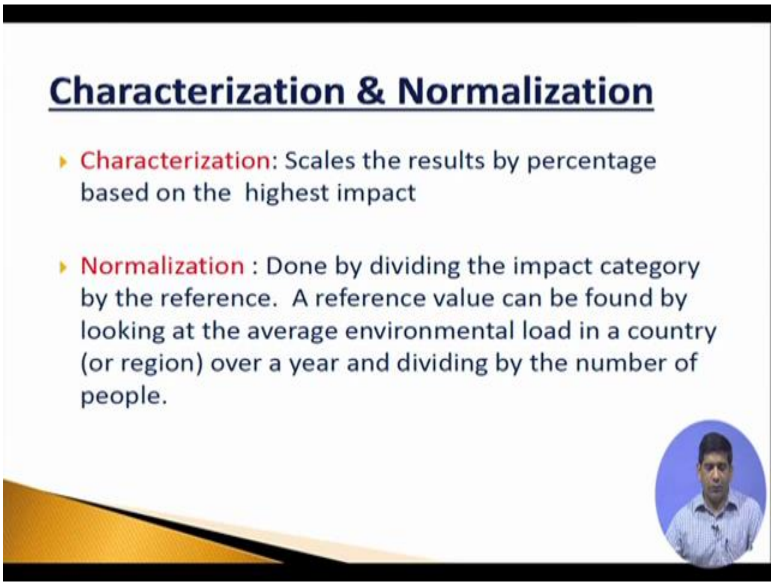

So, we try to remember from the previous video we have to categories. So, you have to scale the result the percentage based on highest impact and then you have to normalize. So, divide the impact category by the reference a reference value, we can find where the average environmental load in a country. So, reference value can be found by looking at the average environmental load in a country over a year and divide by the number of the people in that year.

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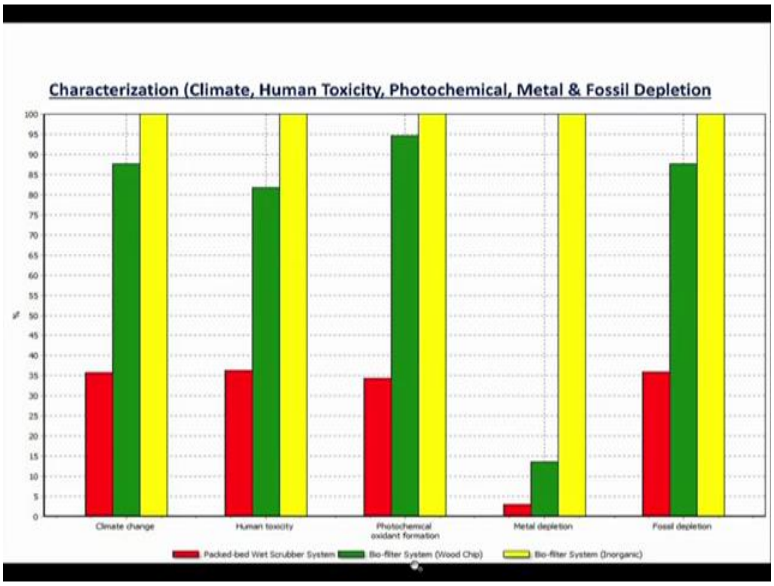

So, this is the total based on hundred. So, we have this climate change human toxicity different impact categories the red one is the packed bed wet scrubber the green one, that you see over there is a bio filter wood chip and the yellow one is bio filter in organic. So, bio filter in organic comes out to be the kind of the maximum impact for all these categories that have been listed here and followed by bio filter system wood chips and packed bed comes out to be much better, but again it is costly.

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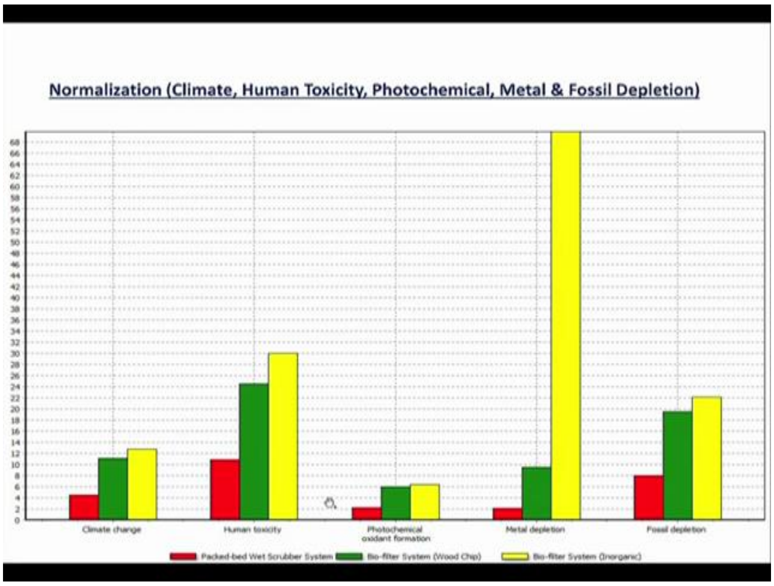

And if we normalize that based on as you can see this metal depletion in this bio filter system because of the usage of a ferrite and others are metals that comes out to be much high impact as opposed to the other impact, but again, it is comes out to be some sort of impact in terms of the photochemical oxidation formation both the bio filter is showing similar impact.

Other categories terrestrial acidification eutrophication eco.

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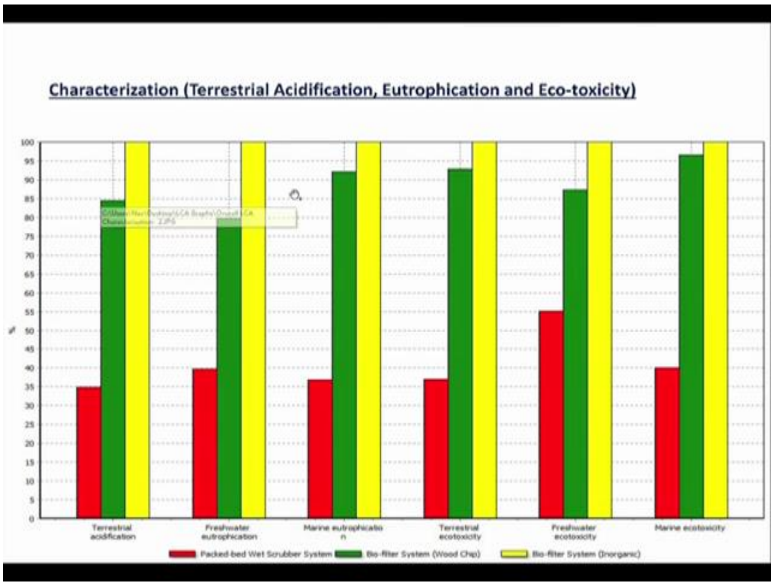

Toxicity again you can have the similar graphs similar graphs showing up in terms the different impact categories.

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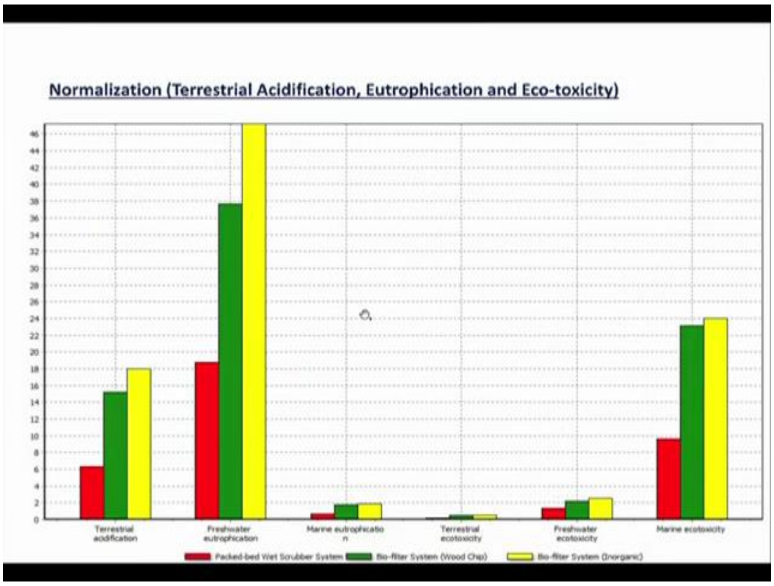

Again if you put in an actual value you see the different impact showing up. What it shows is freshwater eutrophication acidification, you see more impact eutrophication terrestrial eco toxicity the impact is much less.

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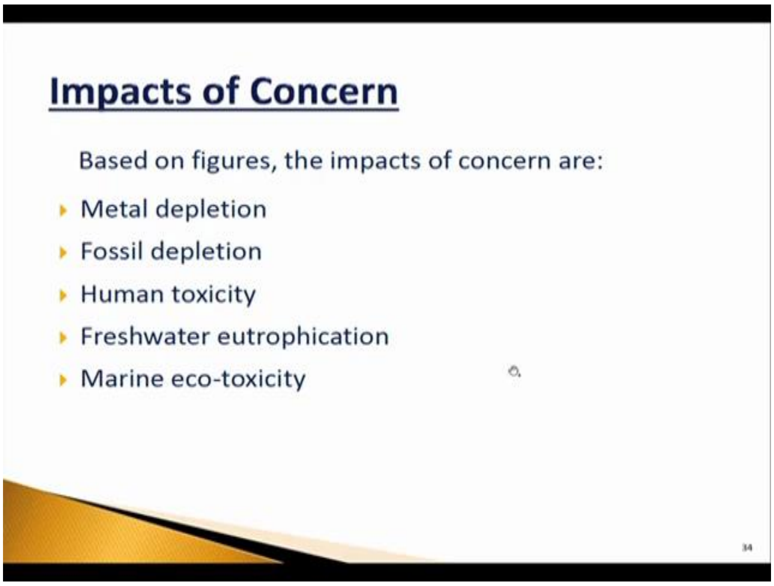

Marine eco toxicity you see higher impact. So, in terms of the figure the impact of concerns is metal depletion just summary of that metal depletion fossil depletion, human toxicity freshwater eutrophication, and marine eco toxicity. So, these 5 categories where we saw some sort of concern.

