Electronic Waste Management – Issues and Challenges

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Lecture – 21
Tutorial – 1

Hello everyone welcome to this course on electronic waste management issues and challenges, I am Arnab Kumar Pahari I am the TA of this course. So, today we will discuss about the typical numerical problem that will be coming to your end exam as well as that is given in your assignment and in the video lecture also. So, as we know our course consist 4 modules typically, in the first module we have discussed about electronic waste quantification and it is economy assessment. We have given some overview of health effects too, what is in the next module we have elaborately discussed the health hazards due to informal recycling of electronic waste whereas, in the third module we have discussed about the extraction of v c s metal from the electronic waste and in the fourth module which is the last module we have discussed the life cycle analysis as well as the legislation related to the e-waste management..

Say for example, what is the salient features of electronic waste management and handling rules as well as what is the present e-waste management scenario in different European countries and USA.

So, first so we basically our numerical problem will be coming from the first and second module which is the e-waste quantification and it is economy assessment and in the second module the health hazards due to informal recycling of e-waste specially. So, we are going to let us start with the first module.

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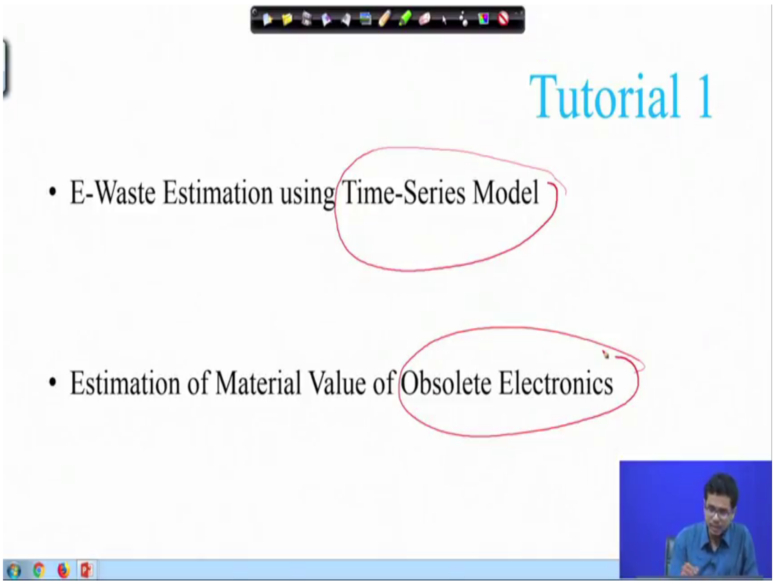

So, in this module we are going to discuss about e-waste estimation using a time series model and second we will discuss about estimation of material value of obsolete electronics.

So, let us start with the time series model.

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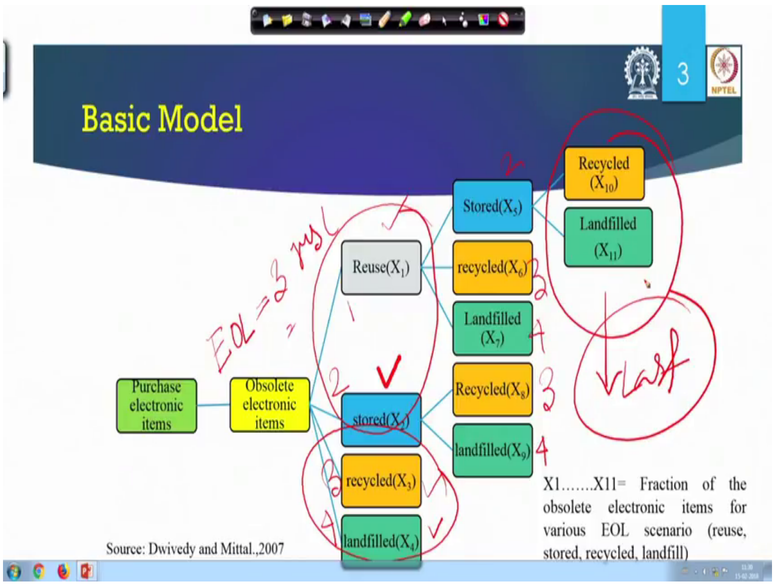

So, this is our typical time series model. So, what is the time series model? You purchase some electronic items or in year for a state or for a country totally purchase of electronics item are enormous then it will become obsolete at it is after its end of life period. What is end of life period? End of life period is different for different items say for example, for mobiles it could be 3 years, but for refrigerator it maybe 7 years, 8 years for TV television it may be 8 years 9 years. So, it basically depends on the product, once it is become obsolete it can be reused, it can be stored, it can be recycled it can be land filled..

