Life cycle Assessment
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Lecture – 22
Unit Process, Data and LCI Databases (Contd.)

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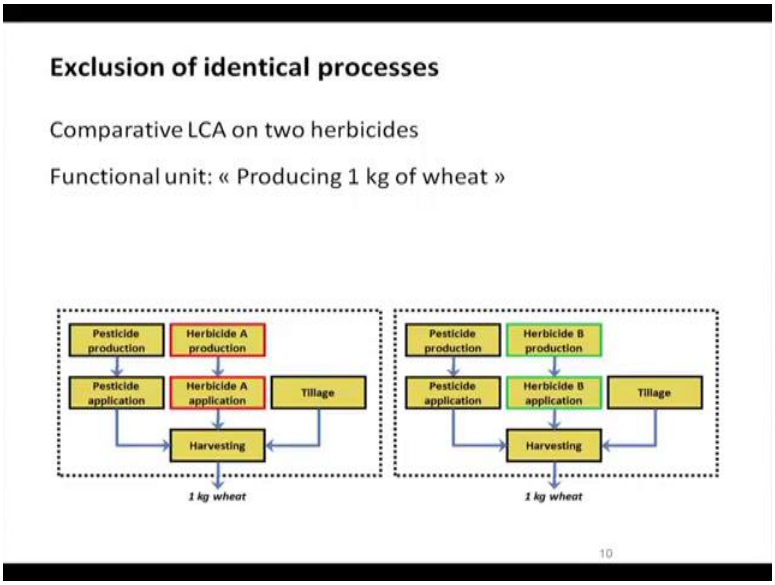

So let us continue from where we left in the previous model, we were looking at how like if you remember I said towards the end of that module that when we have; when we are comparing 2 systems if there are certain unit processes which are similar which have similar impact we can exclude them. So, let us look at the example for that try to. So, I thought it will be better if we look at an example that may help clear things. So, I thought that let us look at this example. So, for example, if you are doing a comparative LCA on 2 herbicides, we know herbicides we use it during the agricultural operations. So, if we are trying to see that the herbicide A verses herbicide B. So, there are 2 different herbicides and you want to look at what is there we want to do a comparative LCA and again we have to have function and the functional unit.

So, what is the role of these herbicides they basically help in the agricultural activity keeps the pests and other things away. So, it is that is your production is better that is the

ultimate goal and. So, it is been a document if you remember what is if you just now what I said production is better. So, production it, functional unit, functional unit we can take a production unit. So, production unit could be say 1 kg of wheat say if you have 2 herbicides used for used in wheat cultivation and then we have you are producing wheat. So, if you are producing for in terms of functional unit of one data kg of wheat of 2 different types of herbicide. So, let us look at it in terms of their comparison. So, on the left hand side there is our herbicide A on the right hand side is the herbicide B.

So, here you have your pesticide will needs to be produced. So, the poster pesticides is produced pesticides is applied herbicide A is product produced herbicide A is applied then you have your tillage where you take the things like you will pick it harvest it. So, that is your harvesting. So, and from harvesting you are producing 1 kg of wheat. So, that is the system boundary. So, system boundary here we have in terms of what in terms of the like a help in production of wheat from this herbicides and. So, this is herbicide A now for herbicide B same thing we have pesticide production pesticide application herbicide production herbicide be pro application then we are doing harvesting and then we do the tillage data for that send them you are producing one kg of wheat.

So, if you compare these 2 particular system if the exclusion of production and application of pesticides tillage and harvesting if the yield if the cultivation yield is the same. So, whether you use herbicide A or herbicide B if you end up producing the same amount of wheat on a particular like a per unit acre per unit hectare whatever per unit area. So, if you are producing the same amount of wheat irrespective of whether you are using herbicide A or herbicide B. So, that tillage will be the same and harvesting will be the same. So, in that case we can get rid of this pesticide production application tillage and harvesting.

So, here since production and application of pesticide tillage and harvesting if they can be excluded if the cultivation yield is the same if the cultivation yield is different then it we cannot do that. So, I hope you are understanding what I am trying to say I will repeat that once more time since the pet the cultivation yield when we say cultivation yield means the amount of wheat produced per unit area per unit area per unit acre per acre per one acre per one data hectare whatever unit you choose if the amount of wheat produced

is the same irrespective of whether you use herbicide A verse or herbicide B in that case we can exclude the production and up production and application of pesticide we can exclude the tillage part we can exclude the harvesting part in the comparison here just because it does it they do not have they will have the same impact they will the impact will be the same.

So, and then we will just we just look at these 2 boxes herbicide A production or application here herbicide B production and application. So, comparing these 2 will be enough, but if we had a difference say now we with herbicide A we are producing one point 5 kilogram of wheat where we used to produce one kilogram earlier. So, then we cannot do that because the impact will be different our functional unit is 1 data kg of wheat. So, we need to adjust our numbers I hope you are getting it I am trying to say. So, that is how it is usually done.