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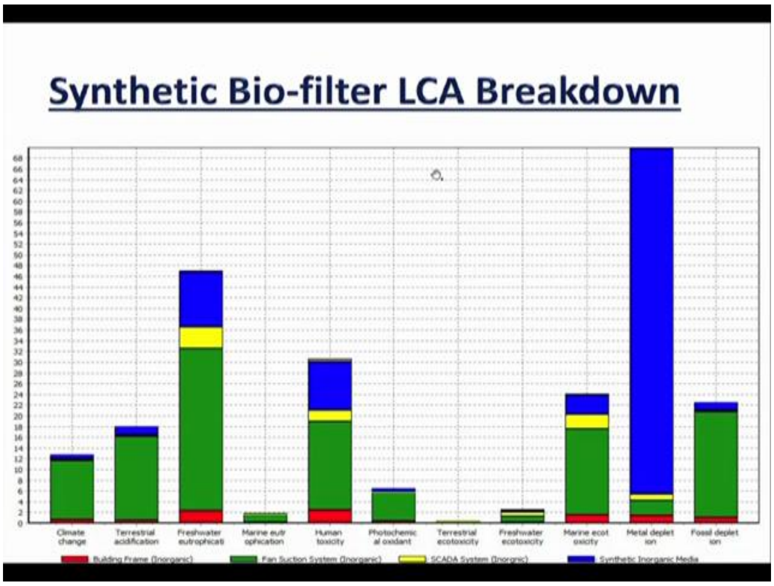

So, if you look at synthetic bio filter LCA if you look at the breakdown of that where the major impact is coming out in terms of a different. So, building frame is a red one fan suction system is the green one scalar system is the yellow one, and then blue is a synthetic inorganic media.

So, in terms of the metal depletion. So, synthetic in organic media is a kind of leading that pack and some in the freshwater eco system ecutrophication and human toxicity as well because of the metals possibly. Then fractions suction system because of the electricity usage, you see fan that is green one is kind of the other big component which is showing in terms of it is impact. So, that kind of give some idea about where is a problem. So, if we can do something in terms of the suction system we can improve that suction system our footprint will go down.

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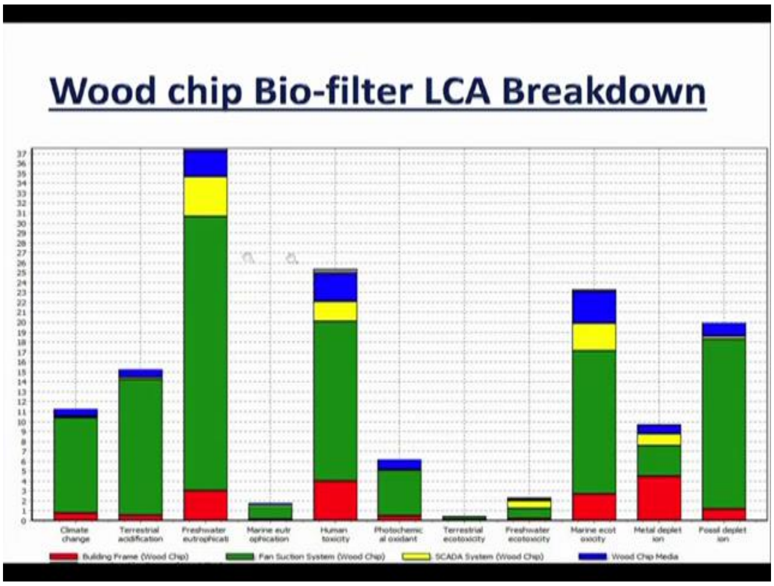

A wood chips bio filter again similar stuff you can see we had majority impact is a green bug part of the bar which is your fan suction systems. So, the fan suction system is kind of the major one that you see for all the 3 categories.

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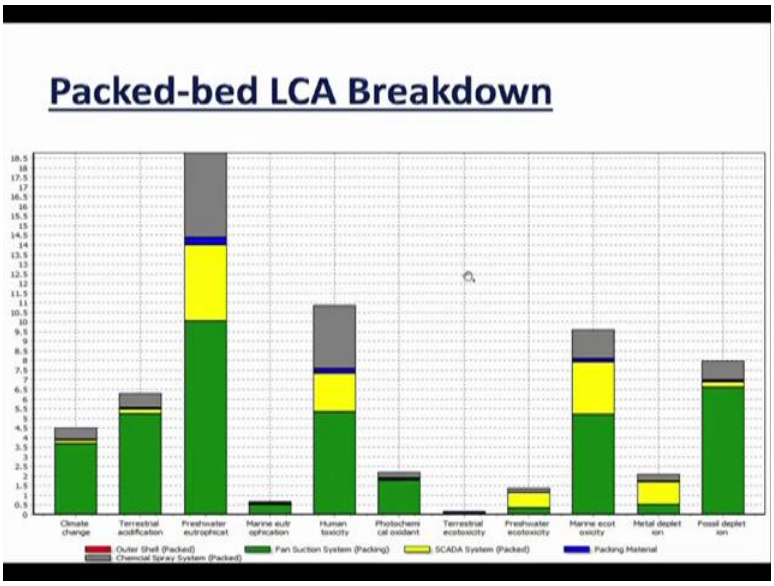

So, here also the green one is a fan suction system.

So, and the grey one is a chemical spray system which is needed for packed bed. So, both. So, significant impact yellow is a scalar system which we see over there as well.

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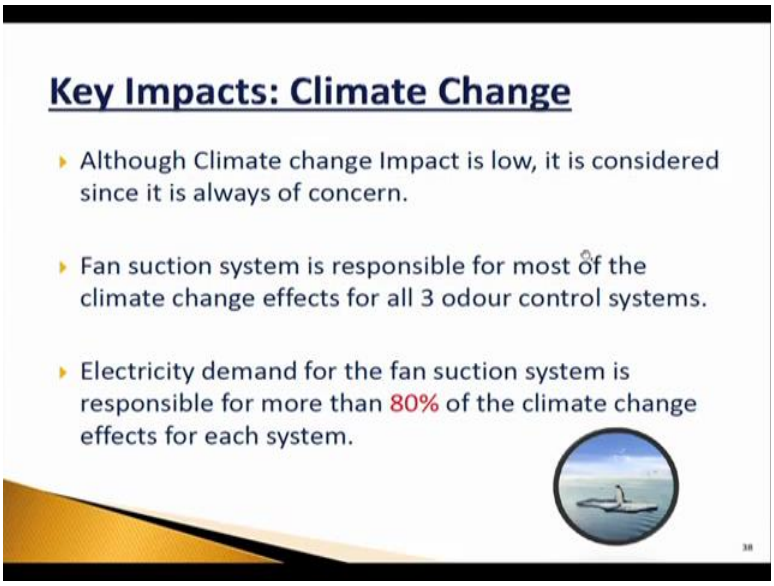

So, in terms of the climate change impact, climate change impact is low, but this considered. Since always a concern fan suction system is responsible for a climate change of effects for all 3 order removal electricity demand is actually the main thing for the fan suction system is possibly more than 80 percent of the climate change. So, it is the electricity the kind of electricity that we go on to use.

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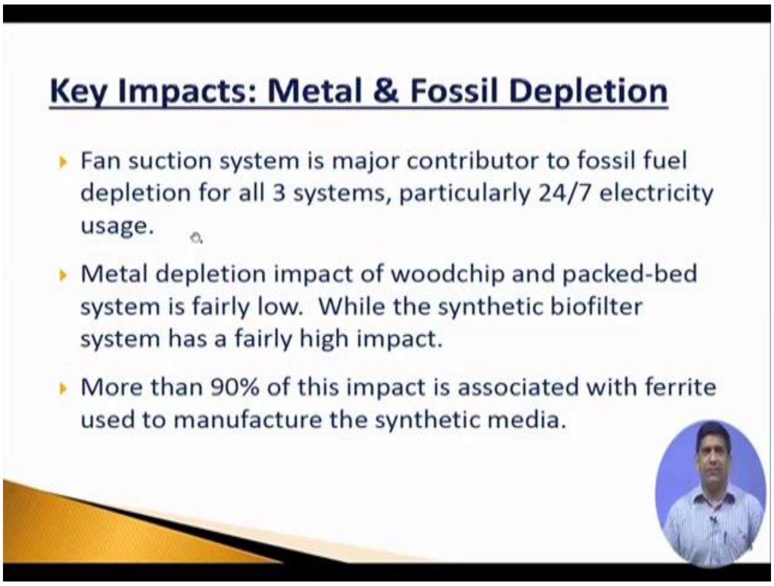

Metals and fossil fuel again the fan suction system the metal depletion fossil is contributed fossil fuel for all 3 especially because 24 hours 24 7 electricity usage is there metal depletion impact of woodchips and packed bed system is fairly low. Synthetic bio filter you see high impact because of a metal being used. More than 90 percent of this impact is associated with ferrite used in manufacture