So, after it is reusing so, what is the way of reuse you can donate to your relatives, can give it to your friend you can give it to your sister what is the storing, you can store it in your home. What is the recycling? You can recycle to the formal recycler like this there is in India we do not have that much recycling facility, mostly we are dealing with the informal recycling recycler like [FL] will come to your house and they will collect your instrument electronic and third one last one is landfill.

So, reuse and stored is the intermediate option and recycle and landfill is the final option. So, as we know as it is intermediate option reused and stored. So, reused item again can be stored recycle and landfill, it can go to option 2, 3, 4 similarly option 2 which is stored it can go to 3 and 4 it can be recycle and landfill. Similarly, again stored item can be recycle can be landfill because the recycle and landfill is our last option, what is X 1 to X 11 at is given is the fraction of the obsolete electronics items for various end of life scenario.

Now, we are going to the next slide.

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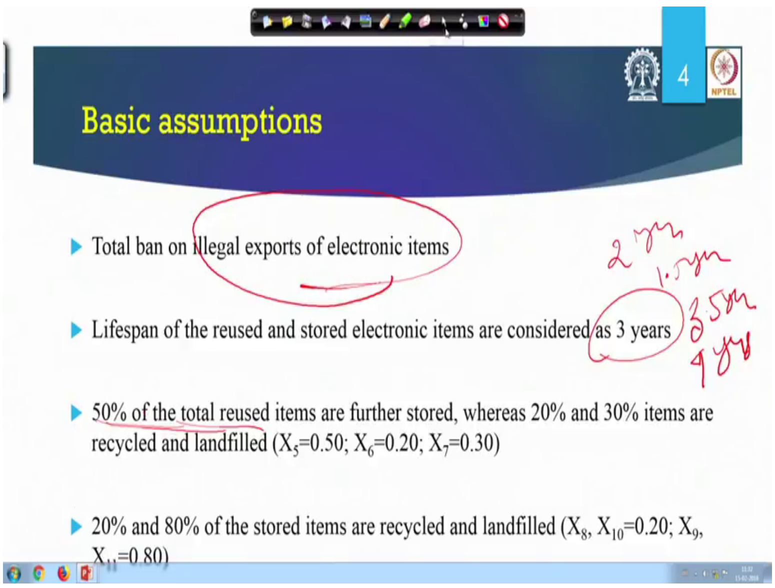

Before going in to the calculation or before calculating the total amount of obsolete electronics items, you have to keep certain factors in your mind, what are the factors? If we will see these days in the news the developed countries like USA, Europe they generate lot of electronics product and they import to the third world country sorry, they export to the third world country, why because they send this to the third world country as a gift..

So, in this so this is called transboundary movement in this case in our model you can say we can consider the transboundary movement, but we have not considered in this model this is the drawback of our model. So, if we will see total ban of the illegal export of electronic item, on the other hand we have assumed lifespan of the reused and stored electronics item are 3 years, it could be change it could be 2 years, it could be 1.5 years, it could be more than 3 years, 3.5 years it could be 4 years, but that depends on your actual observation..

These data all we have collected or shown to you is based on certain literature, certain data and 50 percent of the reused item are further stored whereas, 20 and 30 percent items are recycled landfilled this is another assumption. So, after it is end of life period you are reusing yours first you go back to the previous slide if we will see it see. So, after reusing you can store it you can recycle and you can landfill it.