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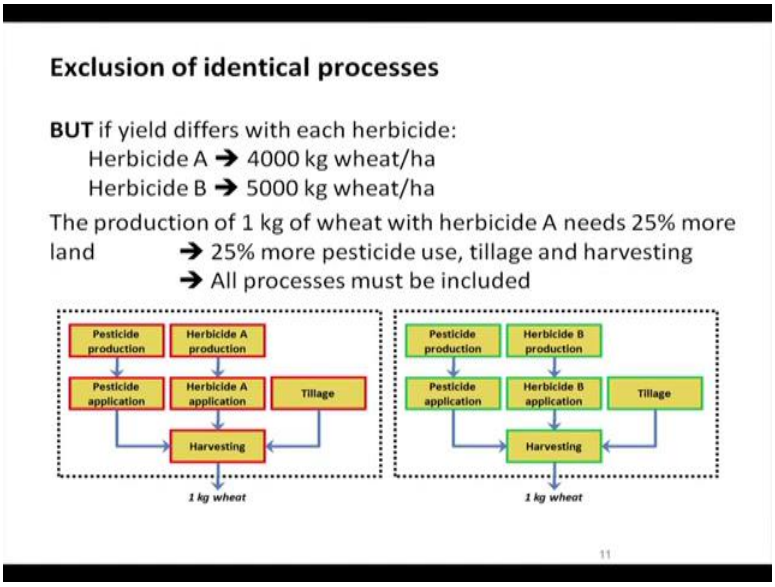

So, exclusion of identical process can be done if we have the if the production is the same, but if the yield differs if the yield is not the same say when we produce when will give herbicide A we are producing 45000 kg of wheat per hectare and while we are using herbicide B we are doing 5,000 kg of wheat per hectare. So, now, what does that mean; that means, that for the production of one data kg of wheat with herbicide A, it needs 25

percent more land. So, if you are producing using herbicide A for one kg of wheat you did you need more you need 25 percent more land. So, 25 percent more land means what that leads to 25 data more pesticides use; that means more tillage more harvesting. So, then in that case we have to include all the processes had not been that both with herbicide A herbicide B we are producing 5,000 kg per wheat per hectare or for both of these cases we have been producing 4000 kg per wheat per hectare in that case there would it would be the same amount of land same amount of herbicide or pesticide same amount of pesticide uses or tillage or the harvesting. So, in that case we could have excluded pesticide production pesticides application harvesting and tillage. So, I really again it is if you since the production is not the same herbicide A to production of one data kg of wheat with herbicide A needs 25 percent more land because herbicide B things are more productive we are producing 5,000 kg per wheat per hectare. So, in that case since you need more land more land means more pesticides use more tillage more harvesting. So, in that case you actually have to you cannot exclude any of the processes while comparing herbicide A and herbicide B impact.

So, everything needs to be included. So, if you have not understood re play this video I have talked already said many times. So, it should and if you not of course, discussion board is there to ask questions. So, it is a, but that is these are some of the very important stuff because when you will be doing a real life LCA exercise there since there are. So, many processes involved it is always better to exclude some processes if you can because that makes your life simple so, but to do that it has to be that you cannot exclude something which you cannot which is not permissible just because it is not an identical process it is it becomes a non identical process in the scenario like this where with her one herbicide A you are getting 4000 kg of wheat per hectare while for herbicide B you are getting 5,000 kg wheat per hectare; that means, there is a impact on land use impact on pesticides use impact on tillage impact on harvesting.

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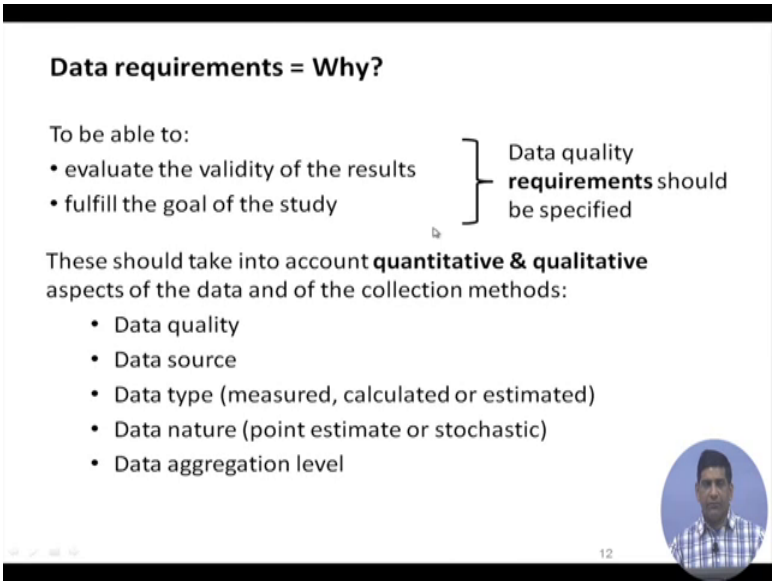

And so that is all that is are there in terms of. So, when you cannot exclude those next if we will look at the data requirement. So, there is a data is needed we kind of talked about that already, but here kind of look it quick summary again these are the stuff coming from ISO methodology data requirement why we need the data because to able to evaluate the validity of result data quality requirement should be specified we need to look at the data quality we need to fulfil the goal of the study those the data is required now we should take into both quantitative as well as the qualitative aspects of data and of the collection methods. So, I need both quantitative as well as a qualitative aspect of data. So, data quality data source data type when we say data type whether it is a major data whether it is a calculated data estimated data whether it is point estimate whether it is a stochastic came from a stochastical model data aggregation was done. So, all those things need to be studied and make sure we have a good data which goes into this exercise.

I hope that by this time since we are in the fifth week now and we have discussed. So, many like aspects of this life cycle analysis methodology I since I hope that you now get the sense of that how complex this can get and at some points and that is why of course, with the use of software and another things our life becomes much simpler, but then this may get complex and say you are doing all this complex exercise, but at the base of all

these as a data and if the data quality is not correct then all the other activities all the other efforts actually goes wasted. So, that is why having good quality data is very very important.

