

Electronic Waste Management - Issues and Challenges
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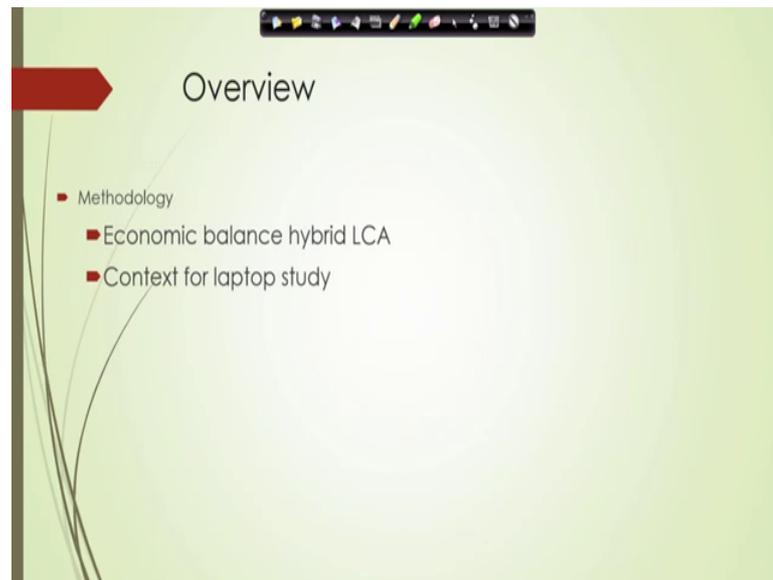
Lecture - 20
LCA applications for Electronics

So, welcome back. So, this is the last video, this will be the last module in as far as the theory goes, as far as the 4-week course content goes. Will have another a tutorial video which will go over some of the problems. So, that will be really helpful for those of you who are planning to take the exam. It would be helpful for everyone and of course, it will have the people who are trying to who are registered for registered or planning to register for the exam, I am not sure whether the date is over or not you can check that on NPTEL website.

So, will continue our discussion that we were having this week regarding having a concept of systems thinking, the concept of lifecycle analysis, trying to get design a better electronic product, and that is true for any product, but our focus here is on electronic since we are talking about electronic waste. So, today we will take the discussion a bit forward and look at some of this economic balance hybrid lifecycle assessment of a laptop computers.

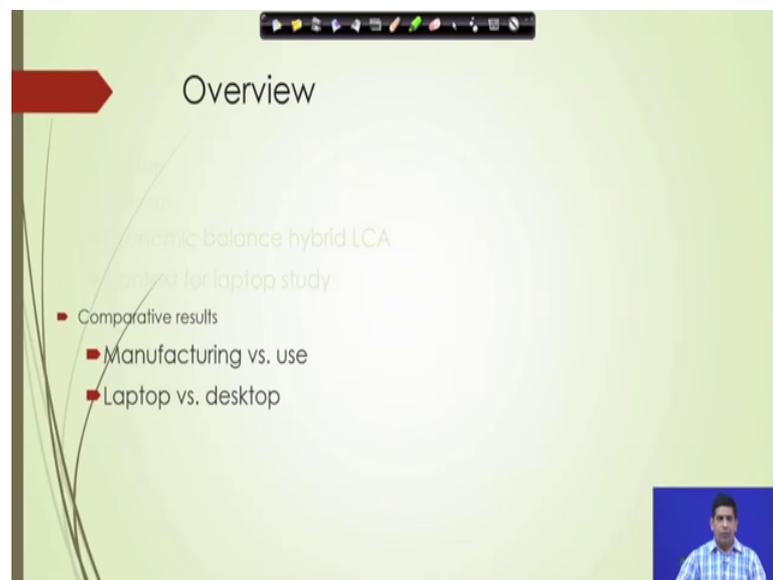
So, if you have a laptop computer, how to go about the economic analysis as well as looking at the life cycle analysis. See, sometimes things may be cheaper when you look at it, but if you look at the life cycle, life cycle costing of that, it may come out to be much costlier. So, we will discuss those aspect in this particular module, and then this will be their kind of end of this course.

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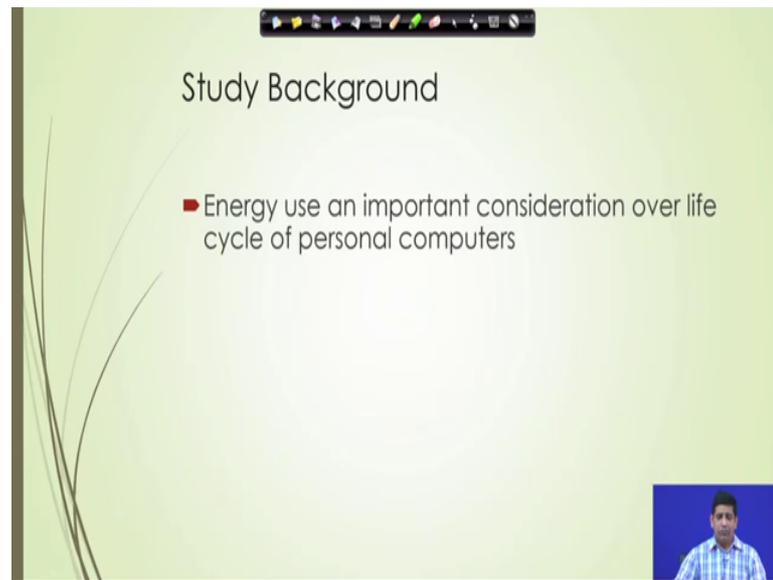
So, in this we will very quickly will have a introduction methodology, what is economic balance have written power model, we put a contest for the laptop study.

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We will talk about manufacturing versus use, laptop versus desktop those comparative will be done.

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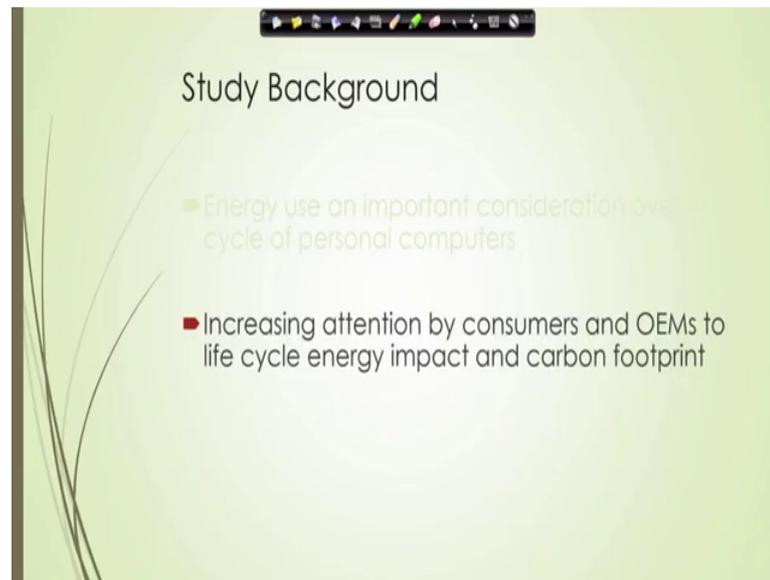


And so, in terms of the study background, energy usage as we were talking about from the very beginning use of energy over the life cycle of personal computers. So, those of you who are who will who will be involved in designing of any electronic product, here we are talking about personal computer and desktop a laptop, but any electronic product, if we can make it more energy efficient.

Anything which uses energy any product which uses energy, if we can make it more energy efficient, we are actually doing good for the environment. We are not only saving the energy bill of course, we do we are reducing the electricity bill of course, that helps the products, but at the same time we are also helping the environment because; that means, less energy will be required, if you are working with coal based thermal power plant; that means, less coal will be burned, less coal will be mined, and all the environmental footprint associated with that will get reduced.

So, energy use will use as a important consideration over the life cycle. And then we also will talk about this OEM.

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Now, what is OEM? Operation and maintenance cost. So, in operation and maintenance, increasing attention by consumers and OEM's in terms of the also lifecycle energy impact and carbon footprint. So, all those things will talk about. Similarly, like if you just my if you talk about the smart phone, one problem we see with many of these smart phones is after a certain time, the battery starts discharging very, very quickly. So, earlier when, I would like, when you when you buy I am just taking my example, when I bought a phone like almost a year ago, at that time it was I will charge in the morning, and then probably it will be good until late evening it will work.

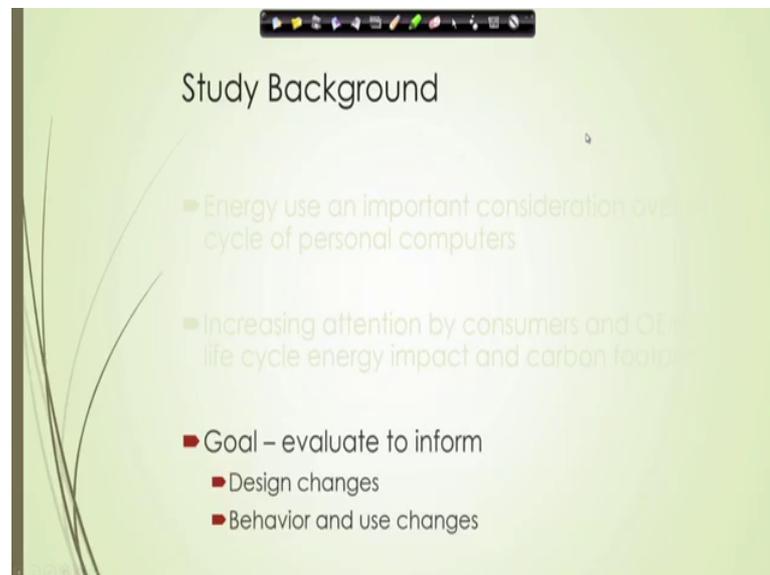
But nowadays the mont if I 100 percent in the morning by afternoon I see the phone is discharging. And that that I here from many people, because another it may be because we are using too many applications, too many apps or though we are not using it properly, maybe we are not charging it, there are different theories out there, you are supposed to let the mobile discharged to almost 0 percent, then only you should recharge it.

I am not sure, which is that is true or not, but people say that some people have said told me that. And there are other say that you should not did go down below 25 percent, because below 25, 25 percent actually it starts it draining them by a battery very fast, and then it is not good for the health of the battery, and health of the cell phone, you should charge it when it is below 25 percent. I am not sure which one is the correct one, if some

of you who are electrical or who knows about battery much more than probably a educate us through the discussion board, will be more than happy, because that is a big problem, we are trying to recharge your phone every day a twice or 3 times a day, especially when it gets a little bit older. When it is new it works fine, even with all those application, when it gets older it started does not work properly.

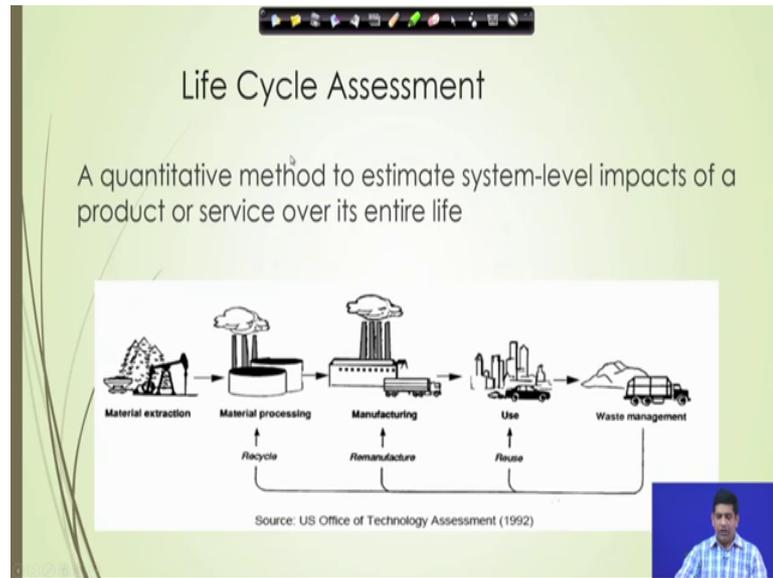
And the other theory is that if you use this power bank, that also destroys your battery. I am not sure, but that is those are the things which I have heard from different people. But how much is the surety? I do not, we do not, I do not know at least there.

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Let me know if you know that it will be nice things to know. So, I saw their operation and maintenance. So, that is of course, is there, and the goal is basically to do the evaluate to inform what are the design changes required to make the electronics make this laptop more environmental friendly, and also the behaviour and use changes, which you will talk about in a minute.