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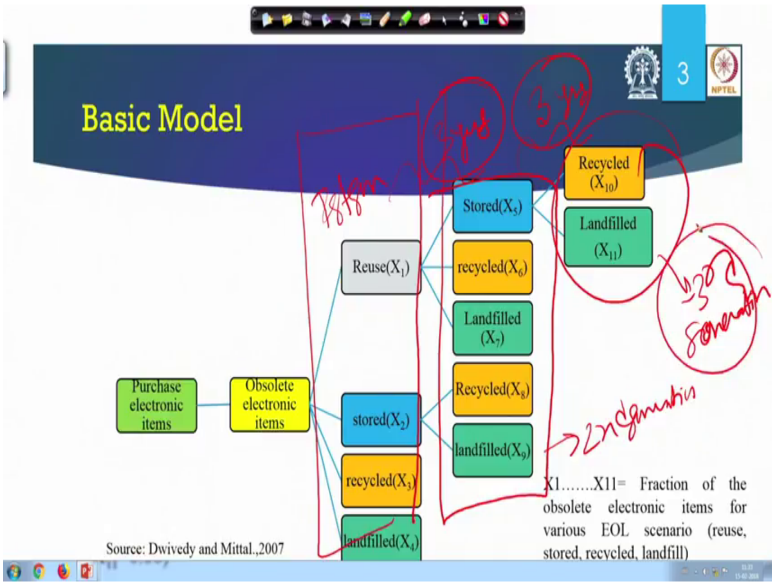

So, this period is 3 years, if you recycle your item electronic items and stored it we are assuming this value we are assuming this time span is 3 years, again if you recycle your stored item after 3 years these values also we are keeping constant 3 years. So, this is my first generation use, this is my second generation, this is my third generation..

So, for all the cases we are assuming 3 years, it again similar thing it could be change also it could vary. So, and 20 to 80 percent of the stored item which was which are coming to the third generation are recycled and landfilled these values all are based on the certain assumption.

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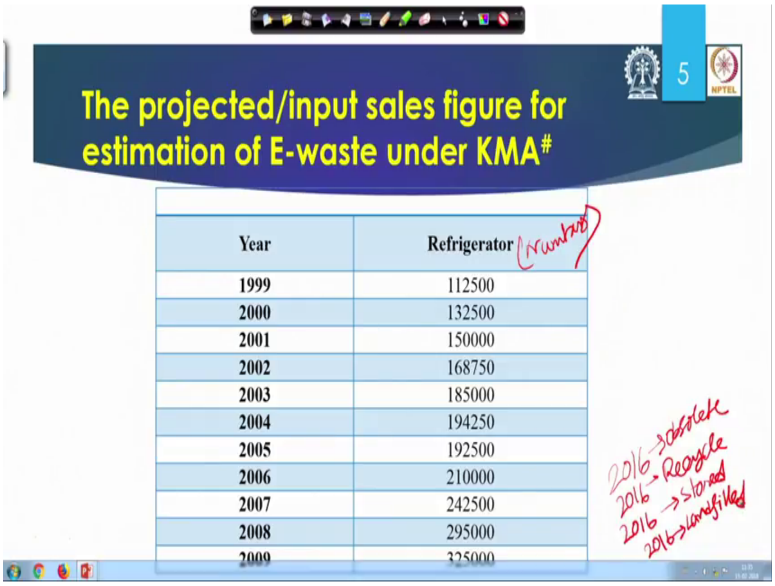

Now, we are going to the typical example, these are the data suppose you have the data of refrigerator under Kolkata municipal area. So, in Kolkata municipal area we have we have collected some data of sales figure of the refrigerator this all are in numbers, this all are in numbers. So, if we will see these values are quite high 2000-2001 we have all the data..

Now, if I you have to estimate the what is the total amount of obsolete in 2016, total amount of obsolete electronics as well as you can calculate what is the total amount of recycled refrigerator in 2016. What will be the total amount of stored refrigerator in 2016, what will be the total amount of landfill refrigerator in 2016 for that you need time series model equation you know the basic data. So, how to estimate? So, how to estimate?.