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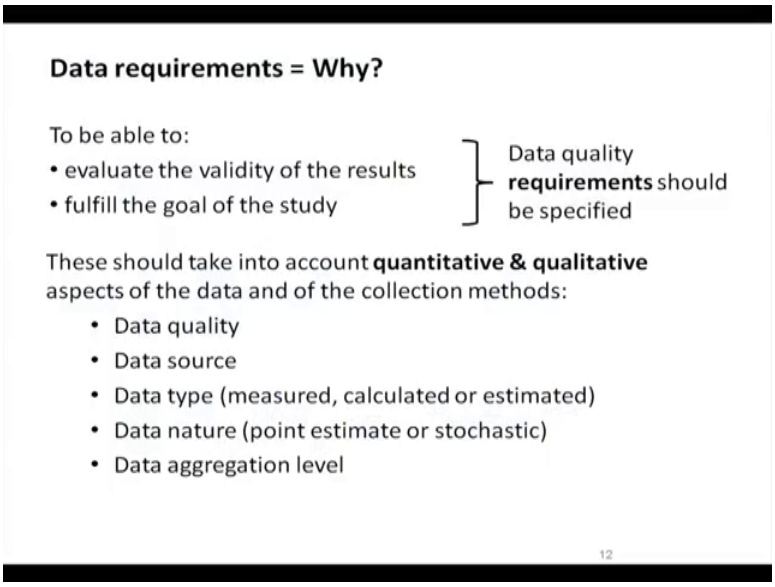

So, if in terms of the data quality we look at the temporal coverage which is the desired age and time coverage of data we mentioned a little bit about that we usually look at the 5 at least like not more than 5 year old data because things do keep on changes. We need to look at the geographical coverage geographical zone which data must be collected local regional national technological coverage combination of technologies say which is the or the best available technology depends on what is most popular which should go for the day technologies which is say - if you want to go for a particular product for that particular product which technology is more popular right now which technologies in terms of what is the production of that using that particular technology. Say if 100 units of certain things is produced say if 60 units is produced using process A and then there are process B, process C we can take a weighted average of what is the production based on that we can take a technological coverage measure of variability of data completeness of data. So, all those things need to be looked at in terms of the data quality.

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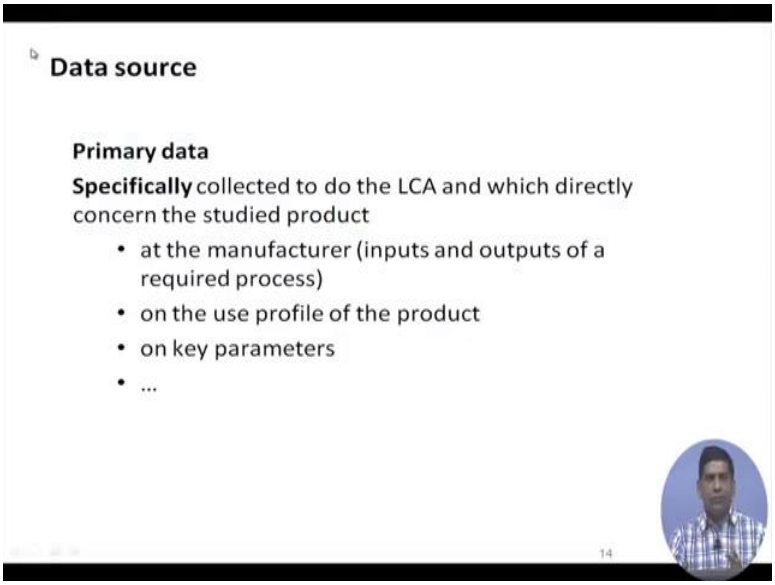

And data source data always having the primary data is the best not only in terms of doing LCA in terms of doing many of the other activities having primary data is always the best thing, but primary data means you have to collect the data on your own and that is may not be possible for many many aspect because you have time limitations as well there is only 24 hours in a day. And so, you need have a time limitation there are there is always a time limit on the project you need to get the project done quickly and if you are working on your masters for master's thesis or a PhD thesis again you have a certain time limit there too you cannot work on a thesis for like n number of years so far that you need to you need to look into. So, when you some of the data that you can collect easily of course, and then whatever you data you cannot collect easily have to rely on the secondary data.

Secondary data is where you basically look at some published report or your data that you got from somewhere else. So, primary data is a specifically collected to do this LCA and which directly concerns the studied product you are looking at what the data that was collected for this particular exercise and it is you can go to the manufacturing plant and then you look at the input and outputs of a required process if you try to find out what is the input what is the output of the required process you look at the on the use profile of the product of key parameters of this all you try to collect data by yourself. So, that is

that is the primary data where you are doing this by yourself.