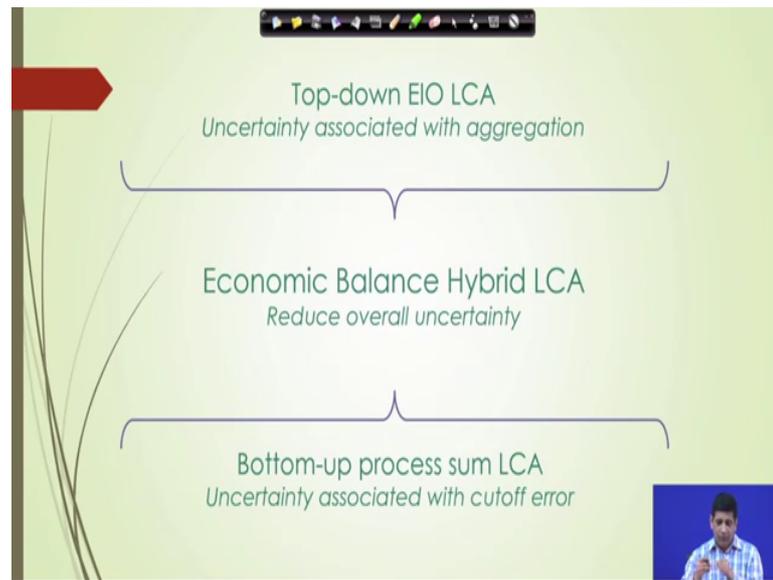
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So, lifecycle assessment you already know that will just skip this slide just take another a sketch for the same thing, that we have been looked at earlier. You are doing a quantitative method.

So, essentially you have a quantitative method you have a quantitative method to estimate system level impacts of a product or service over it is entire life. So, you are having a trying to have a quantification of the method to find out to estimate the system level impact. So, that is what we do in LCA, you have seen several examples already and at the bottom, you see those material extraction processing manufacturing use and e waste management.

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So, here we there are 2 approaches, bottom up process some LCA, where you there will be uncertainty associated with a cut-off error, and also there is a t top down in environmental impact with LCA, which is uncertainty associated with aggregate aggregation. So, we will there are 2 approaches are there. So, it says let us go for something like economic balance hybrid LCA, which is kind of reduces the overall uncertainty.

So, it is you take the top down approach, the bottom up approach, and then try to mix it together and come up with economic balance hybrid LCA, and try to reducing the uncertainty. Since the uncertainty of the data. Because the data as you know from LCA exercise lots and lots of data go there. And if the data quality is not correct, if there is a lot of uncertainty in the data, of course, that reflects in your LCA result. So, that is what we need to look at. So, will try to look at what is this economic hybrid LCA, which is trying to reducing.

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The slide is titled "Context for Hybrid Methodology" and features a table with the following data:

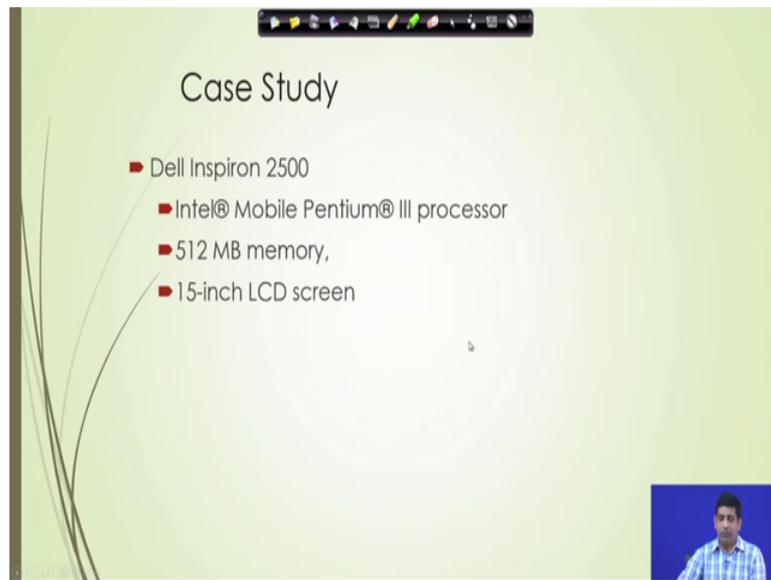
Study	Type	Manufacturing
Williams 2004	Hybrid	80%
EPIC 2005	Process	20%
Choi et al. 2006	Process	50-80%
Duan et al. 2009	Process	40%

Below the table, there is a small video inset showing a man in a blue shirt speaking. The slide also contains two bullet points: "Previous studies applying LCA to desktop computers" and "Likely underestimation of manufacturing impact by process LCA alone".

So, context for hybrid methodology, previous study they have done applying LCA to desktop computers. They underestimate the study has been shown that it under estimate manufacturing impact by process LCA alone, if you look at the process LCA, it underestimates the impact.

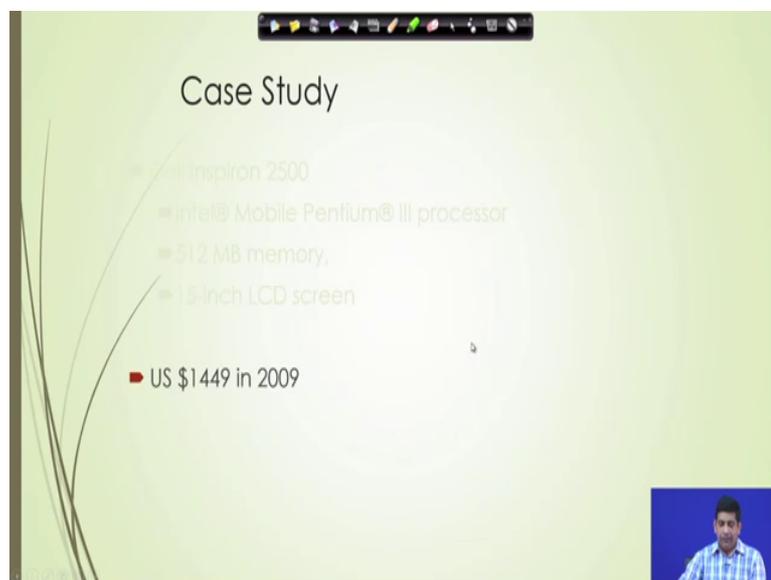
So, then as you can see over here Williams there are several studies listed over here. And the type of LCA was done whether it is a process based, hybrid or manufacturing Angela to look at the impact. The habit shows more impact in terms of the manufacturing, while the others in the process based different methodology was used you see the ranges from 20 to 80 percent, but this one showed 80 percent. So, we do not really to evaluate this further we will like to look at how this hybrid methodology is used.

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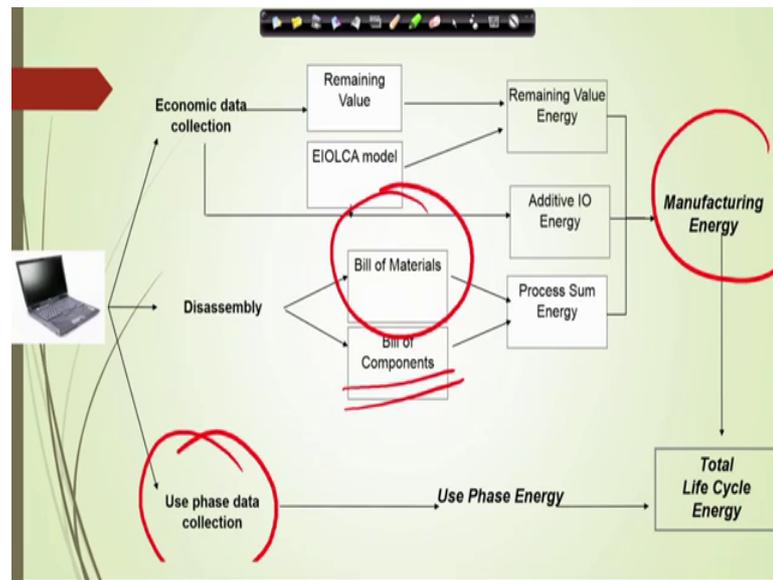
So, we do a case study, which if you take the dell inspiron 25, 100 which is intel mobile Pentium 3 processor, this much of memory this much of LCD screen, not a brand-new computer, it looks much older maybe around maybe 10 years older model.

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Then its cost is around yet around 10 years ago, it is around 1450 in 2009 in US dollar. That was the cost mostly used for residential purposes.

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So, this is your then you disassemble it, when you find out bill of materials. So, that is really the important part of any electronics is you need to know; what are the components which goes into making it, when you are trying to do an LCA exercise. So, if you have a older laptop, you can just disassemble that we have a paper in science of total environment, where we actually have compared 2 ways of hand drying. So, if you go to airport these days. Many airports have that whatever should I say, let a hand dryer which works with hot air.

So, you can put your hand in there, and then your hand will gets dry it or sometimes it is at the bottom, as well there is a blower hot air blows on you and you the hand gets dry. Other option is you take out those paper towel, and then wipe your paper towel and you throw it away. So, they are both options we compared in terms of what is it is lifecycle analysis for using either of those 2 options. And the paper is already out there those of you are interested you can find that through my Google scholar profile, or if we can put a link on discussion forum as well, if you need if you need to just let us know.

But there we had the reason I am left into this study is, we want you to know what is there in those hand dispenser and what is there in those hand dryer. So, we took an old version of it and took it apart. We took it apart and looked at all the different components we weighed the component for some of the components, which we could not sure we

contacted some of the material scientists, people we even did some XRD and XRF to find out what is in there.

So, you need to do those kind of stuff, that is what I am trying to say. So, here as well in terms of laptop it was disassembled, then they try to look at all the material which is there. So, they had to look at the bill of materials bill of components. So, they looked at all the materials which is present. And after they had a process some energy like find out what is the what is the how much energy is required. They did a economic data calculation.

Then you lose that there yeah, your LCA model, in case of how much energy is required. Then after a certain year what is the remaining value what is the remaining value energy in that particular computer. Then we found out the manufacturing energy; that means, what goes into making this particular computer how much energy is required. Then that is in the that is the manufacturing part.

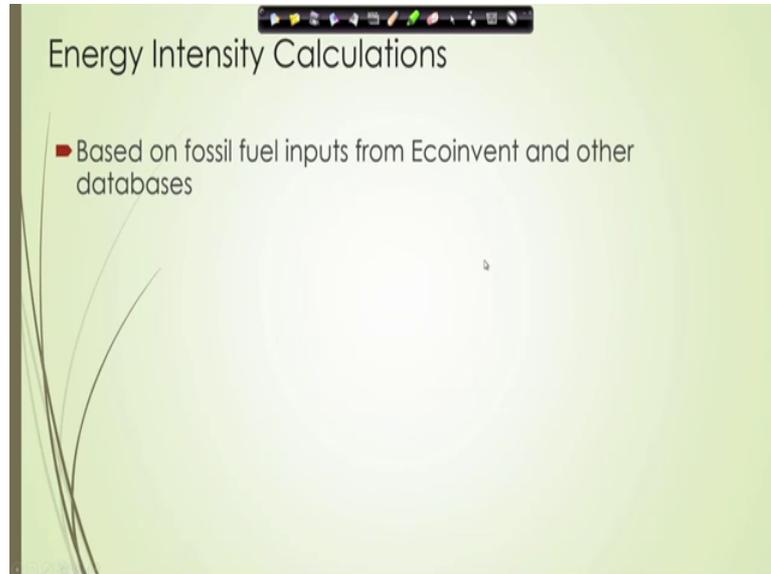
And now, we need to look at the use phase data as well, we need to find out how much during the usage what happens to it. So, during the use phase data we use the use phase energy out of this how much what is the how much time how quickly you need to charge the battery, and how long last how many hours you can use, that battery for what kind of battery it has, power requirement and all those things that will give you use phase energy.

So, based on the manufacturing energy, and the use phase energy you will get the total lifecycle energy. So, if you look at from the energy point of view, and you need to look at both it is not only the use phase energy, use phase energy is important as well. As the manufacturing energy when you are looking at the lifecycle of an laptop, because if laptop is there which requires very frequently charging.

And then there is your you end up using lot of energy to charge it although it may be made of material which is environmental friendly. But at the same time if you have a laptop which once you charge it also depends on the type of battery you have. And it lasts for a longer period of time, because the processes processors are much better more energy efficient. And that makes it usage much simpler to use that. So, it is a sorry buy much better in terms of the environmental footprint in terms of the use phase energy.