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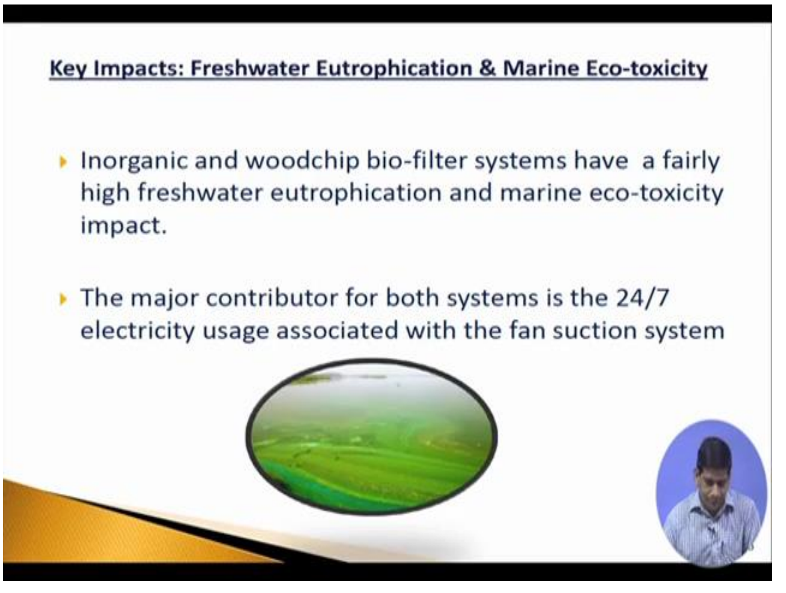

Freshwater eutrophication we inorganic woodchips have a fairly high freshwater and marine eco toxicity is impact the major contributed is 24 7 electricity usage.

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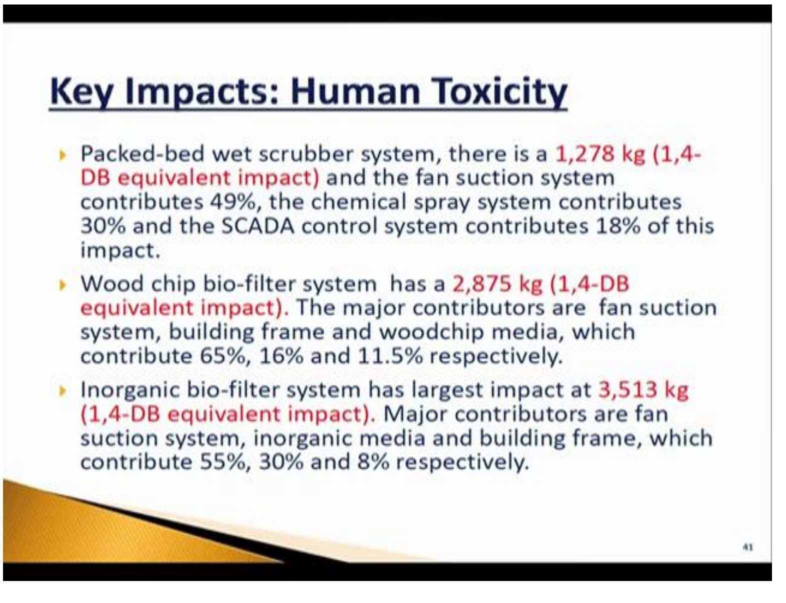

Human toxicity we have packed bed wet scrubber system which is a there is a higher the fan suction system contributes for a 9 percent. And the chemical spray third thirty percent is scadar control system of 18 percent of the impact and the. So, here again woodchip bio filter major contributes of fan suction system building frame, and woodchip media inorganic bio filter major contributes are fan suction system inorganic media and building frame.

So, it is kind of similar of you look at the proportional, it is a similar type of effect is coming from each of this system.

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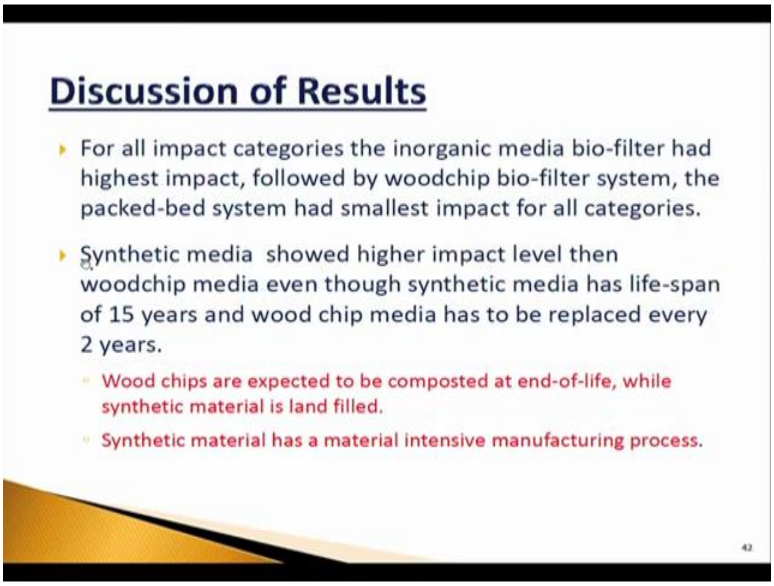

But the level is little bit different. So, for the all impact categories the inorganic media bio filter at the highest impact followed by the woodchip bio filter system the packed bet system had a smallest impact of all categories. Synthetic media showed higher impact level then woodchip media even the synthetic media as a lifespan of 15 years. And wood chip media has to be replaced every 2 years and wood chips are expected to be composted, but at the end of life that is what it is has been assumed while the synthetic media will be landfill synthetic material as a material intensive manufacturing process. So, there are also leads to kind of the problem with that.

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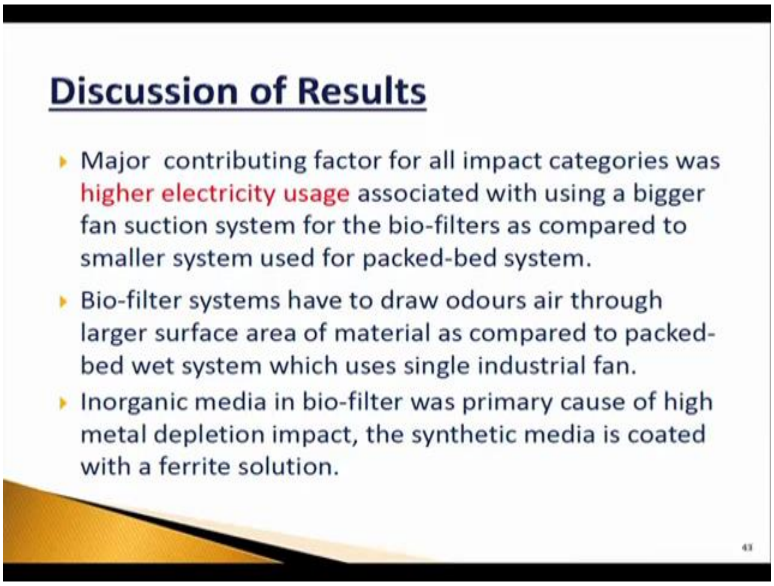

So, major contributing factor for all impact categories, where the high electricity usage. So, if you can somehow reduce the electricity usage that will reduce the environmental footprint. So, an engineer as an engineer what is the take home message with the take home message we have is this energy usage is a big deal in terms of all these process. Other there are other environmental impact associated with other things there, but energy usage is one of the key star. So, if we can come up with renewable energy greener force of energy that will help us to reduce the environmental impact. Bio filter system have to draw odors air through the large surface area which uses a single industrial fan inorganic media in bio filter was primary cause a high metal depletion impact.

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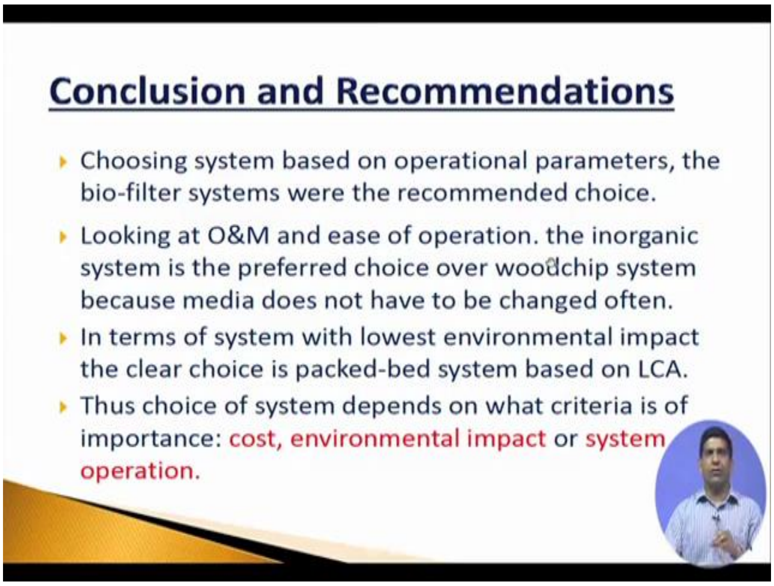

So, in terms of conclusion for this particular study, what we found that choosing system based on operational parameters the bio filter system was recommended choice. Looking at the operational and maintenance and ease of operation inorganic system is preferred over the woodchip because media does not have to be change that often. In terms of system with lowest environmental footprint clear choice of packed bed system based on LCA. Thus the choice of the system depends on what criteria is important cost environmental impact or system operation.