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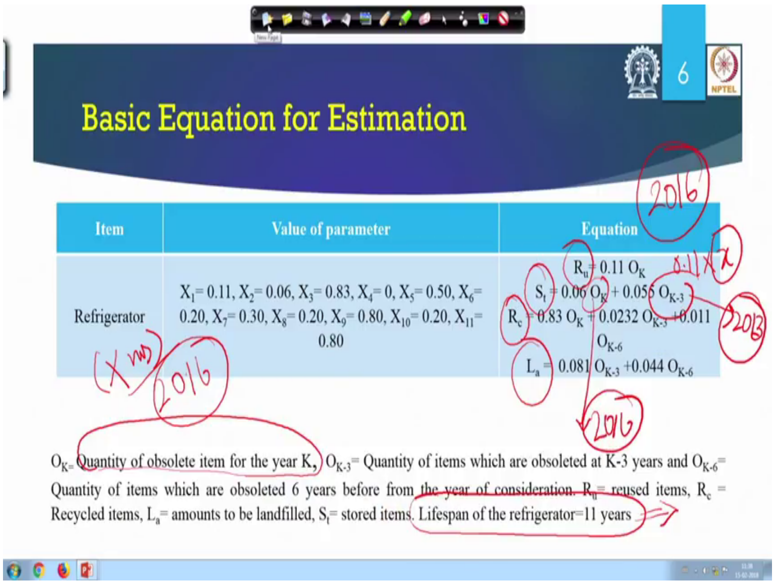

We are we have, we have been developed this equation, how we have been developed this equation, but how to develop this is the major things we have asked in the forum also. So, how it is developed? First things suppose you take refrigerator its amount is X suppose in 2016 as I have already given the example you want to determine all of the quantity, reused quantity, stored quantity, recycle quantity, landfill quantity how to calculate. First say for example, in refrigerator O K what is the O K; O K is the quantity of the obsolete item for the year K and you should keep in the mind what is the lifespan of the refrigerator, lifespan of the refrigerator is the 11 years.

So; that means, in 2016 those refrigerator at purchasing 2005 will become obsolete in 2016, that you should keep in the mind because in the calculation if we most of the time we did the do the mistakes. Most of the time we did the same mistakes we are not taking in to consideration the lifespan of the refrigerator because, if you want to now this is the single example of refrigerator..

Now, if you include various kind of electronics, there are different types of lifespan you have to take in you have to take in you have to take in the account all of the thing you have to take all of the lifespan of all the electronics item, then we have to develop step by step equation for each of the electronics item and once you determine for each of the electronics item you have to simply add these are the amount of the stored item, these are the amount of recycle item, these are the amount of landfill item, these are the amount of reusing item.

So, coming back to the example say for example, in the refrigerator the see for example, this is the X number assuming this is the X number. So, what will be the reuse item one 1.11 into X; X means this X number refrigerator I am just determining for 2016, say for example. So, this X number refrigerator become obsolete in 2016. So, it has reached its end of life period in 2016, now what how to calculate the stored item, the recycle amount which reached at it is end of life period in 2016 as well as who is become of obsolete 2013 because, the amount which is obsolete in 2016 we restored for 3 more years as per the model.

Similarly, for recycle items if will go back to the model, similarly for recycle items if will look at the model the amount which become obsolete in 2016 the amount which become obsolete in 2013, the amount which become obsolete in 2010.

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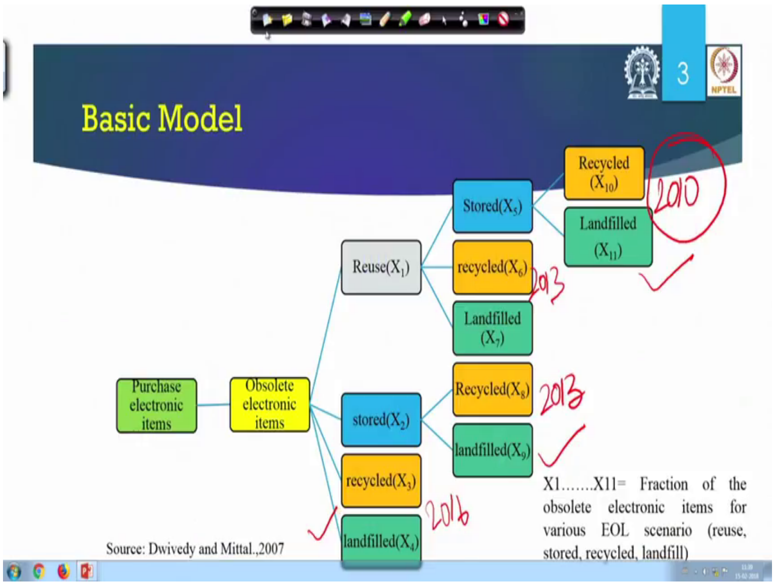