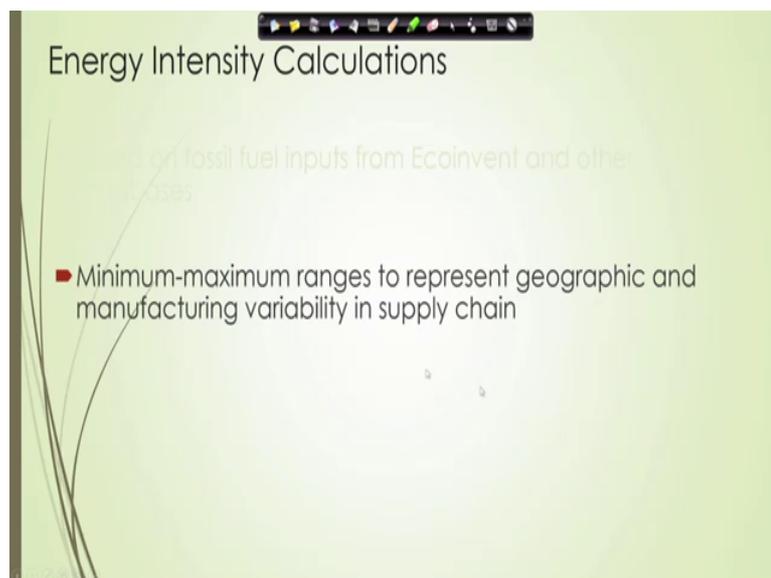
So, we need to look at the both aspect manufacturing energy as well as the use phase energy to compare.

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So, we can do energy intensity calculation based on the fossil fuel input for eco invent and other databases, we talked about the decline when data base.

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So, we can now if it is a fossil fuel or it is a non renewable energy. Minimum maximum range to get the geographic and manufacturing variability, because geographically some places you may have more coal let us play some other place you may have more hydro.

So, you can look at the minimum and maximum range in terms of the energy. Also, the manufacturing variability will be there in the supply chain depends on where things got manufactured, what kind of energy they used.

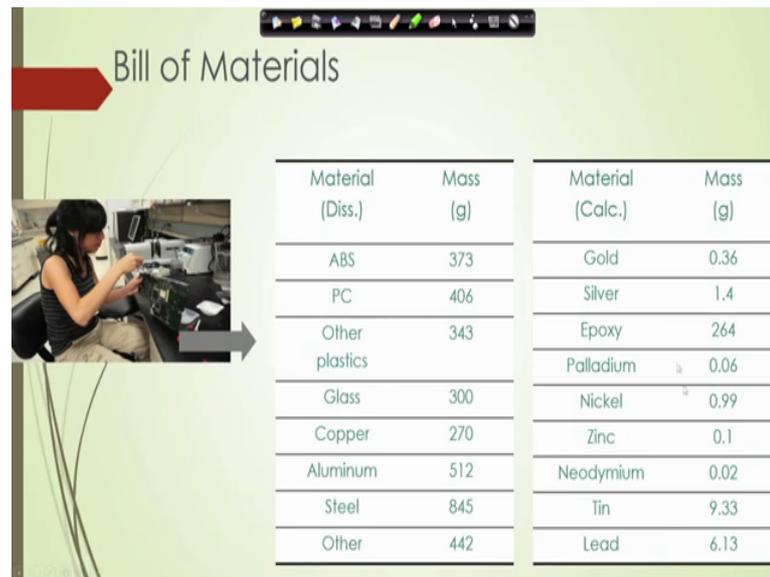
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Mode	Time in mode (%)	Power (watts)
off	60%	1.26
sleep	10%	9.05
idle	30%	18.32

So, if you use a and then in the use phase, if you have a like a lifespan of almost 3 around 3 years. And if you look at how much off mode sleep mode idle mode. So, how will you get these data. You try to do some survey talk to some people and try to find out what is the typical usage they have. So, we have to do some data collection into the people's behaviour people's usage behaviour, when how much is off sleep or idle. And then what is the power requirement even in the offs, you have certain power requirement then sleep, you have some on the idle also it has certain power it will based on how much time it is off or sleep or an idle, there are certain power requirement which was there.

So, the power value for the use models and here, it may include the it is for the usage. It is a use phase yeah, it is for the use phase assumption. So, this is the data for the use phase not for the manufacturing phase bill of materials.

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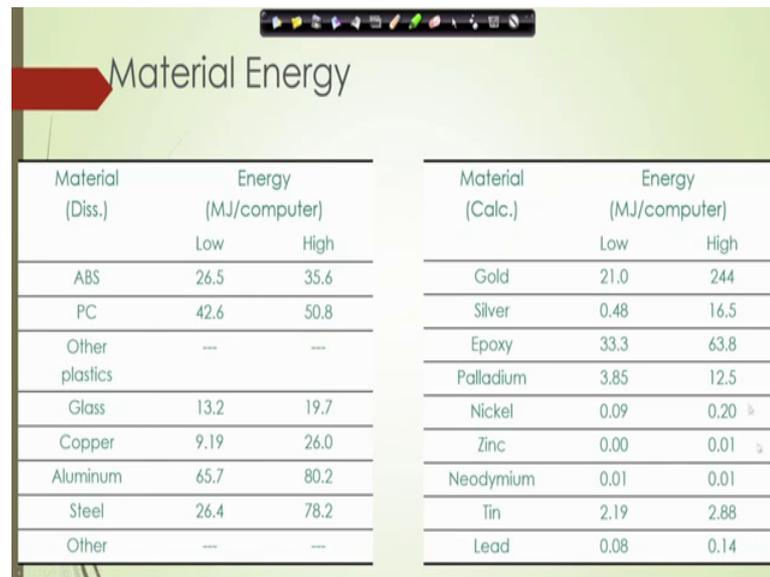
The slide features a red arrow pointing to the title 'Bill of Materials'. On the left, a photograph shows a student sitting at a desk with a computer, with an arrow pointing from the photo towards the tables. The tables list materials and their masses in grams.

Material (Diss.)	Mass (g)	Material (Calc.)	Mass (g)
ABS	373	Gold	0.36
PC	406	Silver	1.4
Other plastics	343	Epoxy	264
Glass	300	Palladium	0.06
Copper	270	Nickel	0.99
Aluminum	512	Zinc	0.1
Steel	845	Neodymium	0.02
Other	442	Tin	9.33
		Lead	6.13

If you look at different types of plastics printed boards other plastics glass, copper, aluminium steel and others that is the distance mastoid anagrams; so, you have this student is taking it apart, and sees may weighing the different components, from this selected laptop and finding these material this may not be the total exhaustive list, there will be some more material there, like, a gold, silver, epoxy, palladium, nickel, zinc, neodymium, tin, lead.

So, here as you can see one laptop, and this is not this is again, I am saying this is not the complete list there are a lot of other material out there. But if you look at even these ones. Just say, 1, 2, 3, 4, 5, 6, 7, 8 and 10. Like 8, and 9 16. At least 16 material and more being used in just in a laptop. And so, all these has certain environmental footprint.

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The slide titled "Material Energy" displays two tables comparing energy consumption (MJ/computer) for various materials. The left table, labeled "Material (Diss.)", shows energy ranges for materials like ABS, PC, Glass, Copper, Aluminum, Steel, and Other. The right table, labeled "Material (Calc.)", shows energy ranges for materials like Gold, Silver, Epoxy, Palladium, Nickel, Zinc, Neodymium, Tin, and Lead. Each table has columns for "Material", "Energy (MJ/computer)", and sub-columns for "Low" and "High" values.

Material (Diss.)	Energy (MJ/computer)	
	Low	High
ABS	26.5	35.6
PC	42.6	50.8
Other plastics	--	--
Glass	13.2	19.7
Copper	9.19	26.0
Aluminum	65.7	80.2
Steel	26.4	78.2
Other	--	--

Material (Calc.)	Energy (MJ/computer)	
	Low	High
Gold	21.0	244
Silver	0.48	16.5
Epoxy	33.3	63.8
Palladium	3.85	12.5
Nickel	0.09	0.20
Zinc	0.00	0.01
Neodymium	0.01	0.01
Tin	2.19	2.88
Lead	0.08	0.14

Then material energy in terms of the energy consumption how much the energy they require, lower in terms of to produce that how much energy is required to make glass or copper or aluminium.

So, millage milli mega joule per computer. So, this is your low and high and this is we are talking about manufacturing phase not the use phase, do not get confused. This is the material energy required to produce this material which will go into the laptop. So, that is what we are looking at here. So and for the other materials here as well. So, this is what is the energy.

And that is why you are low and high depending on where you are depending on the efficiency of the process, but where it is being manufactured there are different countries based on the technology that is being used to make those stuff in terms of the gold or silver and other stuff; whether it is being produced in country x versus, country y using process a or process b the values do differ.

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Process Sum Energy						
Process	Source	Years	Norm.	Fossil Fuel MJ/norm	Electricity kWh/norm	Total Energy MJ/Comp.
semiconductor	US census	1995-2006	cm ² silicon	3.2	1.5	247-405
	US MECS	1998, 2002		3.2	2.0	
	Japan natl.	1999		2.3	1.1	
	Facility (UMC)	1998-2005		n/a	1.5	
circuit board	US natl.	2000	m ² board	93	28	30-43
	Japan natl.	2001		141	40	
	Facility (anon)	2001		190	27	
silicon wafers	literature	mixed	kg	n/a	2,100	60
LCD	EPA	2001	15-in unit	n/a	n/a	264-932
	EUP	2007		n/a	n/a	
computer assembly	US natl	2002-2004	unit	85	35	435-541
	Firm (HP)	2000		35	51	

Then you take the data and you try to do a process some energy. So, like how much is the total energy that is required, in terms of like semiconductor circuit board silicon wafer LCD, and the computer assembly. If you look at the total energy, and the fossil fuel also is given and electricity, how much kilowatt hour normalized. So, you have total energy that mega joule per computer, and for semiconductors it is 274 for this again range 32, 43 silicon wafers LCD, computer assembly.

So, these are we get the process some energy, the energy that is used to make this particular product.

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Additive Input-Output Correction

Process	IO Sector	Value per laptop	Total intensity	Total energy per laptop
		(\$)	(MJ/\$)	(MJ)
Electronic chemicals and materials	Photographic Film and Chemicals	60.5	7.4	445
Semiconductor manufacturing equipment	Semiconductor machinery manufacturing	63.1	7.1	449

Then you look at your additive input output in terms of value per laptop. How much is the dial in value in terms of the laptop. Total intensity like a mega joule per dollar, we had the mega joule initially, now mega joule per dollar, then you can find out what is the total energy per laptop, and you get in terms of the mega joule how much energy that goes in there.

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Energy Intensity Totals

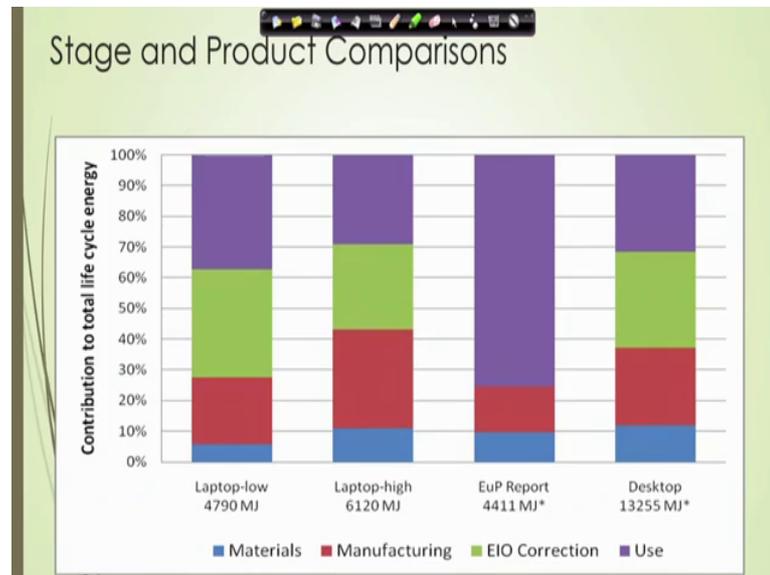
Category	Energy/computer (MJ)	CO ₂ /computer (kg)
Process-Sum	1315-2645	93-136
Additive IO	893	72
Remaining value	800	62
Manufacturing total	3009-4339	227-270
Use phase total	1781	159
Life cycle total	4790-6120	386-429

Ranges represent minimum and maximum values

So, this is how you find out from the energy input. You can find out what is a CO₂ equivalent, what is the minimum and maximum value in terms of the CO₂ equivalent

that is coming out? So, in terms of the manufacturing phase, use phase and the life cycle total phase. What is the carbon dioxide equivalent? Because every impact is finally, converted to a CO₂ equivalent.