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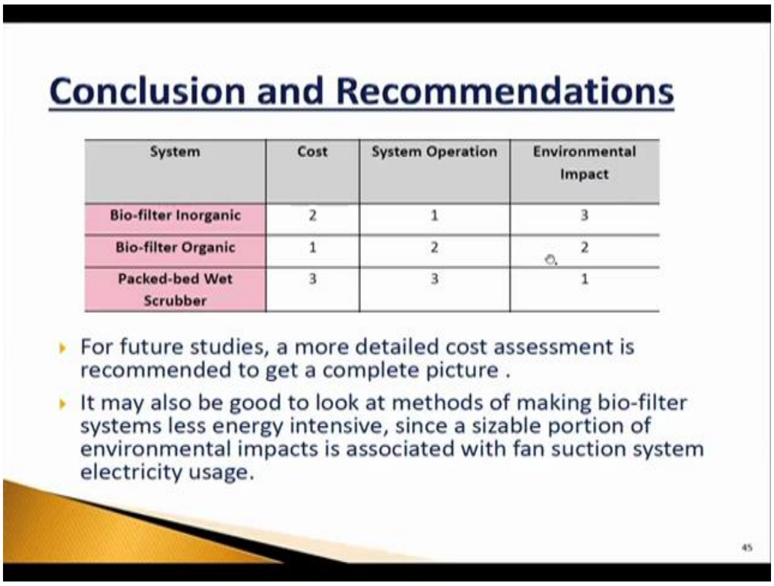

So, we suggested this particular kind of matrix over here. So, there are different systems our there as you can see bio filter inorganic organics and packed by discover. And you have to look at the cost see environmental impact is a very important parameter this whole exercise of LCA is to find out the environmental impact.

So, whatever the data you see over here is based on the LCA exercise, where we got the packed bed wet scrubber as number one then bio filter organics is 2 and bio filter inorganic is 3 in terms of the ranking, but it is only the environmental impact when you one you implement a project, you look at the cost of the project you also look at how does the system operation, whether you will be able to run that system whether you have the main power to run it how sophisticated the system is. So, all those how easy this to operate the system. So, those things do come into picture when you finally, decide. So, here in terms of cost bio filter organics comes out to be number one than bio filter inorganic and packed bed wet scrubber is very costly. So, that is as number 3.

In terms of system operation also packed bed wet scrubber actually come out to be number 3 which is in and one and 2 is shared between inorganic and organic bio filter, but in terms of environmental impact bio filter organic bio filter inorganic is comes out to be number 3 organics is number 2 and packed bed wet scrubber is number 1. So, going by the different criteria's if you look at it is seems like the pipe bio filter organics seems to be the most preferred one because that is got number 1 in cost and number 2 in both system (Refer Time: 25:28) as well as the environmental impact. So, that is as the highest ranking. So, it will be that is kind of gives us some idea of about the picture. So, of course, we will be going to look at the more detail cost assessment and also we if we can look at the method of bio filter system less energy intensive. Since sizable portion of environmental impacts is associated with fan suction system if you can come up with that process that will really help.

So, that is kind of a summary of this is particular case study of how it is being done. So, this is the specification gives you an example of a how LCA exercise is conducted. So, now, let us take a quickly look at an another example a small example and then we will kind of close this particular video. So, for the other example which we will possibly look at is comparing this kerosene lamp versus solar lamp. So, if we are doing a kerosene lamp versus solar lamp try to compare these 2.

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We are using a kerosene lamp which is used in India or lower like in an in our rural areas, but we also solar lamp is coming up. So, how they compare.

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And we kind of this was again this project was done by one of my student, who is brain camenzuli this is his slides I am just presenting it to you. He did a project with me on this particular small project it is an under it is a B. Tech, thesis project where he kerosene lamp and solar lamp.

So, it is goal was again the goal is to compare kerosene lamp with the solar lamp determine which one is the favorable option.

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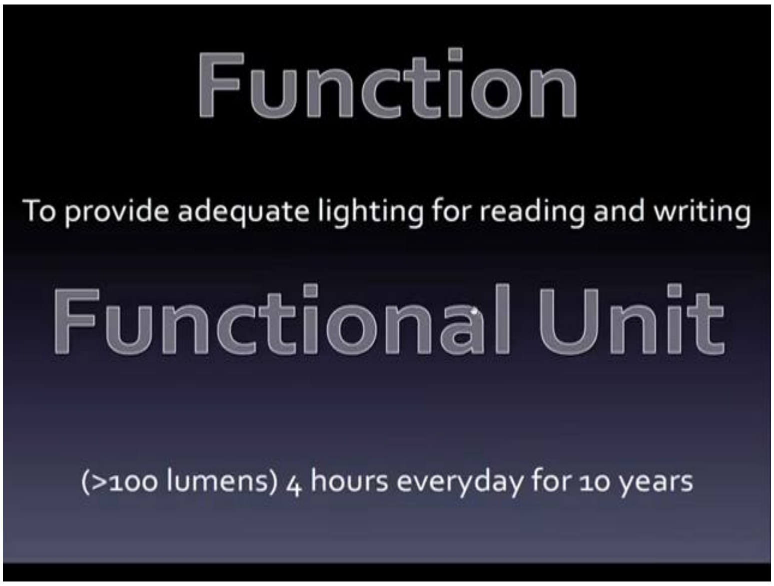

So, again we have to have a function in the functional unit. The function was to provide adequate light for reading and writing functional unit. It chooses hundred lumens 4 hours of everyday usage per 4 hours of everyday usage for 10 years. So, so that was in terms of a the like a function and the functional unit then we have to have the scope.

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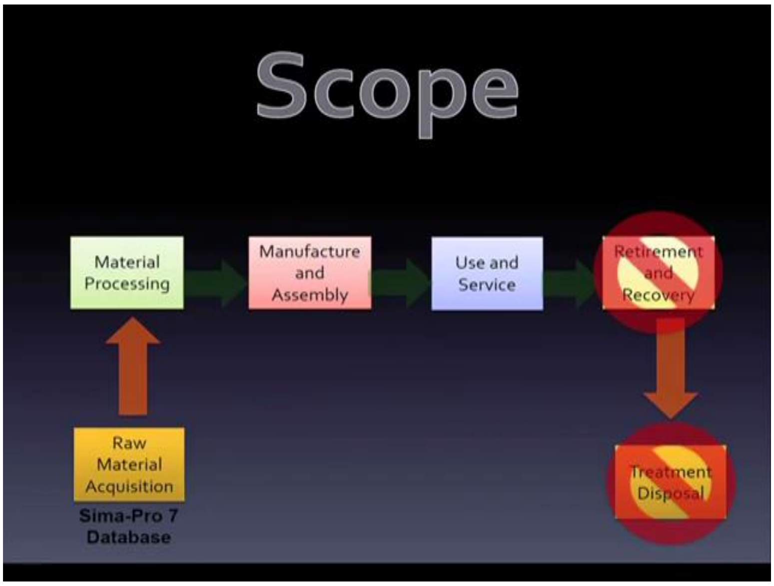

And the scope you start with the raw material acquisition you go for the material processing manufacturer assembly, use and service retirement and recovery and treatment and disposal, we did not go to that part. So, we all we did a cradle to gate. So, this was a he did a cradle to gate study

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So, this was the different component since this wasn't this particular solar panel that we solar powered per lamp that we used if had different components. He different components were not available like what are the different components out there is a what I did he took a solar this, particular one took it apart and looked at the different components and tried to quantify what are the different components out there and what are the different materials present there.

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So, then assumption was useful life 10 years assemble in Shenzhen china distributed in Tanzania Africa. So, we kind of use that part as well. So, transportation cost involved.

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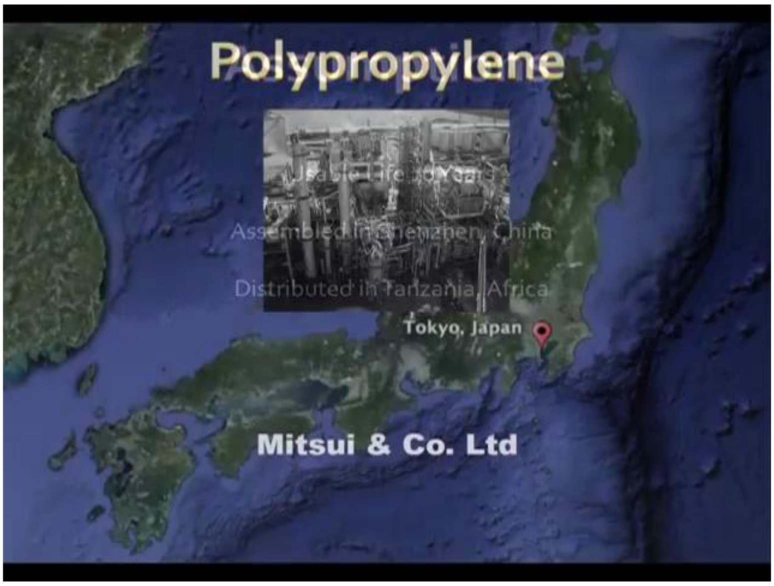

So, polypropylene it is a coming from Mitsui company limited from japan.

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Then we had polyethylene coming from Shandong in china, which was produce in this polyethylene.