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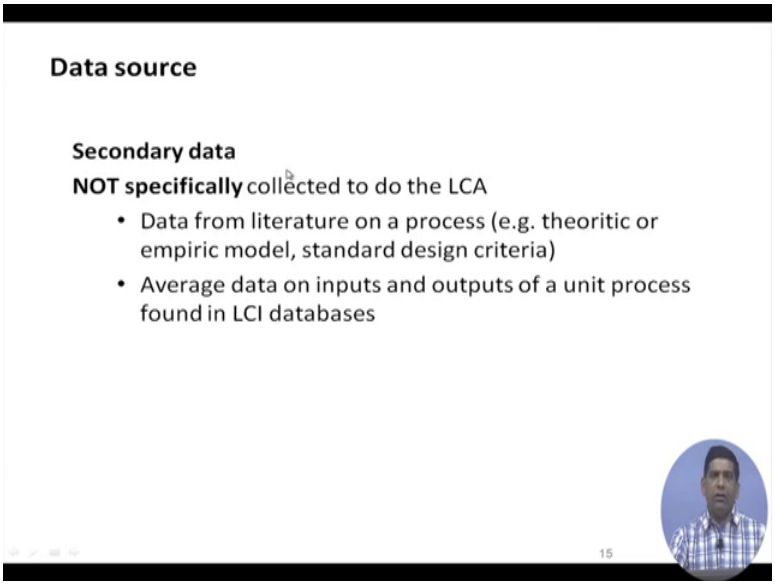

Secondary data is data has been collected elsewhere by someone else, but not specifically collected to do this LCA it was not a specifically done for collection of LCA. So, it is a data from literature on a process that is a theoretical or imperative model standard design criteria so, but based on that you have data available, but it was not done collected for this LCA exercise, but you are taking that data and use trying to use it for LCA exercise. So, that is an average data on inputs and outputs of a unit process and that is you found it in LCI database. So, that is LCI databases are available which is used for collecting data for getting data for doing your LCA like LCA exercise.

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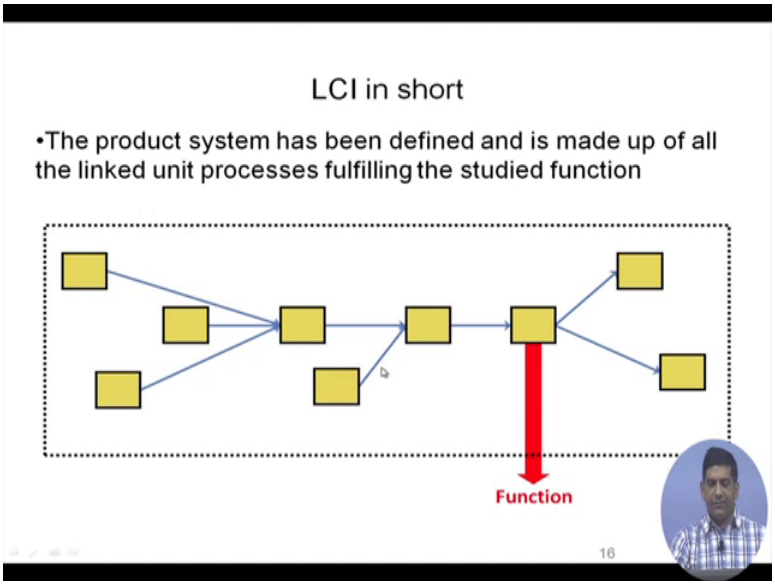

Now, what is LCI that is your; it is a LCI in short will try to understand that it is a product system has been defined. So, you have this is your whole kind of system boundary each of individual boxes are our unit process each boxes are having a unit process and then we are all these unit process together is doing the function.

So, that is the function that we want to do and this unit processes are linked together. So, has been the cyst product system has been defined and it is made up of all the linked unit process. So, that is fulfilling the studied function. So, whatever function we are trying to achieve. So, these are different boxes or each of them as unit process they are linked to each other some are independent some are connected to each other and then you this is whole together is give is giving us a function.

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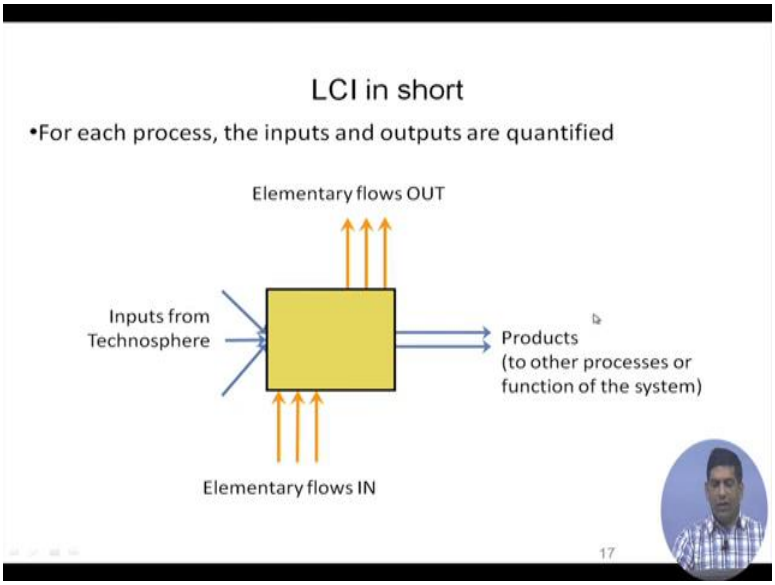

So, if you look at the individual ones in terms of the life cycle inventory for the individual ones for each process we quantify input and output. So, that is why you have a say this is one particular unit process it has elementary flows in that elementary flows in could be coming from some other process before it there is some other inputs from techno sphere which is coming from the outside which is not related to the other unit process going on. So, there is some input from outside there is some elementary flow out which will again can become a input to the other unit process and or you can have some products as well or to go to other process or function of the system. So, this is your elementary flow in and elementary flow out where you have your materials energy that is coming in and the material energy waste that is being produced that is going out.