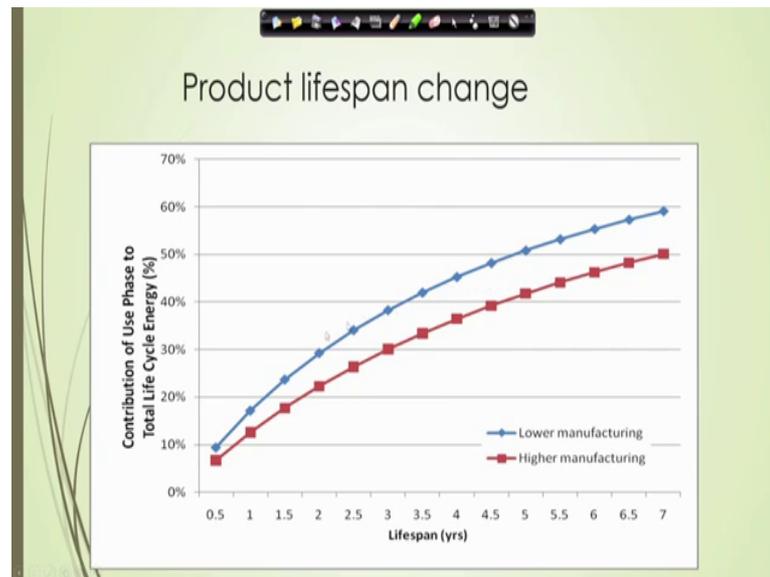
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Then you look at in terms of the material manufacturing and with the CIA, corrections, where they are trying to get rid of some of their uncertainties. And this is your use phase. So, laptop low laptop like, a high because they are based on range. Then you have a European some project report and desktop, as you can see, the total is 100 percent, but what where the major majority input is contribution of total lifecycle energy. So, in terms of the material used, you see that at the bottom. Manufacturing is kind of in the middle and it tells you based on the different manufacturing methods, you have different values out there, for high lab like a high duty laptop or heavy-duty laptop to the lower variety of laptop.

But EIO correction what is just to get rid of the inter uncertainties in there. And the use phase, as you can see depending on, where you are in the world, based on the type of energy that you use, you will have a lot of the use phase is still is one of the kind of the predominant phase, where based on the energy requirement during the usage in terms of the life cycle energy required.

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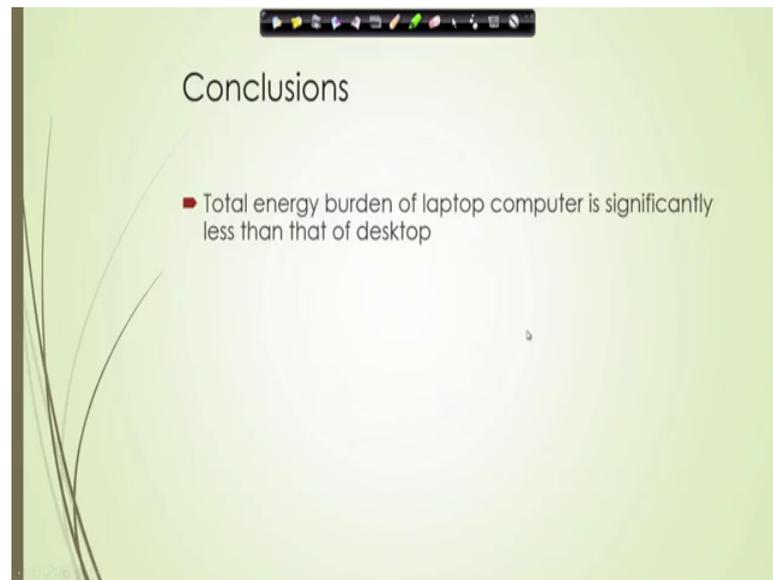


So, as the lifespan lower manufacturing, and the higher manufacturing, your contribution of the use phase. for the lower manufacturing as you can see the use phase kind of keeps on going we when it gets older.

So, after say 6 years or so you almost 60 percent of the footprint is coming from the use phase, rather than the material production phase. And for better manufacturing, you kind of goes down to around 50 percent. So, that is kind of gives you the value between a better computer one than a not so good computer in terms of the environmental footprint. That you can even see that many times say as your laptop gets older, it gets more and more heated up, you see things getting heated up. So, it is using lots of energy is getting dissipated we are where energy is getting converted into heat energy and that energy is getting away.

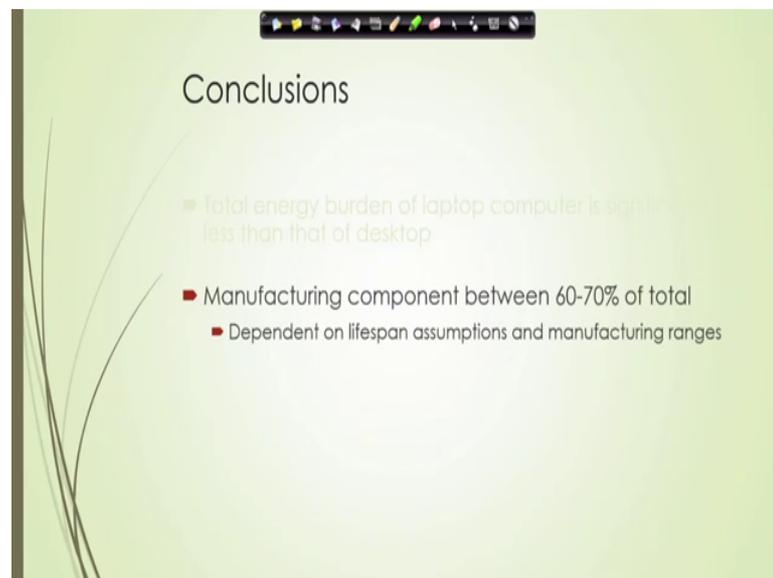
So, we are losing that heat as well. So, that is it become the energy usage actually goes up, when you have all these heating and other things happening with that.

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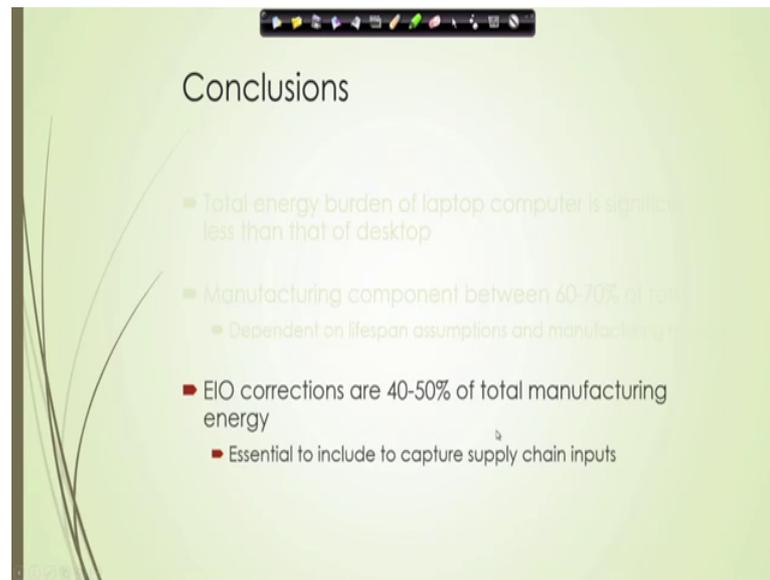
So, total energy burden of laptop computer is significantly less.

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The end of a desktop we saw that manufacturing component is around 60 to 70 percent.

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And depending on how you make the assumptions. EIO corrections are 40 to 50 percent, you should apply that in terms of supply chain input and other stuff. So, that is like a in terms of how this kind of methodology is used to find out kind of life cycle impact. Especially from the energy point of view for a computer so that is one example when you try to design something, you can do these kind of calculations to find out which one or when we go for a better design.

What is the real impact in terms of the energy usage and energy saving in terms when we go for better laptop design or a desktop design. We will talk about very quickly like if you have an institutional management of used computing equipment, how it is done. So, in terms of here will have some introduction motivation that some institutional case study benchmarking survey. Some examples here implications for research in policy let us do it really quickly.

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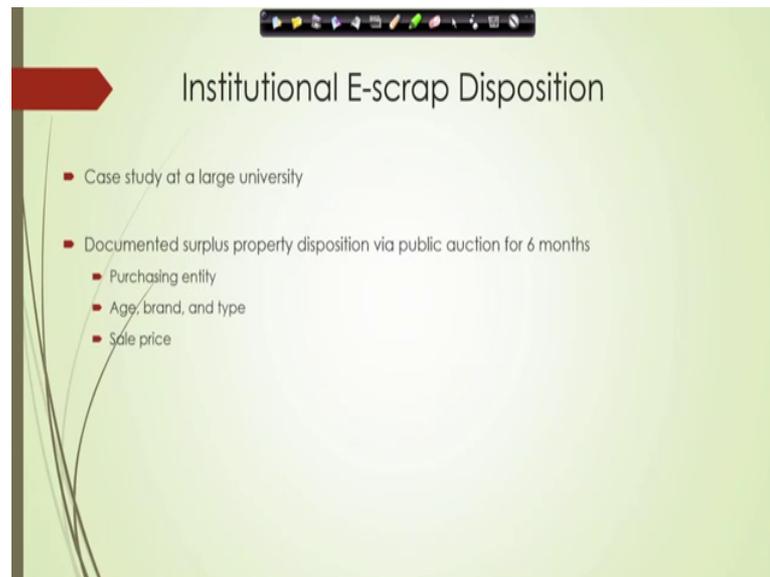
So, when you like if you are a running an institution of you are in a college or a university. You produce a lot of electronic waste; the question is what to do with all this stuff.

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What so, approaches look at the sustainability trade off associated with end of life management option, and then benchmarking survey, how broader implications.

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So, we look at a case study at a large university, and we will talk about documented surplus property it is by a public auction for 6 months. So, there is a purchasing entity age brand and type the sale price.

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Basic characterization

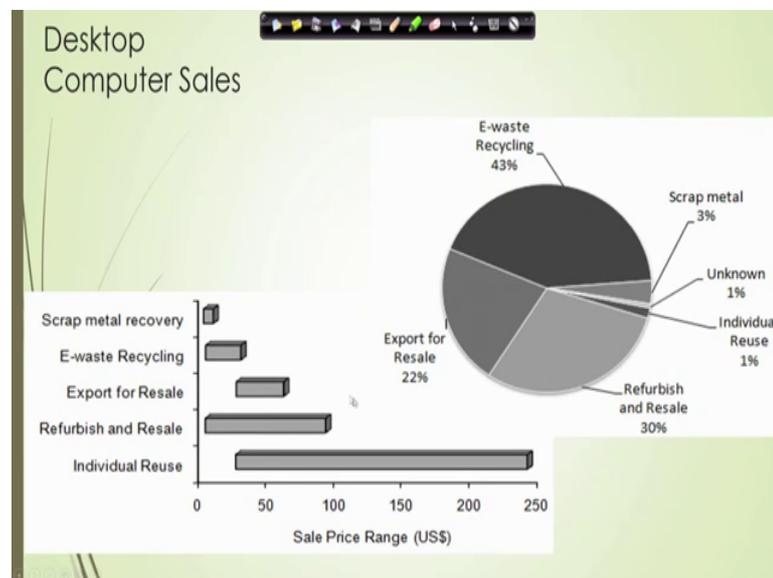
	COMPUTER	LAPTOP	MONITOR	PRINTER	SERVER	COPIER
Units sold in 2008	2,170	303	1,325	420	237	127
Average age (std. dev.)	7.4 (2.9)	8.0 (3.2)	9.4 (6.6)	10.1 (3.1)	7.0 (2.1)	8.1 (2.4)
Age range	1.4-23	2.9-16	1.2-19	1.2-14	2.0-10	4.7-13
Average price (std. dev.)	\$19 (\$5.70)	\$68 (\$35)	\$10 (\$8.50)	\$12 (\$10)	\$46 (\$42)	\$20 (\$8.40)
Sale price range	\$1.33 - \$275	\$1.33 - \$385	\$0.40 - \$125	\$0.80 - \$190	\$1.40 - \$475	\$3.75 - \$100

So, what we try to do is essentially a particular institution, what they try to do is they will put a tender out, where they will say that we want to get rid of all these old computers which we have. And only say computer internally computers printers the scanners, Xerox machines.