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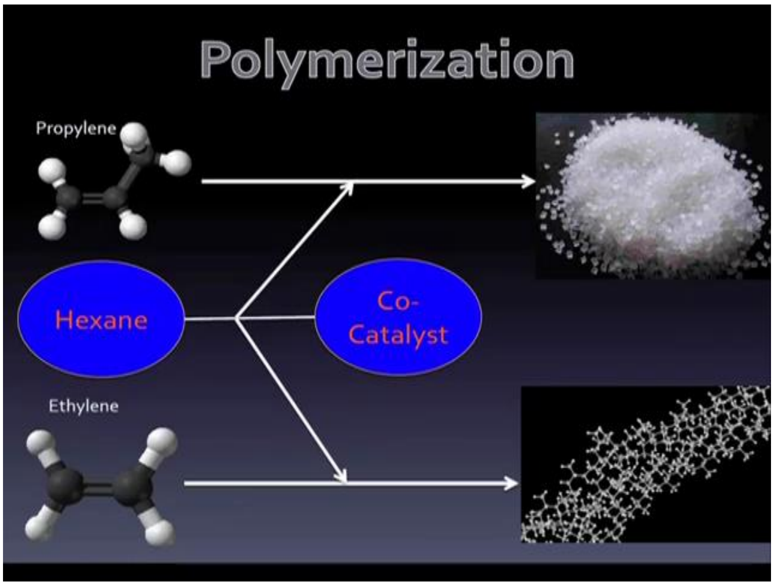

For that and we had a polymerization where polypropylene ethylene will mix together and hexane and CO catalyst. So, there will be polymerization being done.

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Then we have printed circuit board which was done by Zhuhai vastbright technology limited. Again this was a this was a kind of a real project we had the solar lamp we knew the solar lamp being produced and these aware all the different sources are coming in for producing in that.

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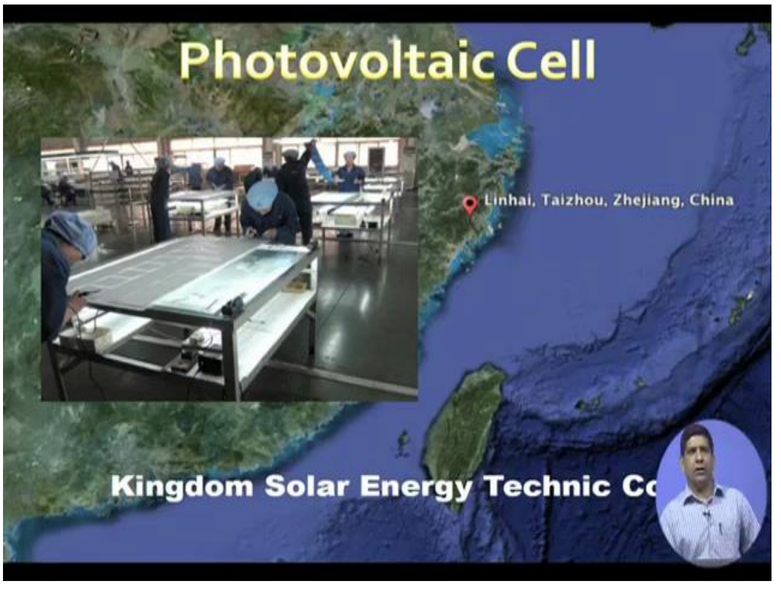

Then photovoltaic cell which is the produced in again in china kingdom solar energy technique company.

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Then we had this led which is again Shenzhen and that is where in Guangdong in china which was Shenzhen eastar battery company limited which is nickel metal battery, that was the led as well as the battery.

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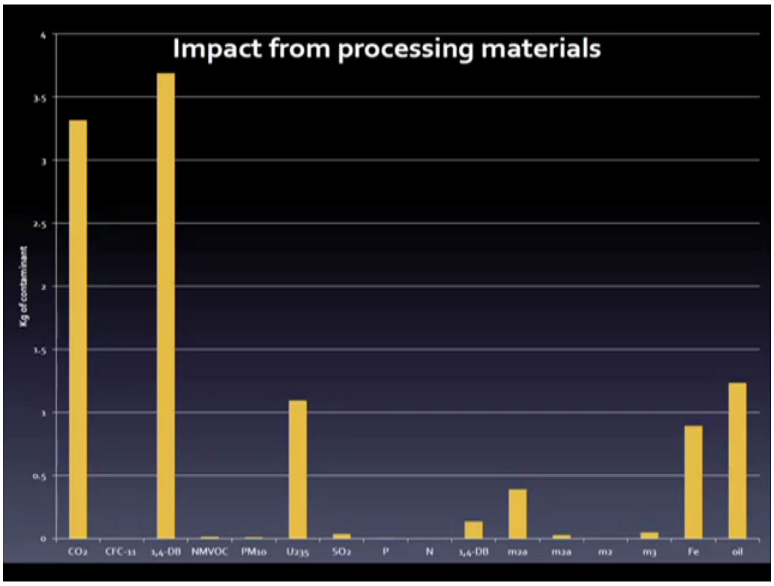

And then we looked at the impact for the different categories. So, we took all these materials. So, you look at the inventory we first refund out what are the different materials. You also had what are the where all these different materials are coming from. So, that we can have the transportation factor included because to form the plant where it is being processed. So, there in then you put all this information in this life cycle analysis software and you start seeing all the different types of emissions coming out. Here on the button on the y axis you see kg of contaminants and on the x axis you see carbon dioxide CFC pm 10u 235 and all those different emissions that is coming out. So, that is your impact from the processing material.

Then you have the impact from the from the transportation.

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So, this is showing you the transportation kind of a cost.

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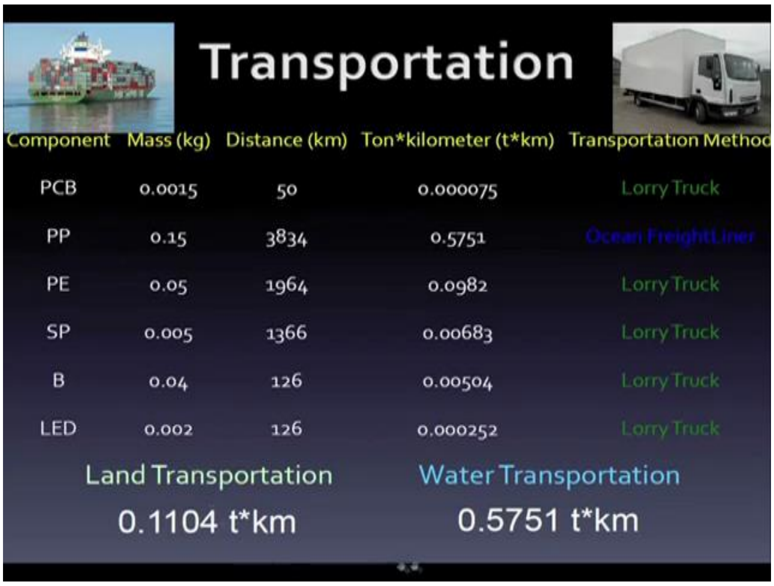

Transportation

Component	Mass (kg)	Distance (km)	Ton*kilometer (t*km)	Transportation Method
PCB	0.0015	50	0.000075	Lorry Truck
PP	0.15	3834	0.5751	Ocean FreightLiner
PE	0.05	1964	0.0982	Lorry Truck
SP	0.005	1366	0.00683	Lorry Truck
B	0.04	126	0.00504	Lorry Truck
LED	0.002	126	0.000252	Lorry Truck

Land Transportation 0.1104 t*km

Water Transportation 0.5751 t*km

So, transportation again we looked at PCB pp for popular polyethylene, what is what are the things coming out if the land transportation as well as a water transportation and ocean freightliner as well. So, based on this how much mass what is the distance is traveling what is the ton kilometer.

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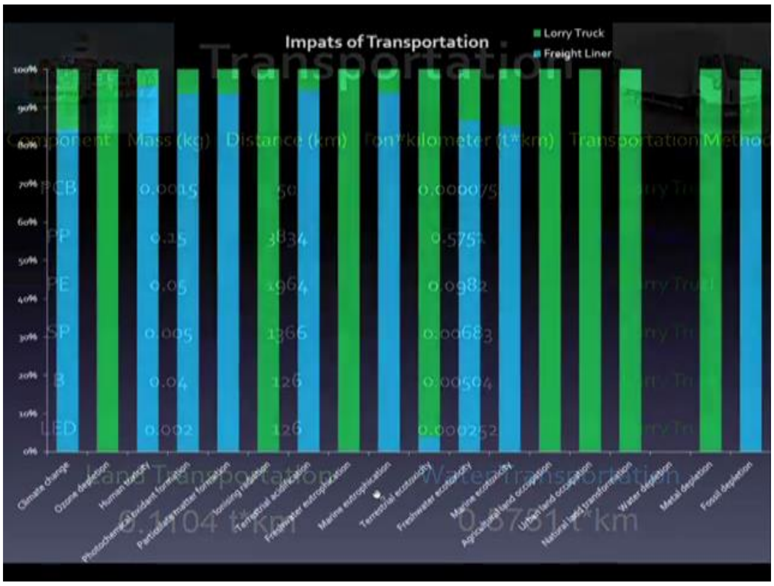

And from there we can kind of calculate what is what will be the impact of transportation, as you can see more and more impact is actually coming from the transportation side for the different type of an impact categories.

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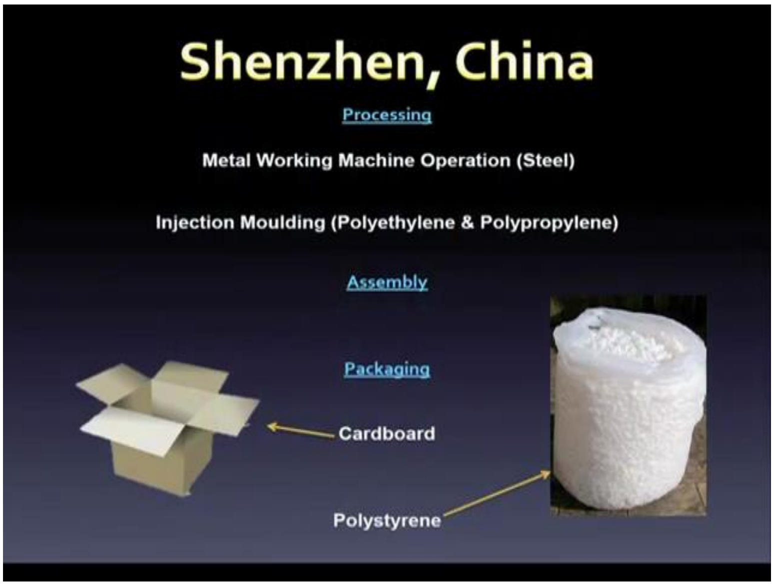

Then we have processing metal working where injection modeling assembly packaging cardboard. So, those things are being made.