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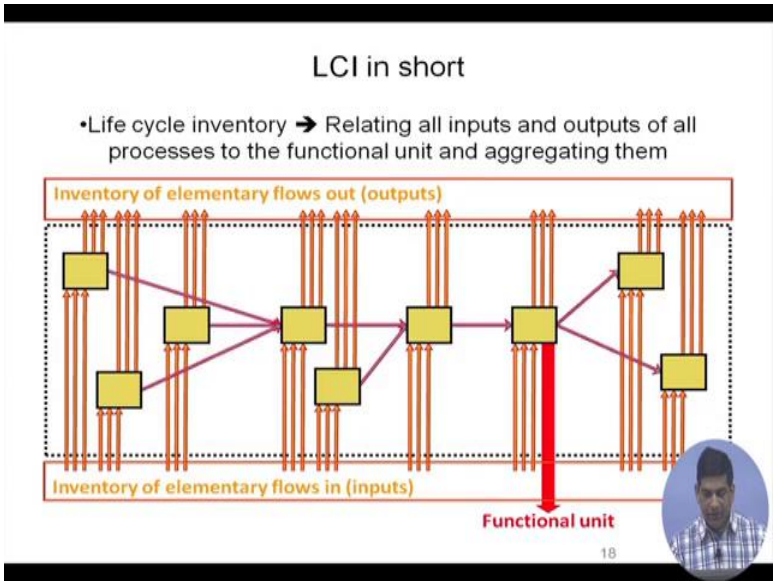

So, that is your input and output this is how for each process we can look at the input and output similarly if you look at all these different process relating all inputs and outputs of all the process to the functional units and aggregating them. So, what we are trying to do over here is for each of these individual unit process we have elementary flow in we have elementary flow out. Similarly for each one of them we have some elementary flow in going out and for this particular function or the functional unit that we are looking at we had we are; we will basically add all them up this is this you add all the input you add all the output and that is it gives you the input and output coming out of this particular system. So, that is how the life cycle inventory is done. So, you add them up and that is becomes your life cycle inventory. So, this is your inventory of the elementary flow which is going in to the system. So, all the arrows which is going into this system that is the inventory of alimentary flow in that is a input and these are the arrows which is coming out are the outputs. So, that is input and output this is how it is done in terms of the life cycle inventory.

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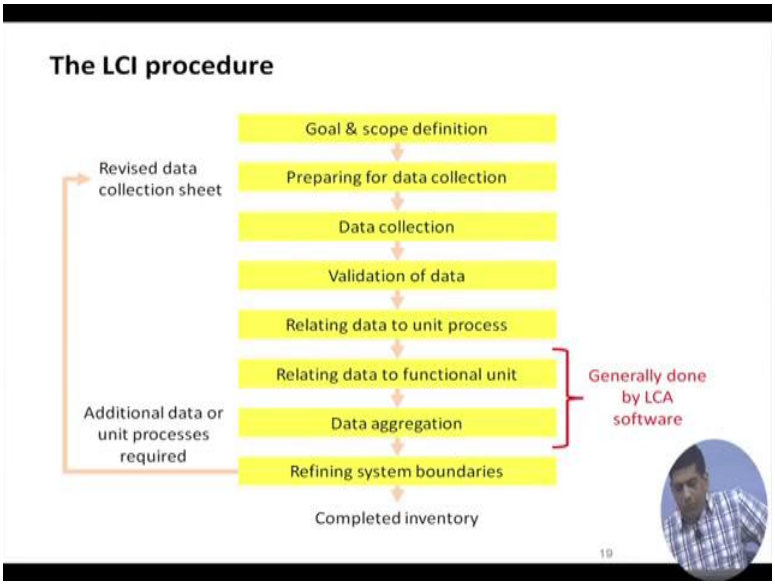

So, again recap we have been; so, in terms of the LCI procedure you have your goal and scope definition you prepare for data collection you go for data collection either primary data secondary data whatever you can able to collect it you validate the data you make sure the data is correct. You get cross checked if you have multiple sources of secondary data you cross check with them if it is in primary data you make sure you based on your research you make based on the data quality QA QC procedure you make sure that the data quality is correct.

Then you relate the data to the unit process and then you relate the whole data to the functional unit you do the data aggregation and as if you look at on the side generally this part is done by LCA software. So, there is LCA software which we introduced to you in a little while. So, later this week hopefully I will look at some of these else what are the different LCA software out there. So, I already talked to you about one which focused on waste management. So, this is generally done by LCA software this is which they help us in doing that then you look at your if you look at your system boundary you feel like maybe you may have to refine the system.

So, you refine the system boundary you may need additional data unit process may be required. So, you go back and revise the data collection seats and the process could be

iterative for couple of times before you are confident with all the data that you have which your LCA procedure. So, this is how in nutshell the LCA procedure works. So, again this is like you have to be based on your goal you prepare for your data collect the data validate the data relate the data to the unit process then to a functional unit do the data aggregation to find system boundary. So, if you will remember we had those relating data to unit process those data after this data actually can come from the database. So, if you remember from the ex bulb example we had for the 1 data kg of glass 1 data kg of cardboard one unit of energy we had this data for that unit process then we can relate data to the functional unit that we did that on that particular slide as well for 228 data gram of glass to 32 gram of cardboard. So, same thing can be done using the software as well and then you look at the data we find system one read. So, that is your complete inventory.