Similar way we have to calculate it for landfill also, these problem we used typically for our research purpose we do not aspect this kind of problem will be given to your end exam, but you should know the logic behind the time series model.

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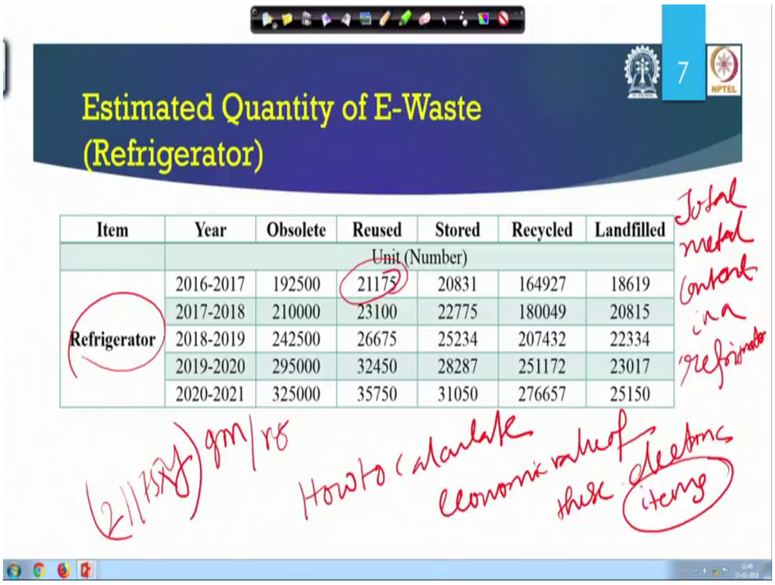

Now, suppose you determine these are the total amount of obsolete refrigerator obsolete reused refrigerator, stored refrigerator, recycle refrigerator, landfill refrigerator. Now, what, how to calculate, how to calculate economic value of this electronic item how to calculate, there are 2 procedures first you can multiply the number with the weight of individual item, if you know the weight of the refrigerator say for example, y..

So, for what will be the total use item 2175 into y this much grams say for example, or kg whatever maybe the yes. Another y k you know the number you go through the total metal content in a refrigerator in a refrigerator like in the next slide we have shown in.

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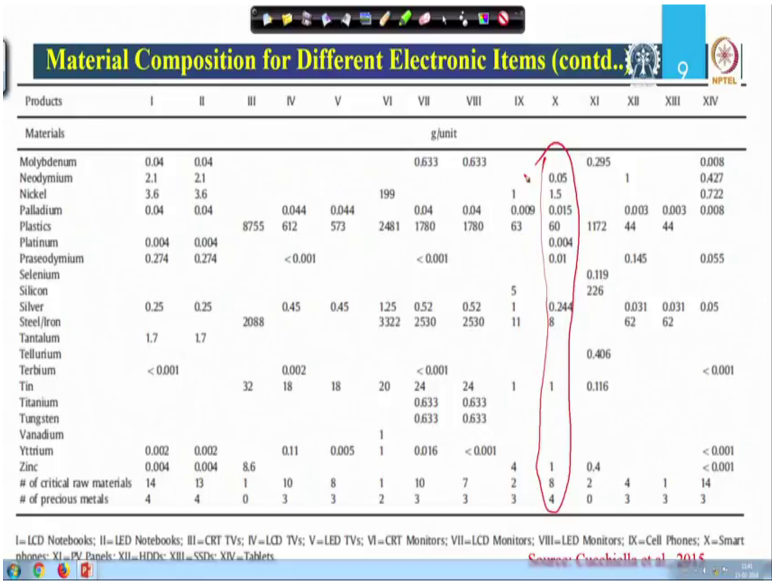

Material Composition for Different Electronic Items (contd..)