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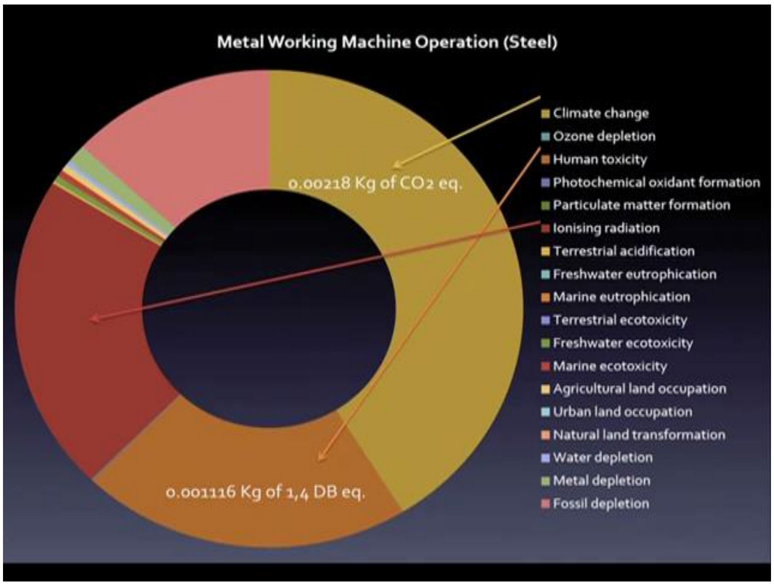

So, this is in terms of what is there metalworking machine stuff how much kg of CO 2. So, different types of metals. So, we will look at the different impact categories. So, this is particular kind of graph and shows you different types of impact categories from the machine the operation for this steel the metal working machine. Then similarly for injection molding what kind of impact is there for the injection molding side for the different categories.

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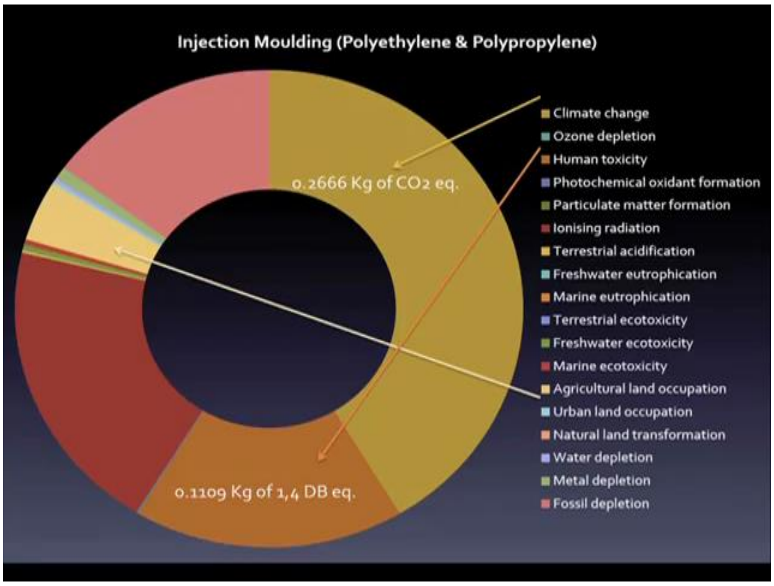

Then it has to kind of transport it to Tanzania.

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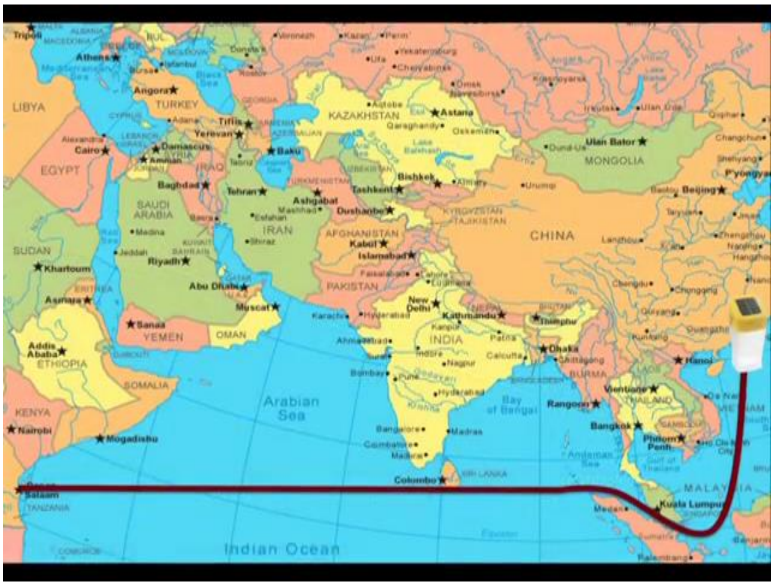

And there it would be looked at. So, there is a transportation. So, in terms of the transportation from china to Tanzania.

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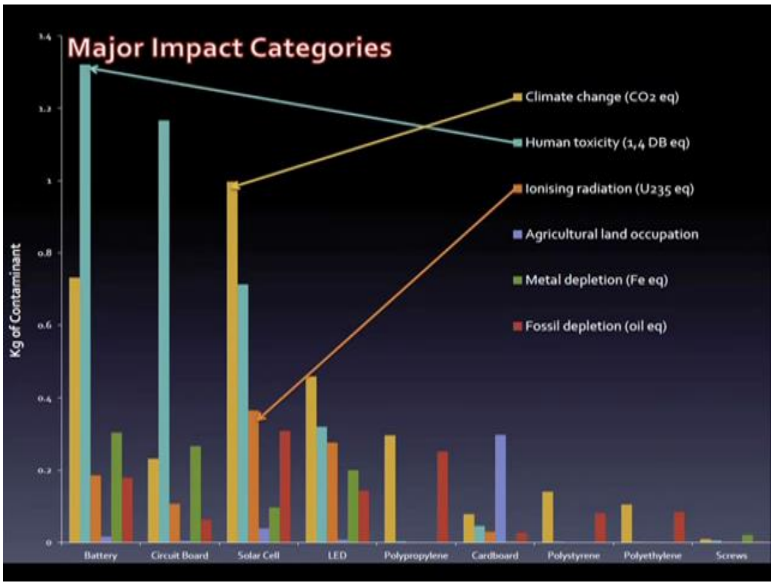

What are the impact categories how much is the impact we try to try to quantify that? So, then you take it to again different types of an impact categories.

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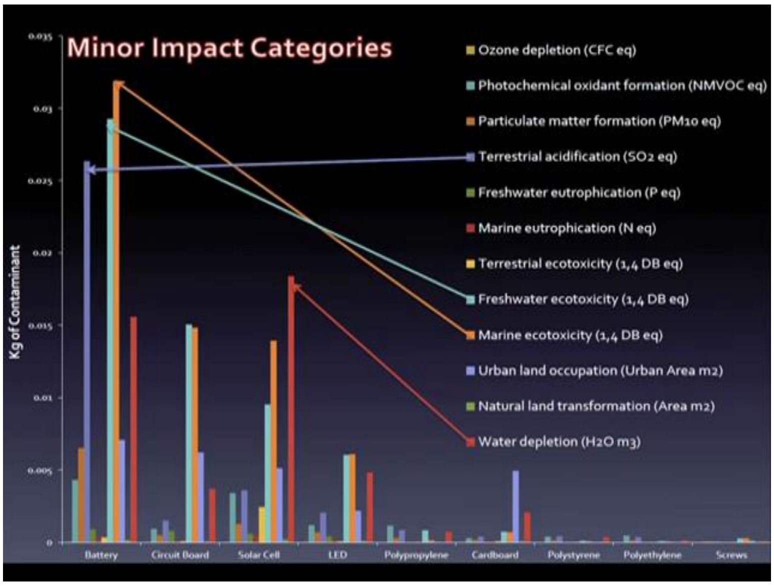

From the battery for the different types of a battery circuit boards solar cell led polypropylene cardboard polystyrene polyethylene all the things that is out there we kind of look at their stuff.

Then we had the that is for the solar lamp for the kerosene lamp.

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We are using if say 2 year usable life one and we have a width we have if uses a recycle material and it is developed in Nairobi Kenya as well is no transportation that much transportation involves.