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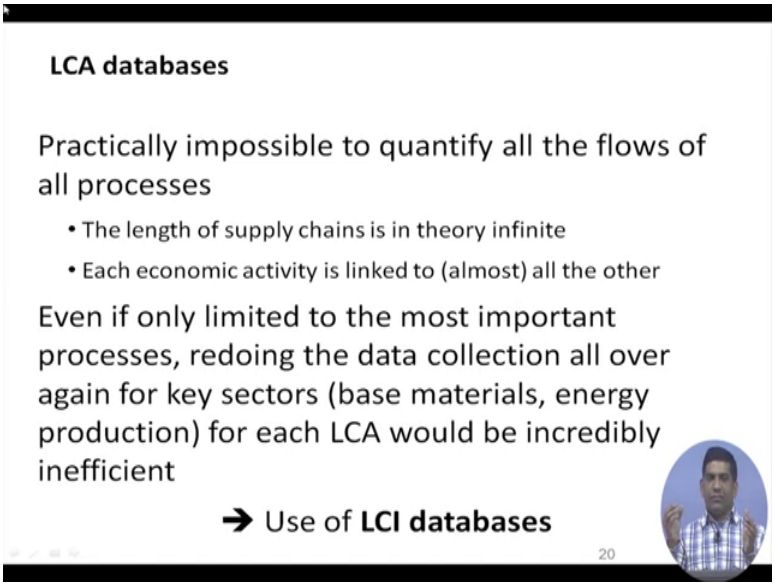

So, this is LCA procedure is really a big area which needs to be done in part of LCA exercise. So, there are LCI databases or LCA databases it is for particular it is impossible to quantify all the flows of all process because the length of supply chain is infinite. So, if you think about even for a smaller product you how you can go all the way to the mining and then there are lots of unit processes involved in between, things really gets too big. So, and each economic activity is linked to each other almost all other. So, what

we do is only limited to the most important process we do redo the data collection all over the again for key sectors like base material energy production for each LCA if you want to do it like we have to do that, but if you want to do it for each one each LCA we incredibly inefficient.

So, what we have done rather than going for other than like those important process which is limited which is limited to this particular LCA exercise all the standard unit process all the say for example, glass protection of glass how much in terms of the process of one data kilometre travel by car one data km travel by petrol driven car or a gasoline car or we can talk about 1 data km travel in aeroplane all these things have been these are the standard things and these does not matter in which like a example you use if this kind of data is required these are the standard data and they can be one like they can be quantified a standardized. So, that is why we start data putting this kind of information in LCI databases that is called life cycle inventory database.

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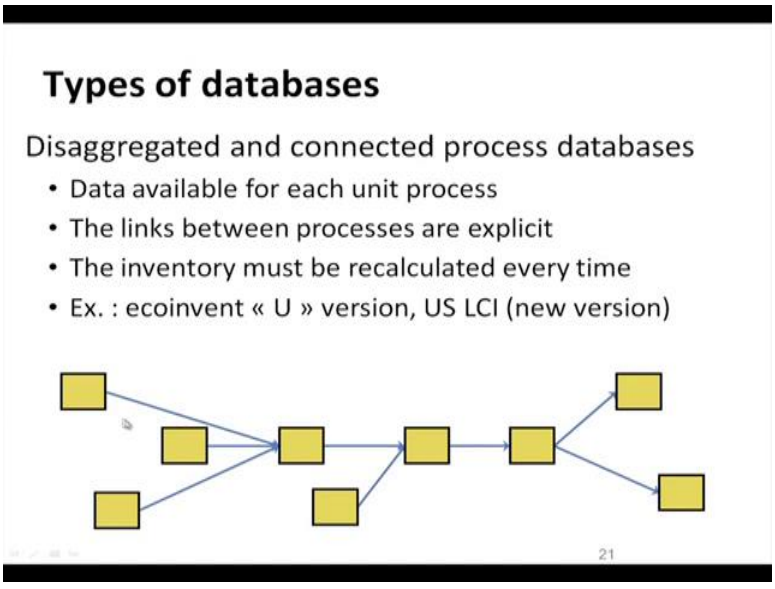

So, there are 2 types of database; one is the disaggregated database and connected process database. So, where disaggregated database is where you have the data available for each unit process for each of this unit process you have the data. So, you can take the data and then you can work with the data the way you want to work it work with links

between the processes are explicit data is available for each unit process the inventory must be re calculated every time. So, we have to do the inventory every time thus eco invent like the U version or US LCI which is another United States life cycle inventory database the newer version they have this aggregated data.

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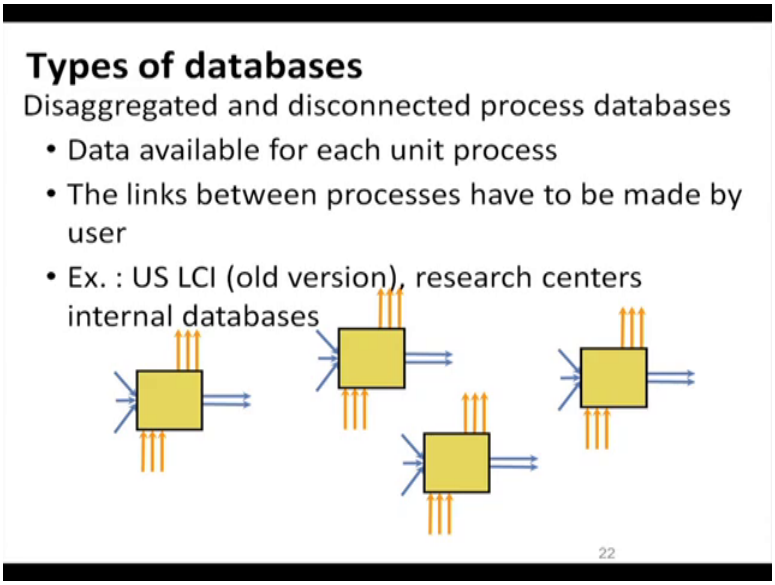