So, all those old electronics that they want to get rid of. And, and then there is a cell price range, like, how much there is an expected value, and then based on how people will bid, based on that you have an estimate of the price, and then you based on the bidding price that people come forward with; you decide how much it will cost you, it like how much you will to charge based on the, and then based on the bidding, you whoever bids for the higher value you give the material to them. One thing as per the money as per the e waste management rules, we have to make sure that it goes to a registered recycler.

Now, it has to be registered collector registered recycler with who is registered, with the state pollution control board and central pollution control board. So, it has to go there, as an institution. So, this is just one example where they looked at units sold in 2008 average age. And in the bracket, you see a standard deviation. Age range some got bad even at 1.4 aor like years and comes somewhere, we went for 23 years people used. It then average price, in terms of how much is the price value left. And then what is the estimated value left, and then sale price ranges in which it got sold. So, depending on how which people have what value people have seen it.

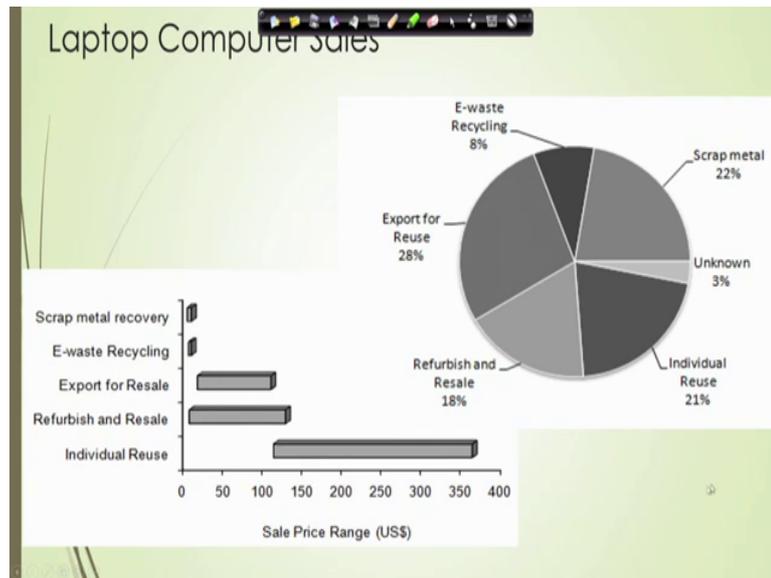
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So, in terms of the desktop computer sells, scrap metal recovery, e waste recycling, export for resale, refurbish and resell, individual reuse that is also individually reuse see you see more price you can put it on EBI and other places.

So, this is the same values put it in a pie chart, where e waste recycling export for resale refurbish. So, e waste recycling was pretty high, then refurbish and resale is around 30 percent. Even some people individual reuse although price was much higher, but only one percent.

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So, some really good computers which was going to about their Laptop computer again similar stuff, individual reuse is higher here; for resale export for reuse. So, this is how for that particular university things got sold.

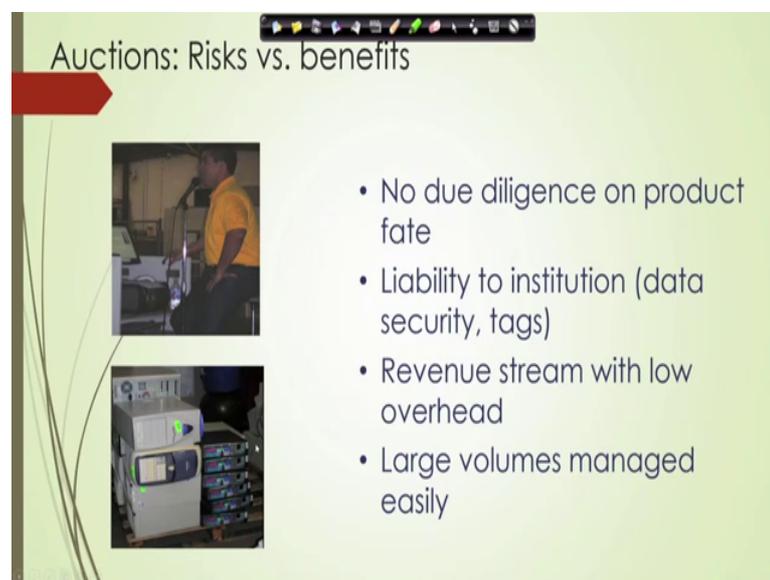
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The table titled "Profits associated with EOL pathways" compares the profits for Computer and Laptop across five categories. The total profit for each category is also provided.

Category	Computer	Laptop	Total
Individual Reuse	\$ 1,683	\$ 5,998	\$ 7,681
Refurbish and Resale	\$ 4,484	\$ 544	\$ 5,027
Export for Resale	\$ 5,119	\$ 967	\$ 6,086
E-waste Recycling	\$ 2,405	\$ 39	\$ 2,444
Scrap metal	\$ 226	\$ 93	\$ 319

So, in terms of profit associated with end of life pathways, if you individual reuse, this is the computer and the laptop refurbish resale this price they got export for resale and the e waste recycling scrap metal. So, as you can say of course, the individual reuse will fetch them the higher value. Because somebody have found a computer which they think has a value, and then it must be much cheaper than what is available in the market. So, they went with this old computer which they can use it. And refurbish resale and export for resale even it goes abroad e waste recycling scrap metal. Of course, that will forgive you a lower value.

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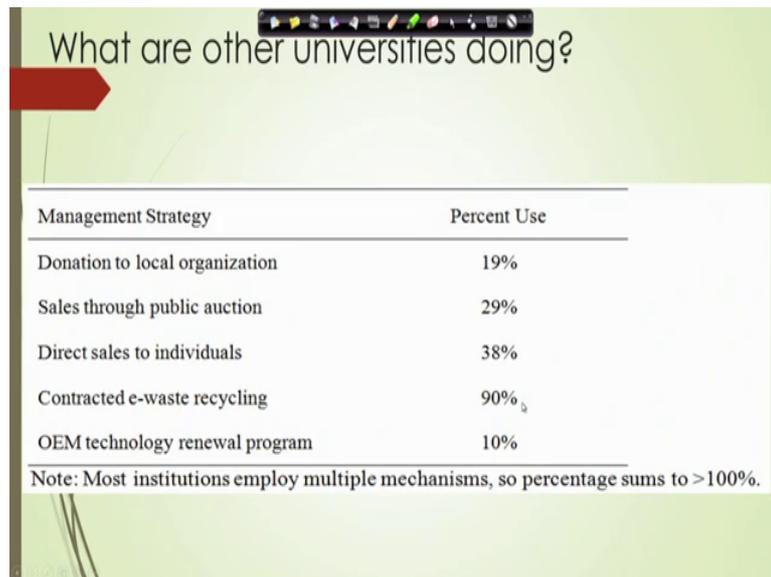
Auctions: Risks vs. benefits



- No due diligence on product fate
- Liability to institution (data security, tags)
- Revenue stream with low overhead
- Large volumes managed easily

So, when you are looking at any product, as you saw earlier we have to put a new diligence to product fit. Now as per the e waste management rules, we have to do that. if you do not manage it properly, it becomes a liability to institution data security tag revenue stream with low overhead large volume is actually managed much easily.

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What are other universities doing?

Management Strategy	Percent Use
Donation to local organization	19%
Sales through public auction	29%
Direct sales to individuals	38%
Contracted e-waste recycling	90%
OEM technology renewal program	10%

Note: Most institutions employ multiple mechanisms, so percentage sums to >100%.

So, we have to look at all these risk and benefits. What the other universities are doing they are donating to local organization, sales through public auction direct sales contract e waste recycling, OEM technology renewal program.

So, they are different people are doing it very differently. This is again it and it is a case study from a e waste perspective in India, as per the e waste management rules 2016, we have to manage it through the registered recyclers; registered collection collectors of electronic waste.

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Donation programs

- Social benefits
- Extends lifespan but dependent on age
- Low volume throughput

COMPUTERS FOR SCHOOLS
Your old Computer ...New to a Student



There are donation programs, there is a social benefit is there extends lifes lifespan. But depending on age low volume though put actually not much is in direct product resale.

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Direct product resale

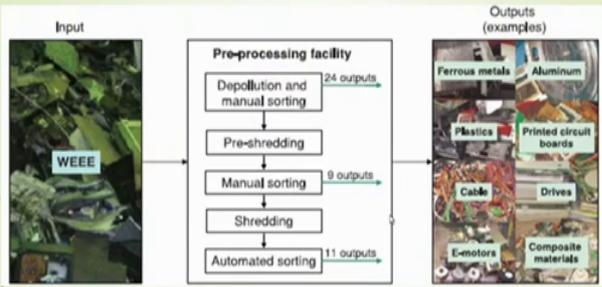


- Extends lifespan
- Revenue for institution
- Requires time / labor for diagnostics / refurbishment
- No knowledge of product fate

You can put it a deal, and people can buy. It revenue for institution requires time labour refurbishment, no knowledge of product fate, what will happen we do not.

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E-cycling



- Due diligence in contract / bidding
- Cost to institution
- Material recovery (10% of total energy)

So, and e cycling, which is e cycling is done, we are something output plastics various metal shredding and all that we talked about all that leasing, can be leased out and that is one way of doing it too.

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Leasing

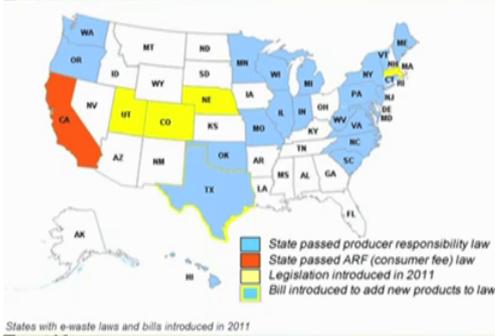


- Transfers liability back to OEM
- Planned refresh rates shorten lifespan
- No understanding of ultimate product/ material fates

So, broader dimension of this challenges we are in the US, there is no federal policy, in India we do have a federal policy now.

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1. Institutions lack guidance regarding used equipment

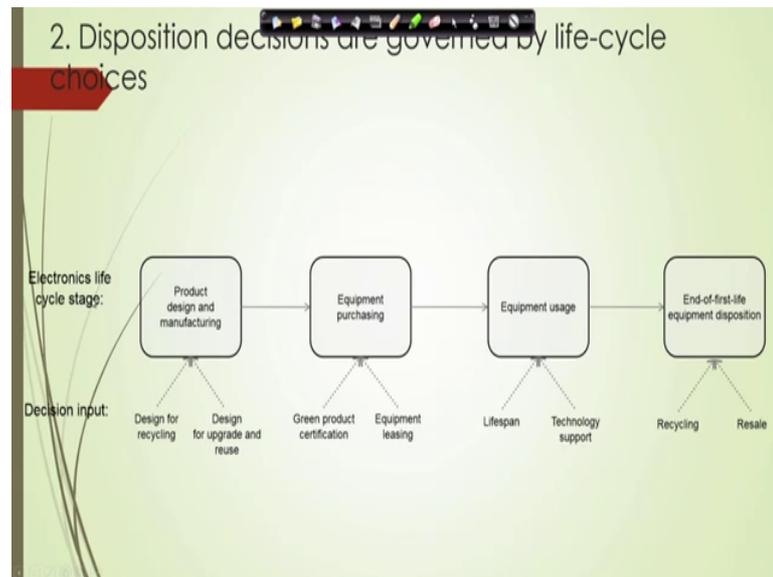


- No federal policy
- Patchwork state policies
- No science-based best practices

From: Electronics Takeback Coalition

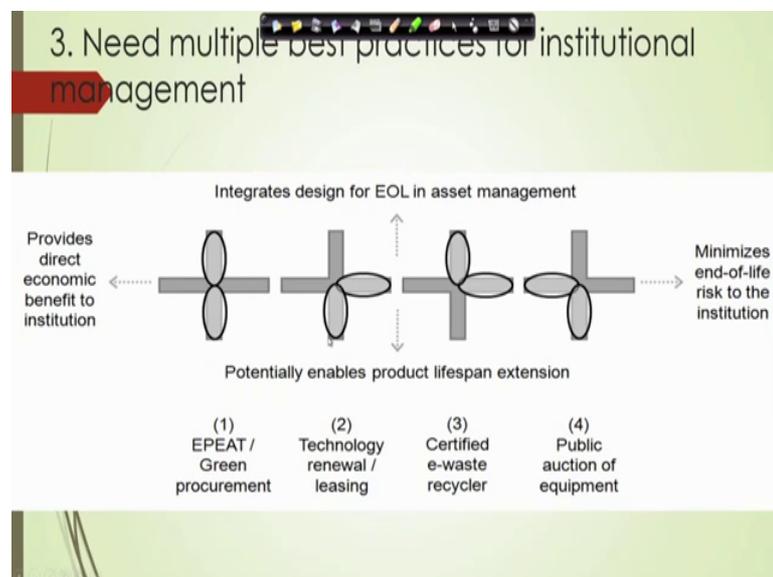
US they have the state level policy. So, it is not that the US is behind us with us, but they have a state level policy, not a federal level policy patchwork is state policy is there, still a lot of work needs to be done in US in terms of the electronics take back coalition. No science based best practices is out there.