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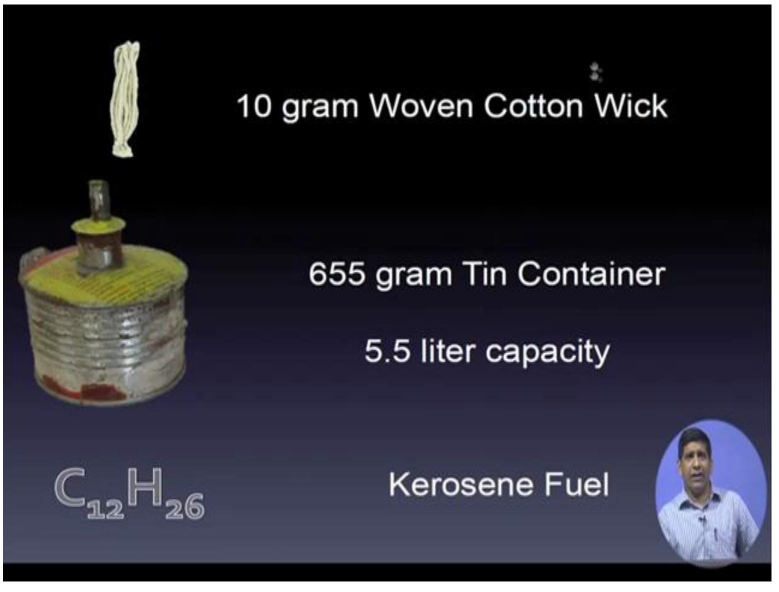

So, it is a 10 graphs of woven cotton wick 655 grams of tin container 5.5 liters of the capacity then the kerosene fuel used for that.

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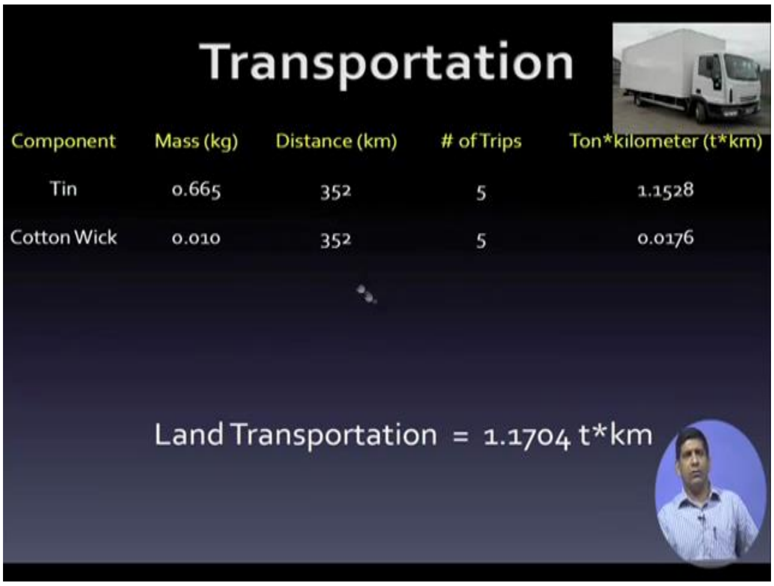

So, in the transportation little bit of transportation which is involved from the plant to the site. And this we kind of source this much kilometers and this is the 10 kilometers we have calculated.

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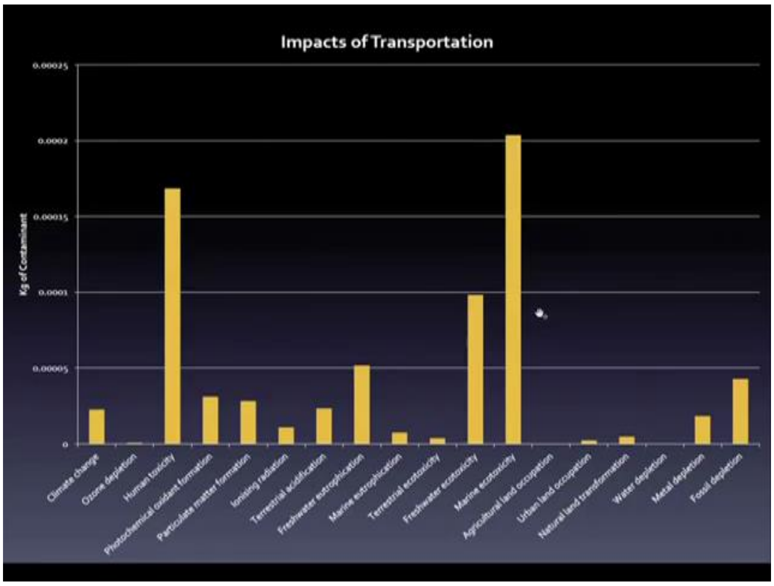

And then for again for similarly we have looked at the environmental impact categories for all these different impact.

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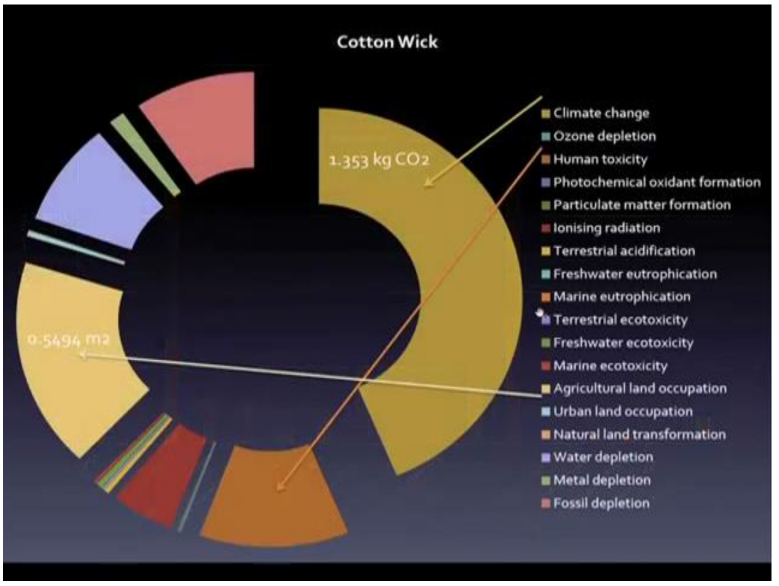

From the cotton wick as well, but will be the potential impact again CO 2 emissions was the number one.

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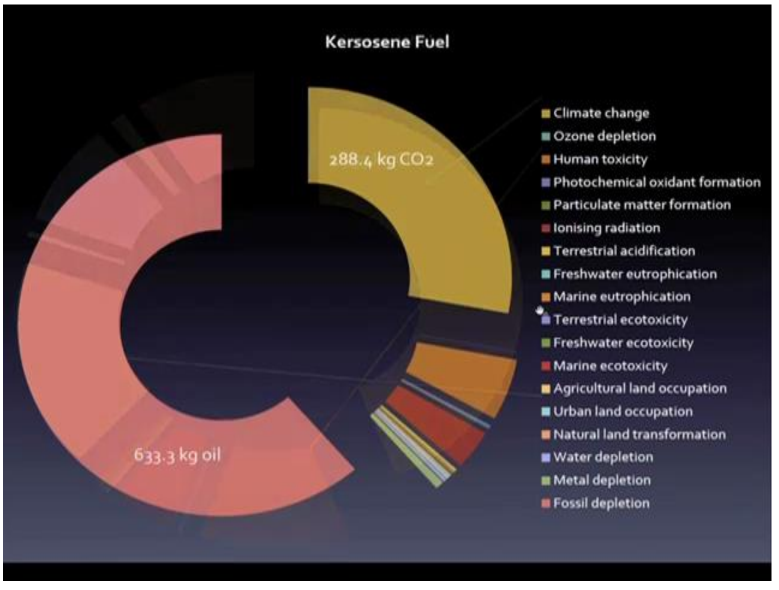

Kerosene fuel as always saw the impact and for the kerosene fuel we see that different types of impact that is coming out. It is fossil depletion is actually the kerosene since it is a fossil depletion it comes out to be much higher.

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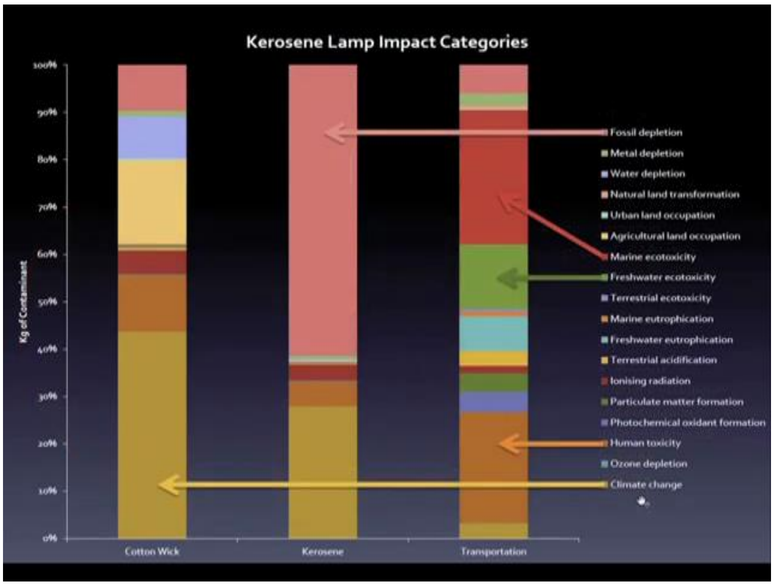

So, the different important categories for the kerosene lamp again the fossil depletion and the other categories this. So, up is higher.