So, disaggregated data is actually or the disconnected process data it is you have data for each unit process. So, it is one way, it is good, it is a good for if you are doing research and if you are really want to get into each individual data and see how things are working. So, link between the processes have to be made by the user. So, you need to have some better understanding of how things work as well. So, you may have to say if you whatever LCI LCA you are going to do for all the unit processes that you that goes into that you should have the understanding of how these unit processes are linked together which sometimes may not be a say like we are not expert of everything. So, we may not have the understanding of how this unit processes are really work in terms of when the when a one particular product is manufactured, but we need to learn it or we need to take the help of the people who knows it to kind of have this link because we have to do the link.

So, there are, but it good for in terms of the research centre. So, that is why research

centres internal databases they usually try to go for this disaggregated database. So, you have these unit process for each one of them you have the data then you have to put it in a how they are connected together. So, you have to do it by yourself.

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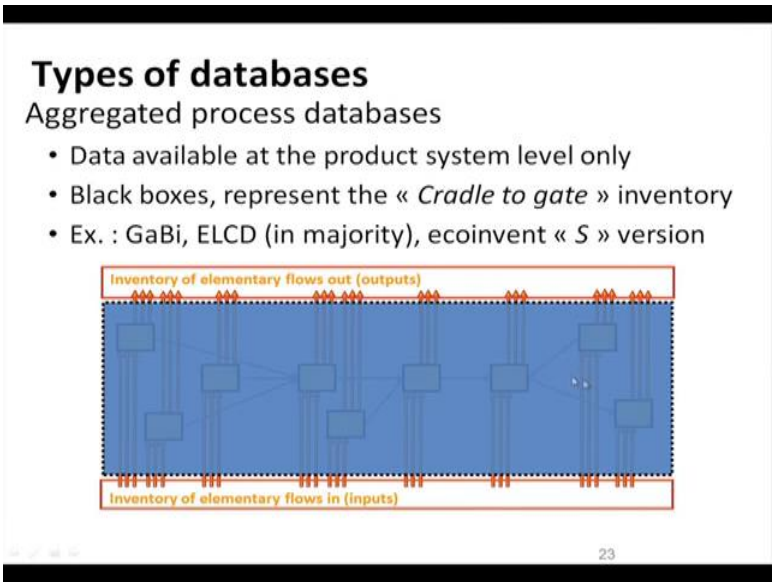

Other database is a disintegrate aggregated database aggregated database where you have this like a black box this is your black box you all this is a inventory of elementary flow coming in inventory of elementary flow going out. So, this is more like a black box for us data available at the product system level only. So, far this individual unit process that you see inside did we do not have data for individually what we have data is of by all the elementary flow going in all the elementary flow coming out, but in between we do not know which.

So, if it comes out to be say for example, if this comes out to be highly like a bigger environmental footprint we would not know which one say there are how many unit process has been shown here 3, 3; 6, 3; 9. So, there are 9 unit process we have the data as a aggregated data for all these nine together. So, for individually out of this nine which one is the culprit in terms of the bigger environmental footprint we will not able to find that. So, which will we wish we will be able to find it, if it was a disaggregated database as it was earlier? So, there is a difference there is a benefit of having both here it

becomes easy to use. So, it is like a black box represents the cradle to gate inventory gabby ELCD European most of the database over there eco invent s version they all use this aggregated process database. So, there is that is a data.

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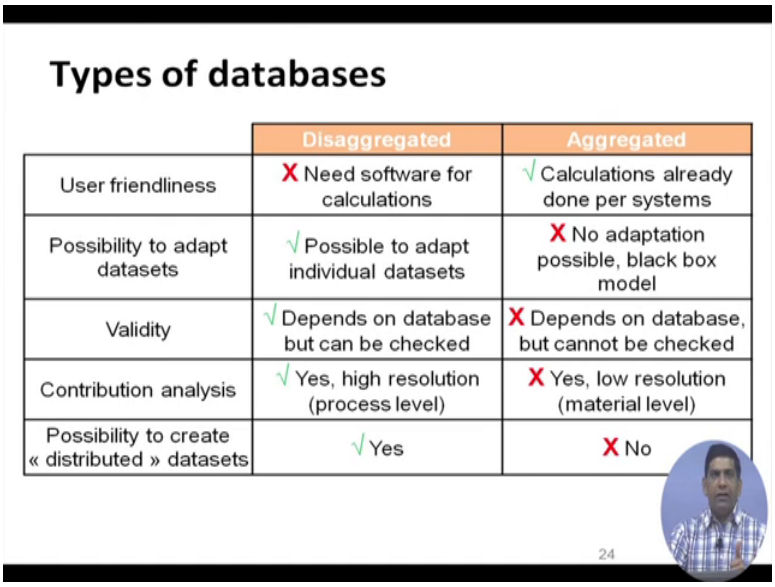

So, disaggregated aggregated in terms of its user friendliness disaggregated you need software for calculation here aggregated calculations already done per system you already have this done possibly to adopt data set data it is possible to individual data set and disaggregate it is actually, it is basically if you are working in a research mode where you trying to do some research activity your disaggregated database actually comes out to be much better aggregated there is no adaptation possible it basically like a black box.