Products	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
Materials							g/unit							
Molybdenum	0.04	0.04					0.633	0.633			0.295			0.008
Neodymium	2.1	2.1								0.05		1		0.427
Nickel	3.6	3.6				199			1	1.5				0.722
Palladium	0.04	0.04		0.044	0.044		0.04	0.04	0.009	0.015		0.003	0.003	0.008
Plastics			8755	612	573	2481	1780	1780	63	60	1172	44	44	
Platinum	0.004	0.004								0.004				
Praseodymium	0.274	0.274		<0.001			<0.001			0.01		0.145		0.055
Selenium											0.119			
Silicon									5		226			
Silver	0.25	0.25		0.45	0.45	1.25	0.52	0.52	1	0.244		0.031	0.031	0.05
Steel/Iron			2088			3322	2530	2530	11	8		62	62	
Tantalum	1.7	1.7												
Tellurium											0.406			
Terbium	<0.001			0.002			<0.001							<0.001
Tin			32	18	18	20	24	24	1	1	0.116			
Titanium							0.633	0.633						
Tungsten							0.633	0.633						
Vanadium						1								
Yttrium	0.002	0.002		0.11	0.005	1	0.016	<0.001						<0.001
Zinc	0.004	0.004	8.6						4	1	0.4			<0.001
# of critical raw materials	14	13	1	10	8	1	10	7	2	8	2	4	1	14
# of precious metals	4	4	0	3	3	2	3	3	3	4	0	3	3	3

I = LCD Notebooks; II = LED Notebooks; III = CRT TVs; IV = LCD TVs; V = LED TVs; VI = CRT Monitors; VII = LCD Monitors; VIII = LED Monitors; IX = Cell Phones; X = Smart phones; XI = PV Panels; XII = HDDs; XIII = SSDs; XIV = Tablets.

Source: Cucchiella et al., 2015

See these are the typical metal content in the different kind of electronic item, here refrigerator is not mentioned, but we had the data for refrigerator also.

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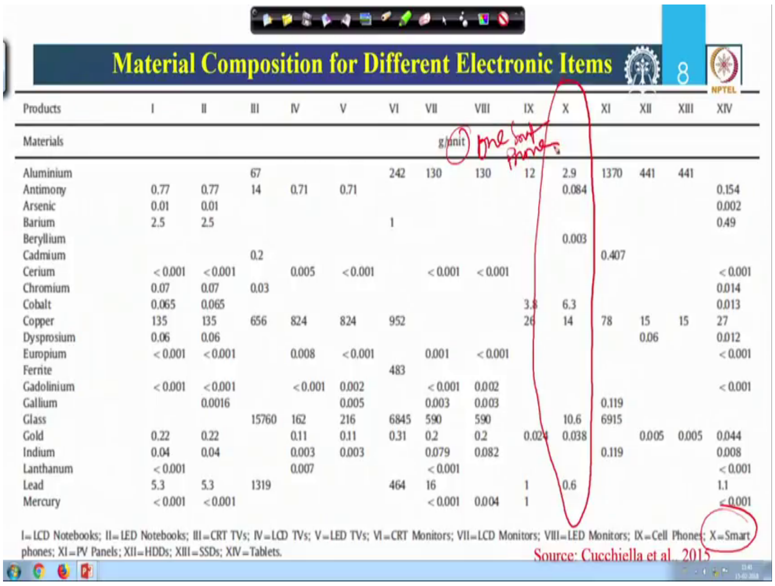