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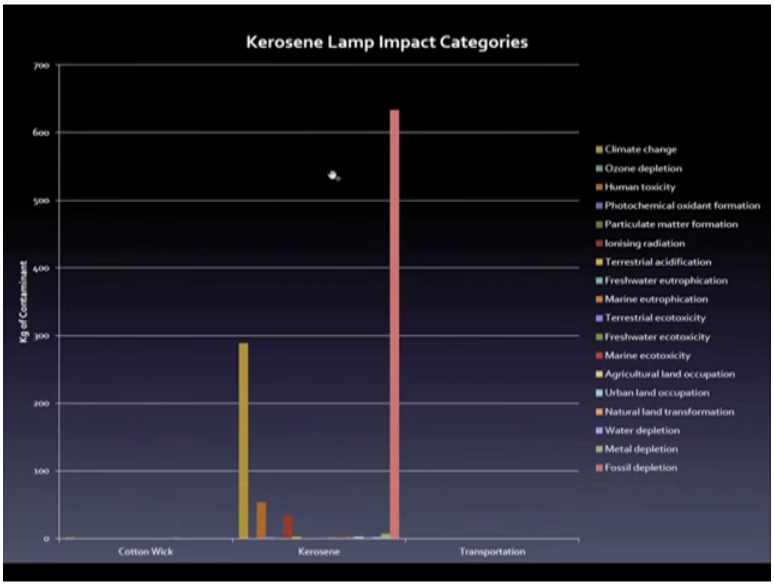

Ah impact categories. So, is at again we look at the cotton wick kerosene lamp and the transportation how much is the impact coming out.

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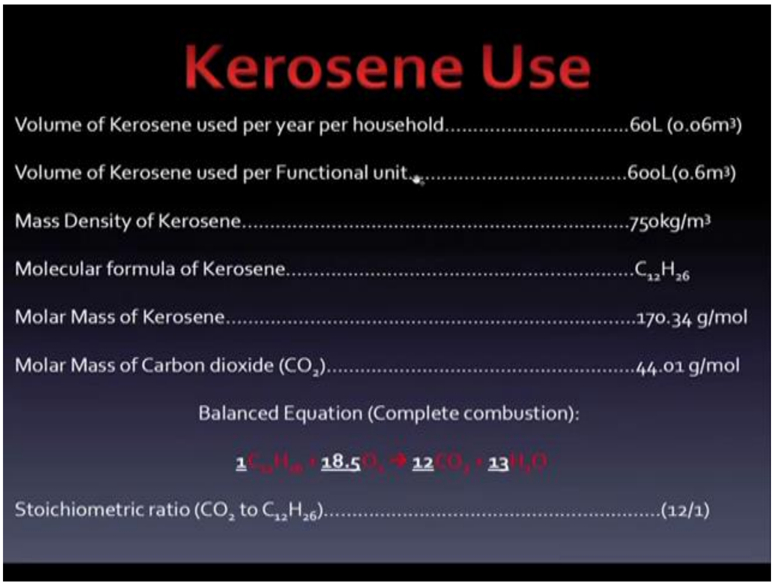

So, it is how much there will be used how much kerosene is used volume of kerosene used per functional unit what is the density and all those calculations you can do for that.

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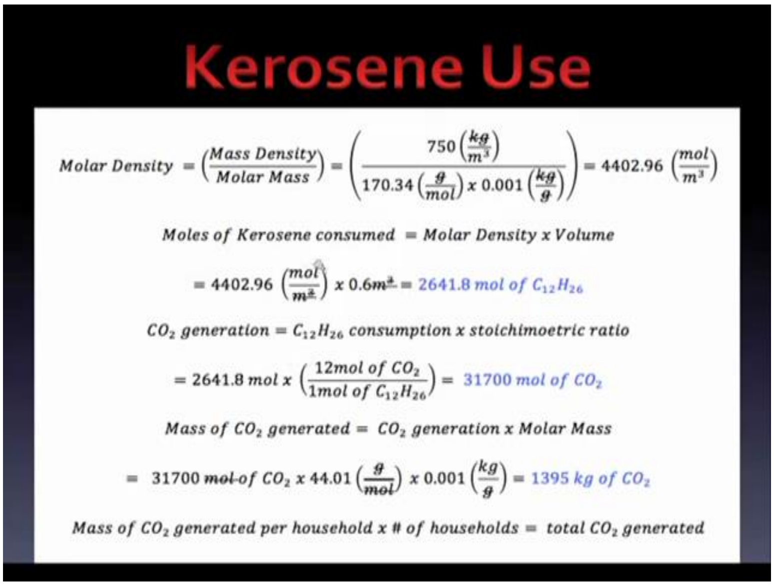

And based on that how much CO 2 will be generated what is the mass of CO 2 generated those calculations can be done.

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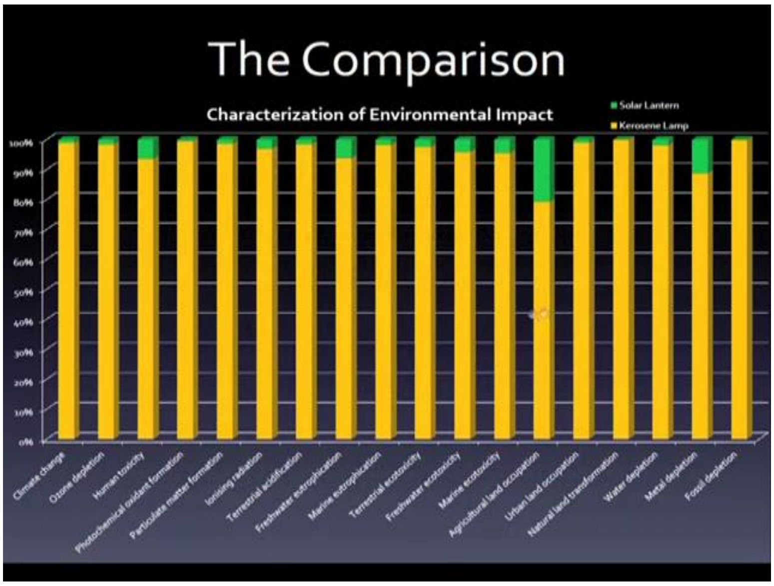

And then you look at the characterization of environmental impact as you can see, solar lamp is much smaller than compared to kerosene lamp. Kerosene lamp impact is much high. Which the answer in kind of already knew isnt it. It is not that we do not knew what is a impact, but here we can quantify how much is out of a different categories if you look at which one you see more like a it is a kerosene lamp is much higher than solar in most of the categories.

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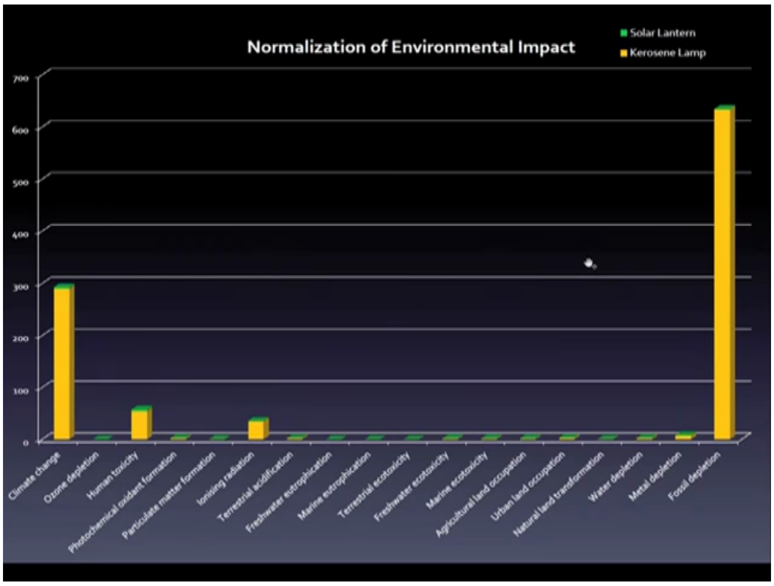

So, that is kind of gives you an idea and you can then you can normalize. It again you can have normalized the data you can see for most of it, you do not see much impact in terms of the solar latin and you, but in the some you see more impact in terms of the kerosene lamp which you showed up here.

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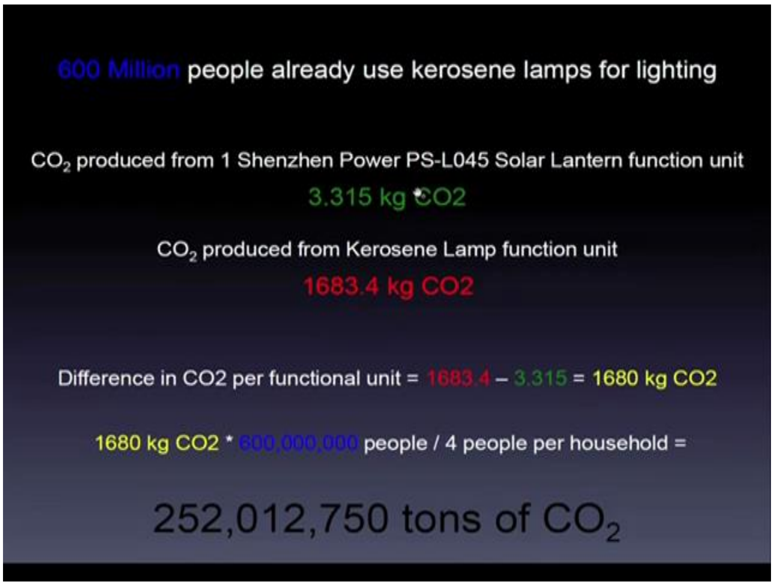

So, 6 hundred people already use kerosene lamp for lighten CO 2 produced is a 3 point one 5 kg of CO 2 for kerosene lamp 1.638. So, much higher. So, it is we can save 252 thousand again million tons of CO 2, if we use in terms of it is an if you start using solar lamp as a I suppose to using kerosene lamp.

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So, how much environmental saving we can quantify again. For many of this exercise you may say that I already knew the answer that is true you already had the knew the answer that which one is better, but you had the qualitative answer what LCA exercise does is it gives as a quantitative number.

So, that you can use that number and use it for better product design. So, these were the 2 examples in the next media we will look at another few examples in the next few videos and with that, let us close this particular video and I will see you again in the next video for this particular week.