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So, it is a product electronics life cycle stages, we talked about that earlier. So, we need to have multiple best practices for institutional management. There are different things that could be done.

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So, that is kind of then, we will quickly look at just in china and then will stop.

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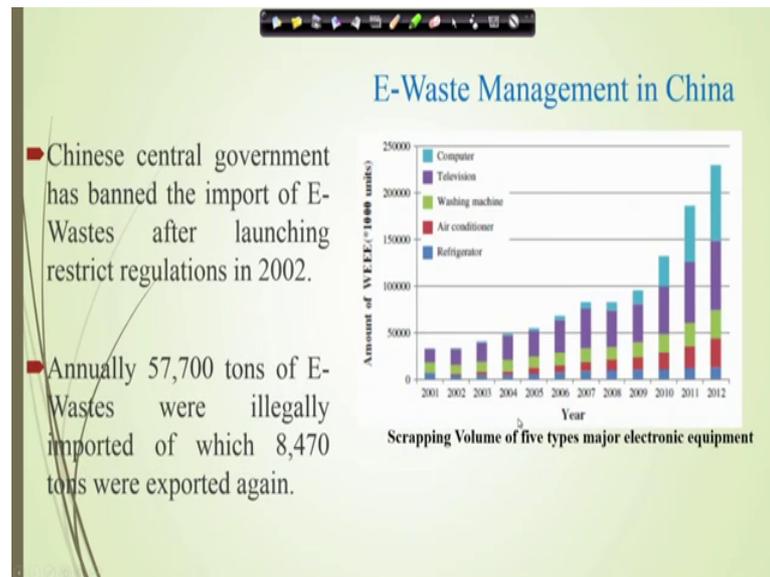
So, we started with e waste in India, and e waste in different places as well. Let us quickly look at what is happening in china. And then we will close it, just since china is similar to India and they also has a lot of issues similar to India.

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So, we will have a quick overview of china, in next few minutes, and then we will wrap up this video. So, the total amount of e waste in china, in I do not it is a sharp increase as you can see almost to 8 almost I think it is in nearly 9 times, 8 to 9 times in 11 years.

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And now, 16 to 80 k g per capita per year, much higher than India is rising by 3 percent per year, and as you can see an exponential increase, and it is going up and up. The Chinese central government has banned the import of e waste now. So, it is a they have a regulation in 2002, but it is still it e waste does come in through Hong Kong and other places, but they are looking at actually banning. Not only e waste for any e waste coming into china for recycling. And since last year and things have been being followed very seriously now.

So, actually they have illegally imported 57,000 tons of e waste, which out of which 84,8400 were exported again, but the remaining nearly 50000 is stayed in you in china.

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So, China's e wastes usually came from 3 major sources household, institutional and school's hospitals and all that, government if you there are 3 channels a second-hand market donate there to home appliance to poor people obsolete e waste to peddlers and then peddler sells us to e waste dealers.

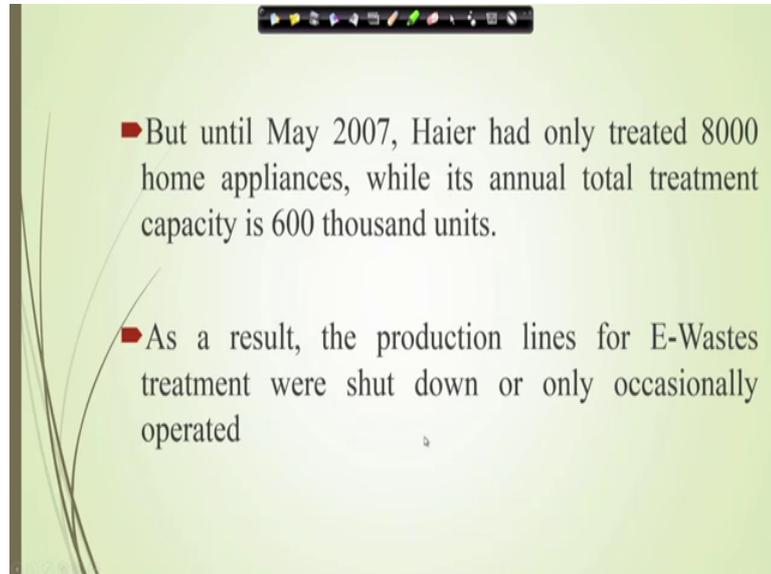
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So, they have an odd national development and reform commission; which was promoted circular economy in China. So, they are kind to promote the e waste recycling,

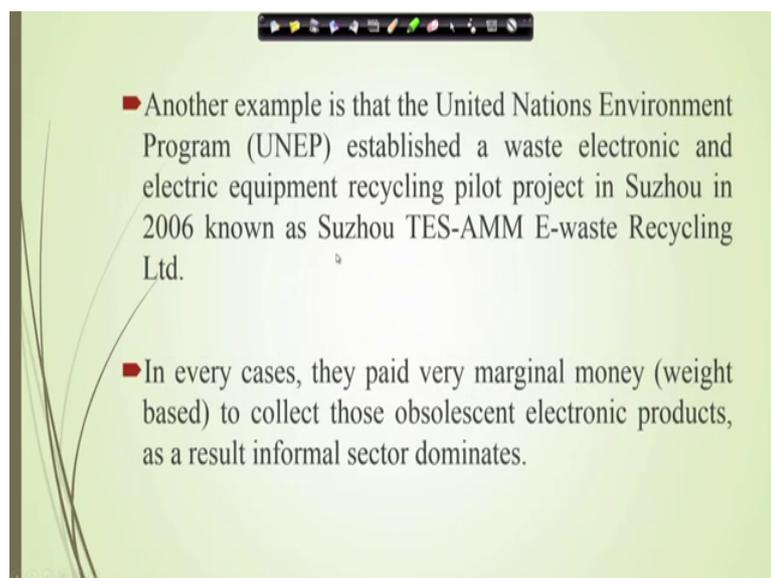
encourage technological innovations as. So, university developed a recycling technology in 2004, which is being used. that they had only 8000 home appliances.

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So, again they have a similar problem as what we have in India now. But they are they have this e waste register like a e waste recyclers, but the e waste recyclers are not able to find the they are not able to get enough material to recycle. So, they are not meeting the capacity.

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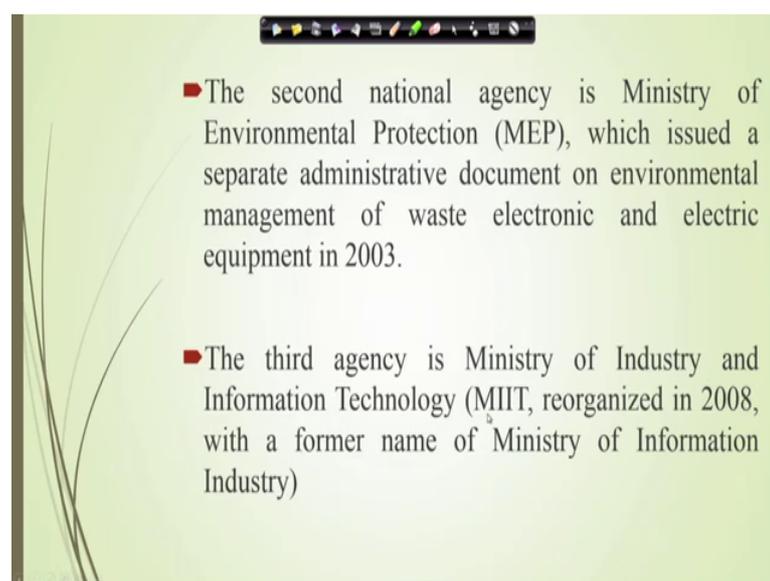
So, it shut down occasionally operated same problem as we have another example is the UNEP they come up with electronic recycling pilot project. They paid marginal money, and this and as a result of informal sector. Marginal money to collect those obsolete.

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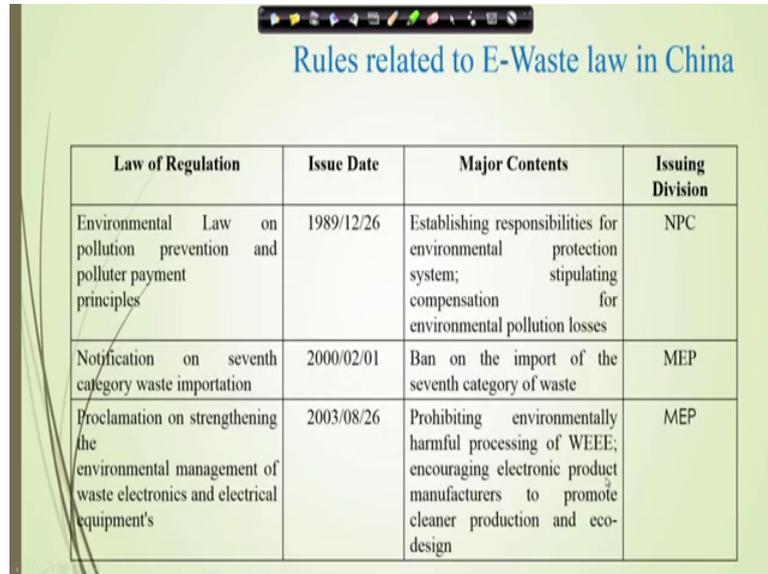
Then there are 3 relevant rules, circular economy promotion rules, solid waste pollution control clean production rules. So, those are used. The national reform commission, this became in charge of resource efficiency.

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Then they had this ministry of environmental import where came in ministry of industry and information technology.

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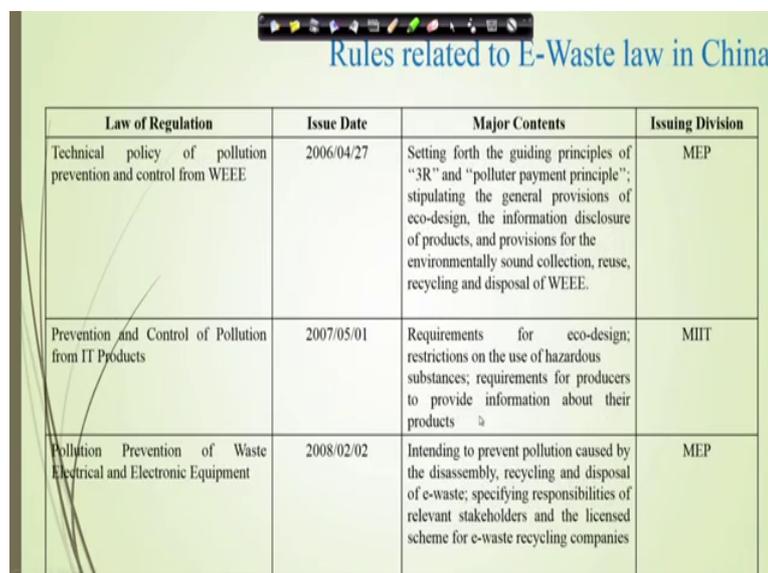


Law of Regulation	Issue Date	Major Contents	Issuing Division
Environmental Law on pollution prevention and polluter payment principles	1989/12/26	Establishing responsibilities for environmental protection system; stipulating compensation for environmental pollution losses	NPC
Notification on seventh category waste importation	2000/02/01	Ban on the import of the seventh category of waste	MEP
Proclamation on strengthening the environmental management of waste electronics and electrical equipment's	2003/08/26	Prohibiting environmentally harmful processing of WEEE; encouraging electronic product manufacturers to promote cleaner production and eco-design	MEP

Can very just give you some idea of what are how the rules in e waste laws in China. I will not go over that in detail.