Validity depends on database, but can be checked here aggregated depends on database, but we cannot really check it we cannot really check it, but most of this databases from a highly reputed companies now. So, we have there is it is there is not much of a problem in terms of database quality because right now we are working as I said we are working with a ecoinvent project and they are very careful in terms of what data we are collecting and there is a standard template and everything, how to collect it of course, there will be some drawbacks there is some data quality issues because our industries are not set up in a way.

So, that we can get very good data right now, but they are all industry is also coming up in that way. So, contribution analysis you can do high resolution process level, but here in aggregated you cannot like a material level on the lower resolution you can do it for lower resolution. Can you produce a distributed data set you can do that with a disaggregated you can look at a like you can make your own unit process different permutations and combinations and look at their in terms of input output and all that aggregated no again it is kind of a black box. So, we cannot really do stuff on that.

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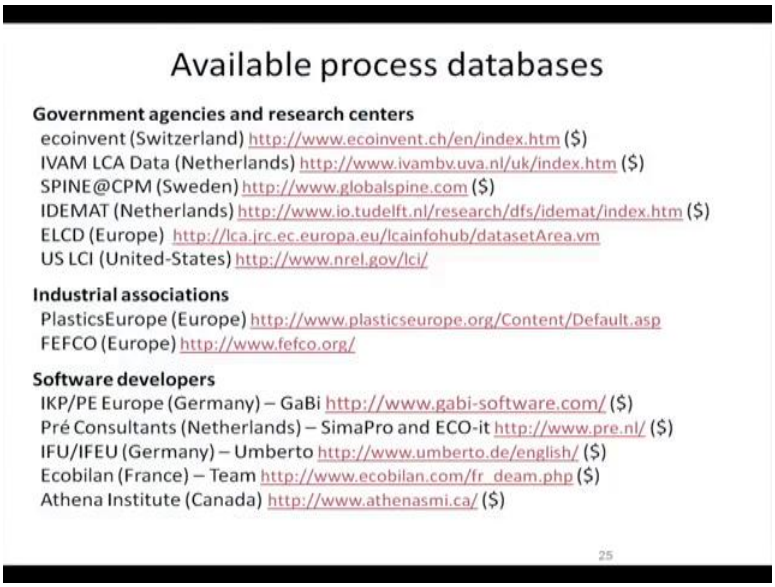

So, there are different database out there and as I said earlier there are lot of databases out there some of them are some of them are it is a free for some you need to pay. So, ecoinvent database the normal this is government agencies and research centre base the one on the top and there is a hyperlink with each one of those as well and as you probably know all the PDF files of these lecture videos that we are we are to producing that you are watching all the PDF files will be available as well all the slide PDF file will be available to you. So, and I will make sure they are these hyperlink remains active on those PDF file. So, you can this ecoinvent this is the most popular one and the one you in the brackets when we have the dollar sign those are the one which you have to pay they are not free database you have to pay for it.

So, ecoinvent which is Switzerland it is a most popular, but you have to pay for that, but I did tell you I think yesterday or sorry in the earlier week video that you need to you can get if you are in India or any like a developing countries emerging economies whatever we want to call it. So, those countries non o e c d countries you have a option of getting a academic licence of ecoinvent for free you cannot use it for commercial purpose, but you can use it for your studies even if you are a say if you if you are a teacher of an institute taking this course you can download that ecoinvent database and you can do some small projects with your students as well.

So, or the students can get those data bases and use it, but there is; you go on the website there is a process for that. So, there is an nether land based data that again has a price Sweden data, another nether land data, there is an European union data which is available for free, US LCI data is available for free. So, this you can get this database is available for free then there is a industrial association the plastic Europe, they have a database for the plastics FEFCO has a again data another database. So, this is also these are again free some of those are available for free software developer and all the software of course, they charge you money for that.

So, Germany has a GaBi which is again many of the Indian professors also use GaBi pre consultants is essentially from Netherlands, they have SimaPro and ECO, it SimaPro is the most popular LCA software used in the world and we like I also use SimaPro for my research projects I have a licence for that. So, ECO, it is also used, this is a new one which is not listed over here that is call open LCA you can also download that that is that is available for free, but has some limitations then there is a France; Ecobilan is a France database, sorry, software Athena institute Canada has a software as well, but all the software there is money involved other than open LCA which you can download, but that has a little bit of limitations.

So, that is in terms of we looked at the different types of database where you have aggregated disaggregated database what is the benefit what is the drawback and we looked at the data the data quality we and these are these examples of the databases which is available some of them are available for free some you have to pay for that, but if you buy software it does come up with a database and SimaPro come for example,

comes with ecoinvent there is a SimaPro, India as well you can SimaPro, India is out there which is promoting SimaPro software in India they do lot of training programs and other things too.

So, with that let us wrap this particular module and then we will look at another we will look at some of the examples again of how we look at life cycle inventory data and from the inventory data how we go for the impact assessment. So, that is how say that is we will we are kind of in the middle of LCA steps. So, we will go for in from inventory to impact assessment and interpretation in subsequent models so.

Thank you. Keep watching and I look forward to seeing you again.