So, there was how that china has made progression in terms of managing it in a much better way, than what we are managing. So, it is there, and who is responsible for what; in china as what we do it in India.

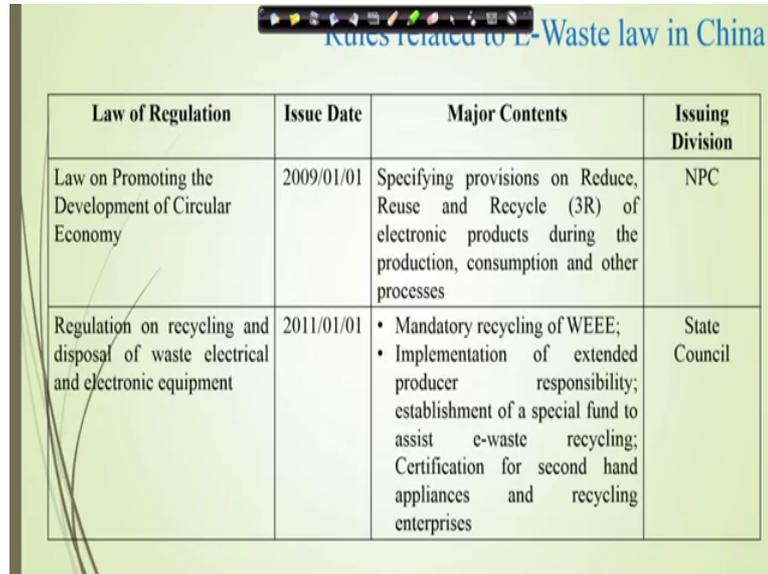
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Law of Regulation	Issue Date	Major Contents	Issuing Division
Technical policy of pollution prevention and control from WEEE	2006/04/27	Setting forth the guiding principles of "3R" and "polluter payment principle"; stipulating the general provisions of eco-design, the information disclosure of products, and provisions for the environmentally sound collection, reuse, recycling and disposal of WEEE.	MEP
Prevention and Control of Pollution from IT Products	2007/05/01	Requirements for eco-design; restrictions on the use of hazardous substances; requirements for producers to provide information about their products	MIIT
Pollution Prevention of Waste Electrical and Electronic Equipment	2008/02/02	Intending to prevent pollution caused by the disassembly, recycling and disposal of e-waste; specifying responsibilities of relevant stakeholders and the licensed scheme for e-waste recycling companies	MEP

So, you can compare, you already we kind of went over the Indian waste management rules quite in detail.

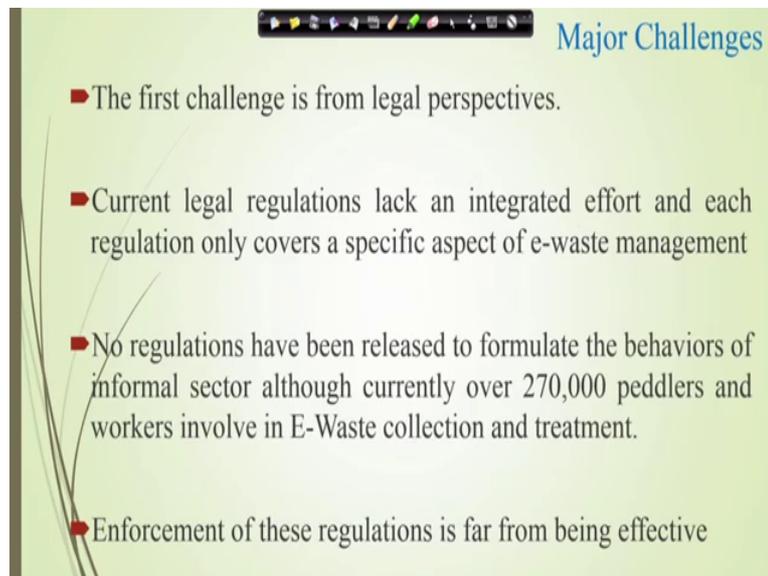
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Law of Regulation	Issue Date	Major Contents	Issuing Division
Law on Promoting the Development of Circular Economy	2009/01/01	Specifying provisions on Reduce, Reuse and Recycle (3R) of electronic products during the production, consumption and other processes	NPC
Regulation on recycling and disposal of waste electrical and electronic equipment	2011/01/01	<ul style="list-style-type: none">• Mandatory recycling of WEEE;• Implementation of extended producer responsibility; establishment of a special fund to assist e-waste recycling; Certification for second hand appliances and recycling enterprises	State Council

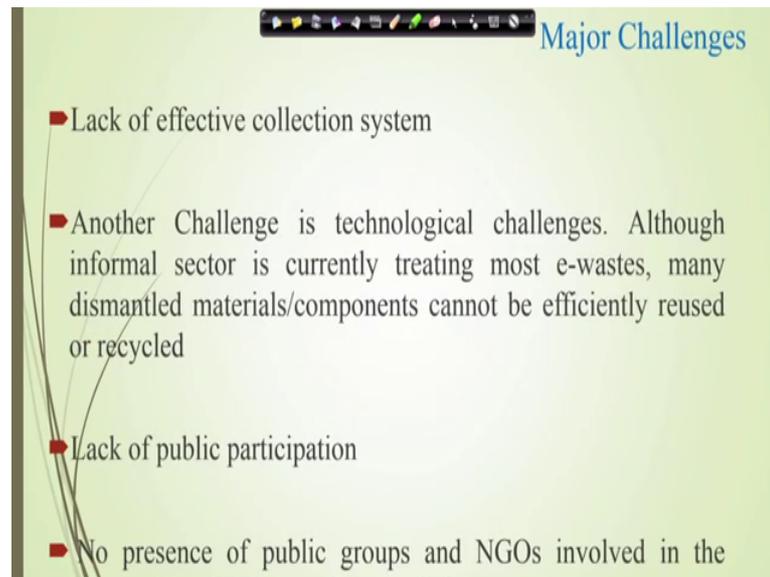
So, I just provided you the Chinese rule.

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- ### Major Challenges
- The first challenge is from legal perspectives.
 - Current legal regulations lack an integrated effort and each regulation only covers a specific aspect of e-waste management
 - No regulations have been released to formulate the behaviors of informal sector although currently over 270,000 peddlers and workers involve in E-Waste collection and treatment.
 - Enforcement of these regulations is far from being effective

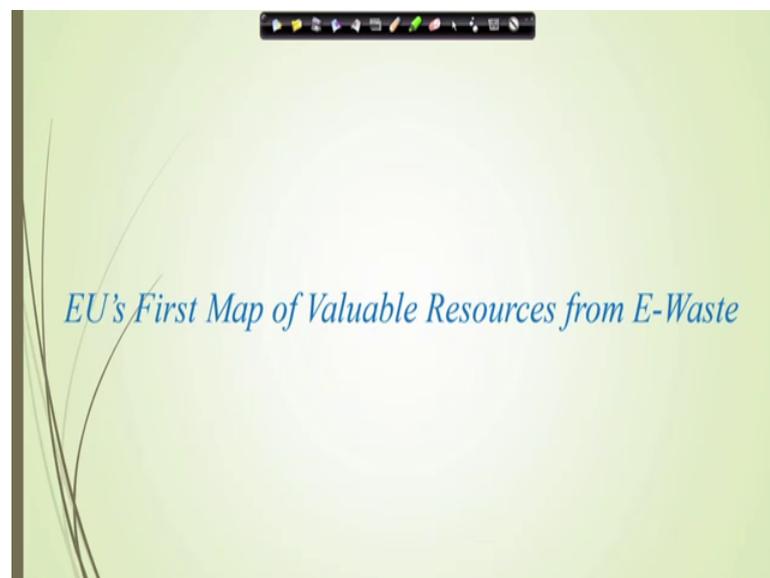
Just for those of you are interested can compare that, again they have the same similar issues here, it is implementation of the sea waste management rules for behaviour of the informal sector enforcement is not being effective.

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Lack of effective collection system, technological challenges is there, lack of public participation NGO's are not that much is coming out.

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So, that is how, that as you saw it is very similar, but china has made some recent progress.

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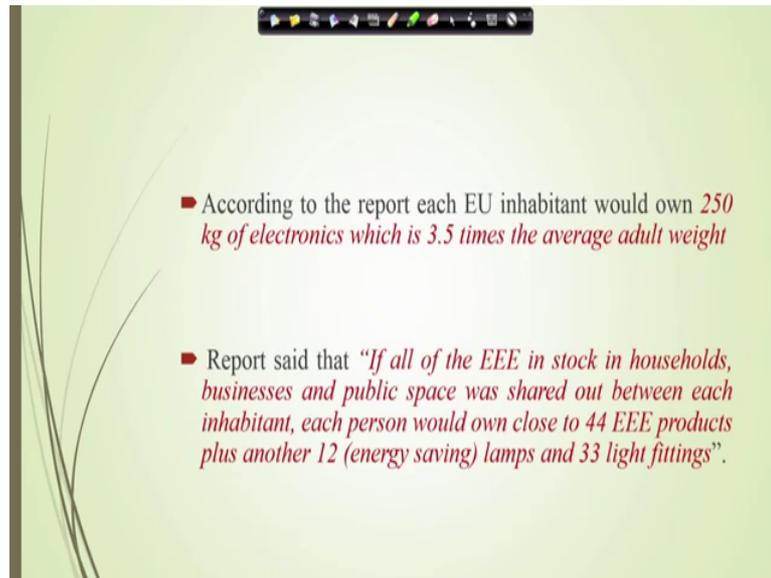
And in terms in terms of the management of electronic waste and if you look at how things are working in you here, are few slides to give you some information on that.

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No need to kind of read stuff from there.

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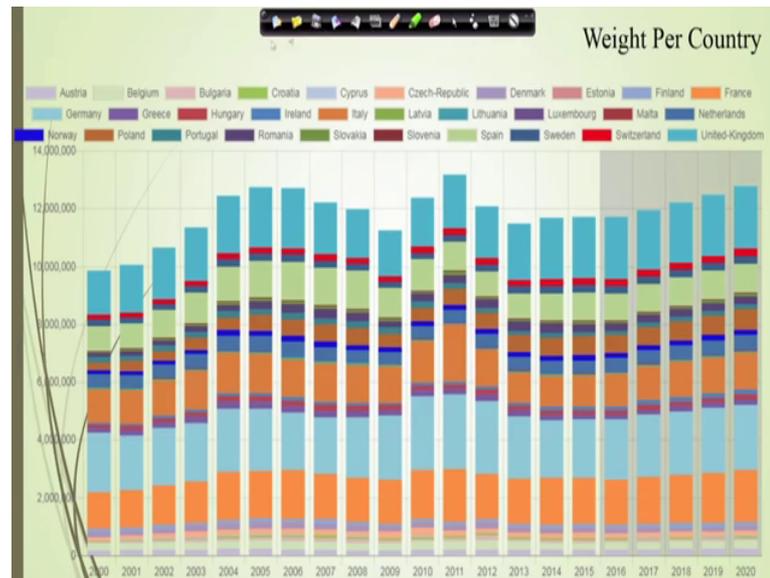


I will just show you some of these maps. So, as you can see, weight per capita this is in the different Chinese sorry, European union countries, we are seeing more and more small equipment a small equipment is that peach colour, as you can see more and more peach colours they started dominating now small equipment's. And then small IT equipment, large equipment is your light blue colour, which is another bigger category.

So, as you can see the smaller equipment is getting more popular, as more and more cell phones and other things are coming out. And the small IT is that grey colour. So, those

are the gray and the peach, if you take that that is nearly one third to maybe slightly more than third, in terms of and this is weight per capita. Remember, weight of this is small equipment is very less, and these are mostly PDA's iPad, your mobile phones and all that.

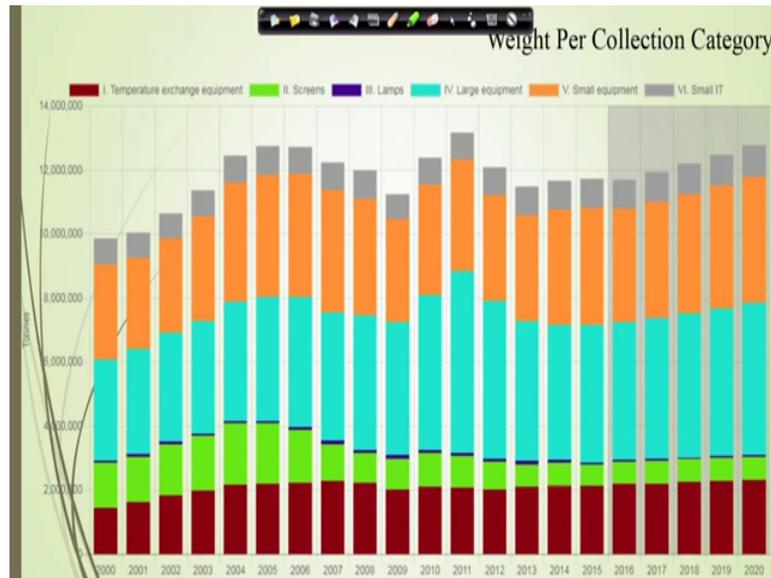
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Again, some in terms of the different countries, weight per country as you can see for Austria Belgium.

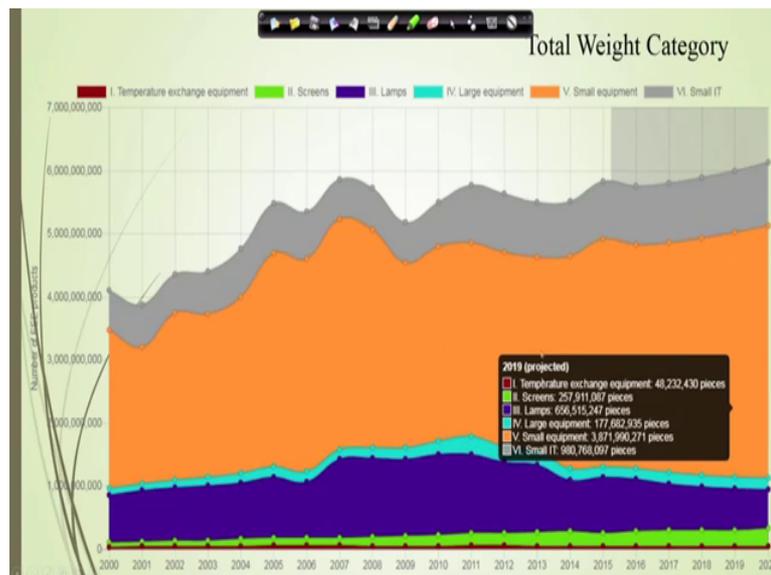
So the country which we can identify the country which produces the most. So, deserve and of course, it depends on their population too. So, some of these data have to 2015 is the real data. From 2016 onwards is like a it is a extra like a estimated data, it is a predicted data.

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So, from the different countries; how the waste is being produced wait for collection care category. As you can see for the temperature exchange equipment is screen lamps large equipment, a small equipment is the per and then a small IT equipment. So, as you can see for the different collection category more and more e waste is being collected for the different types of for, and you this large equipment is kind of going down and the small equipment is picking up, that is.

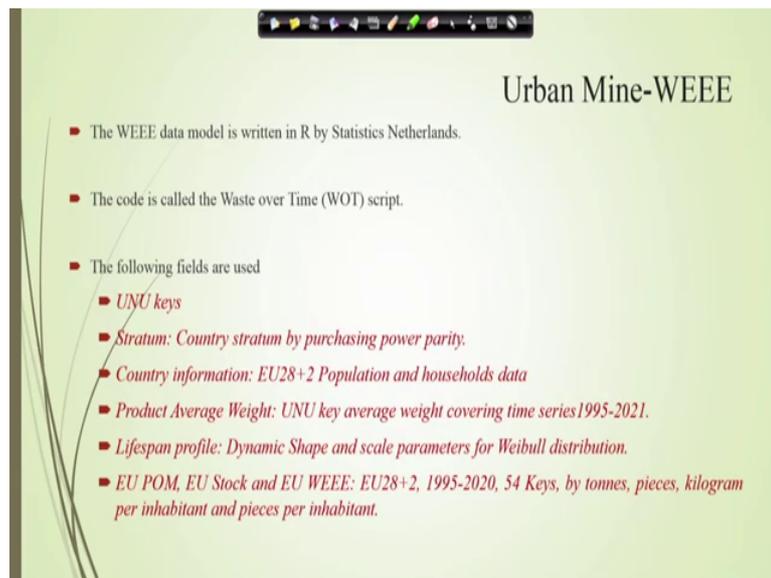
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And this is some projection in terms of how things will project in for 2019, 2002, 2018 as you can see different categories.

Again, this is small equipment is what I am trying to say, this is small equipment which is your cell phones PDA's iPad, mini laptops, those kind of stuff will start picking up in electronic waste stream.

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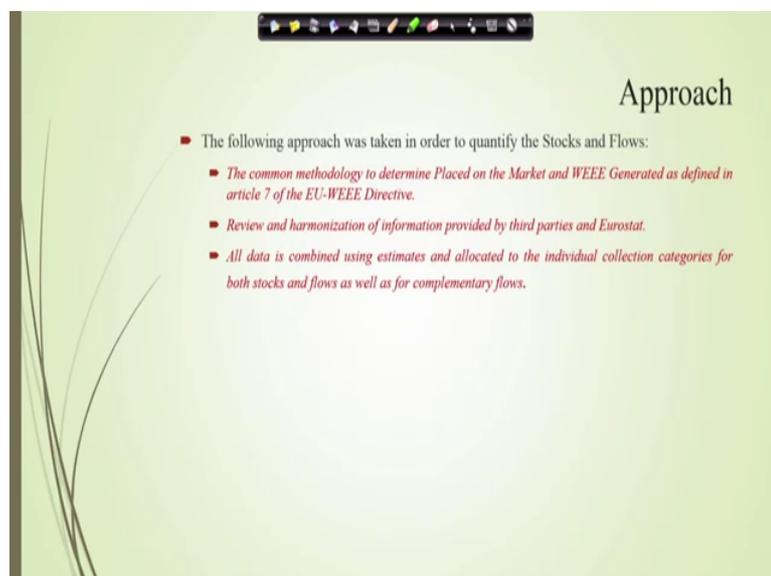


Urban Mine-WEEE

- The WEEE data model is written in R by Statistics Netherlands.
- The code is called the Waste over Time (WOT) script.
- The following fields are used
 - *UNU keys*
 - *Stratum: Country stratum by purchasing power parity.*
 - *Country information: EU28+2 Population and households data*
 - *Product Average Weight: UNU key average weight covering time series 1995-2021.*
 - *Lifespan profile: Dynamic Shape and scale parameters for Weibull distribution.*
 - *EU POM, EU Stock and EU WEEE: EU28+2, 1995-2020, 54 Keys, by tonnes, pieces, kilogram per inhabitant and pieces per inhabitant.*

So, we can do our burn mining, which is another concept of all these heavy metals and other things are there, which should be taken out can be done by urban mining.

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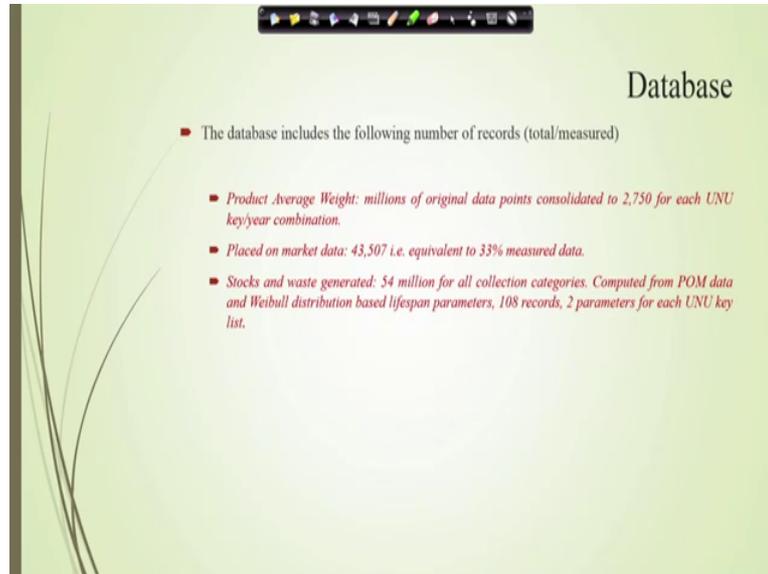


Approach

- The following approach was taken in order to quantify the Stocks and Flows:
 - *The common methodology to determine Placed on the Market and WEEE Generated as defined in article 7 of the EU-WEEE Directive.*
 - *Review and harmonization of information provided by third parties and Eurostat.*
 - *All data is combined using estimates and allocated to the individual collection categories for both stocks and flows as well as for complementary flows.*

And they have they used different approaches for that you those of you are interested can read about it.

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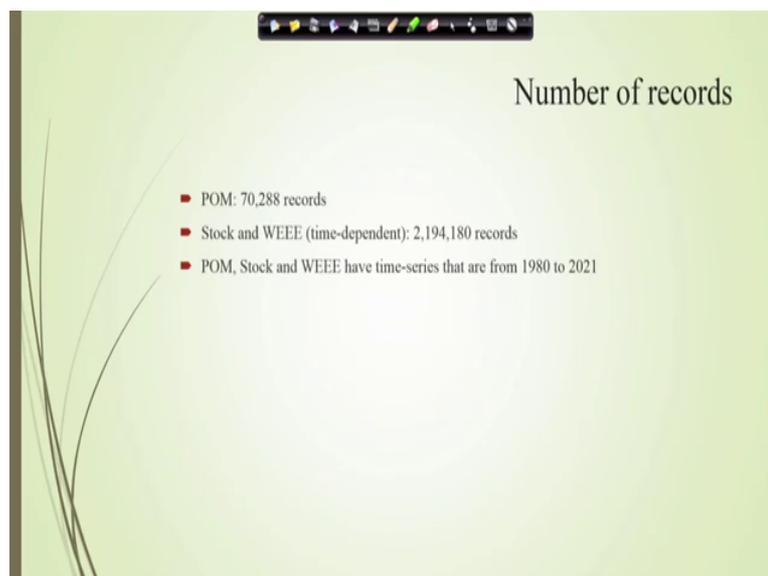


The slide is titled "Database" and features a list of bullet points. The background is light green with a decorative graphic of thin, curved lines on the left side. A toolbar with various icons is visible at the top center of the slide.

- The database includes the following number of records (total/measured)
 - *Product Average Weight: millions of original data points consolidated to 2,750 for each UNU key/year combination.*
 - *Placed on market data: 43,507 i.e. equivalent to 33% measured data.*
 - *Stocks and waste generated: 54 million for all collection categories. Computed from POM data and Weibull distribution based lifespan parameters, 108 records, 2 parameters for each UNU key list.*

And you can there are databases, where the number of records are provided. Where we have several records in terms of EU.

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The slide is titled "Number of records" and features a list of bullet points. The background is light green with a decorative graphic of thin, curved lines on the left side. A toolbar with various icons is visible at the top center of the slide.

- POM: 70,288 records
- Stock and WEEE (time-dependent): 2,194,180 records
- POM, Stock and WEEE have time-series that are from 1980 to 2021

So, that is just a quick look at that, and those of you are taking exam and many of you are taking is I might be wandering over he is covered so much material at the end. Those things are not far actually for the exam. Those EU or china those were just for you to see

the these courses are, these courses are meant to excite you in this particular topic. It is a 4-week course. It is a pretty small course in the in turbine. There are so much material that is out there. So, it is very difficult to where each and every aspect in great detail. So, what we are trying to do here is just to; so, show you some information get you excited about this topic. And then you need to do self-learning on this particular topic. And any questions and discussions feel free you like, our discussion forum is there you put it up there, it and later on as well if you have any interest to know more about this particular aspect. You can always send me email, but not right now.

I cannot entertain several thousand emails. So, sorry for that, but right now the mode of communication is discussion forum. After this like a up after approval of 2018 if you some of you who are working on us some sometimes, some anywhere in the world, and want to communicate on certain aspect you are more than welcome you can always find me on, IIT Kharagpur website.

So, so, this is a that is with this we close this particular session, particular course. In fact, from a theory point of view there will be some tutorial video will be which we posted shortly and you. So, any question any discussion, please put it on the discussion forum and will be more than happy to answer. Again, thank you for taking this course. I hope you enjoyed it, and those of you who are going to take the exam best of luck for your exam. And those of you who has not thinking of taking the exam, again, best of luck for whatever you want to use this information for. And if we can offer any help, please contact us presently through the discussion forum. And we will be more than happy to answer your questions.

Thank you.