Material Composition for Different Electronic Items

Products	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	XIII	XIV
Materials							g/unit							
Aluminium			67			242	130	130	12	2.9	1370	441	441	
Antimony	0.77	0.77	14	0.71	0.71					0.084				0.154
Arsenic	0.01	0.01												0.002
Barium	2.5	2.5				1								0.49
Beryllium										0.003				
Cadmium			0.2								0.407			
Cerium	<0.001	<0.001		0.005	<0.001		<0.001	<0.001						<0.001
Chromium	0.07	0.07	0.03											0.014
Cobalt	0.065	0.065							3.8	6.3				0.013
Copper	135	135	656	824	824	952			26	14	78	15	15	27
Dysprosium	0.06	0.06										0.06		0.012
Europium	<0.001	<0.001		0.008	<0.001		0.001	<0.001						<0.001
Ferrite						483								
Gadolinium	<0.001	<0.001		<0.001	0.002		<0.001	0.002						<0.001
Gallium		0.0016			0.005		0.003	0.003			0.119			
Glass			15760	162	216	6845	590	590		10.6	6915			
Gold	0.22	0.22		0.11	0.11	0.31	0.2	0.2	0.024	0.038		0.005	0.005	0.044
Indium	0.04	0.04		0.003	0.003		0.079	0.082			0.119			0.008
Lanthanum	<0.001			0.007			<0.001							<0.001
Lead	5.3	5.3	1319			464	16		1	0.6				1.1
Mercury	<0.001	<0.001					<0.001	0.004	1					<0.001

I = LCD Notebooks; II = LED Notebooks; III = CRT TVs; IV = LCD TVs; V = LED TVs; VI = CRT Monitors; VII = LCD Monitors; VIII = LED Monitors; IX = Cell Phones; X = Smart phones; XI = PV Panels; XII = HDDs; XIII = SSDs; XIV = Tablets.

Source: Cucchiella et al., 2015

So, if you look at say for example, for the similar kind of for that you want to determine the value for a Smartphone. So, what is the value for a Smartphone, column 10 so, column 10 is for the Smartphone. So, these are the total material cont metal content in a Smartphone aluminium is 2.9 gram in 1 Smartphone per unit means 1 Smartphone another is a antimony. So, this way this way total metal content is given. So, you determine the total metal content and then you determine the total material value in a single Smartphone in a single Smartphone.

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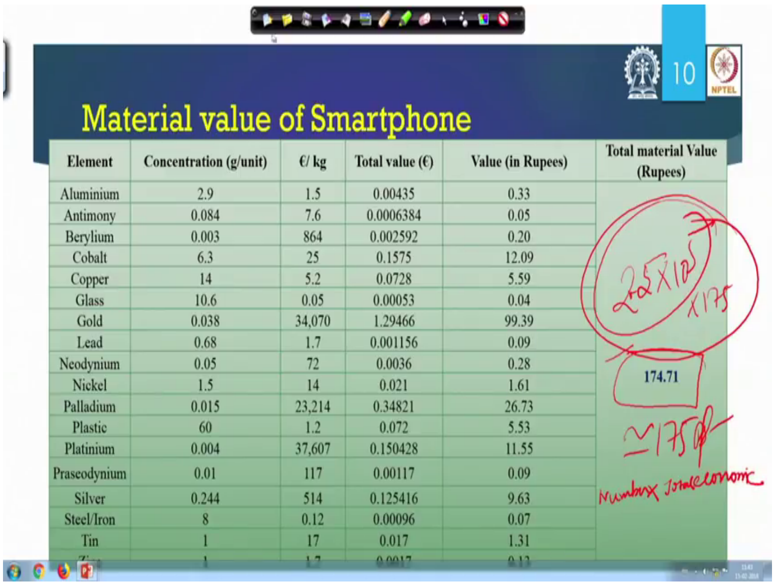

Like we have calculated, it is coming around very small see this is what a Smartphone 174.71 approximately 175 approximately 175 rupees see, but when you look into the quantity in a year the number of Smartphone has become obsolete is into 10 to the power 6. Say for example, around 22.5 into 10 to the power 5 to say for example, I am giving one example that suppose assume your Smartphone total amount of the obsolete quantity of your Smartphone is 2.5 into 10 to the power 5 ok.

So, if you multiply with 175 this is a huge amount that we are becoming landfilling or otherwise we are send it to the informal recycler and on the other hand what is done by, what they have done what informal recycler use to do, they collect this metal through unscientific way and sale it to the authorised recycler, that way they are earning money. So, these way you can calculate the total amount or total economic value of an electronic item, you can multiply with the number into total economic value 1 second you can multiplied with the number you can multiplied with the.

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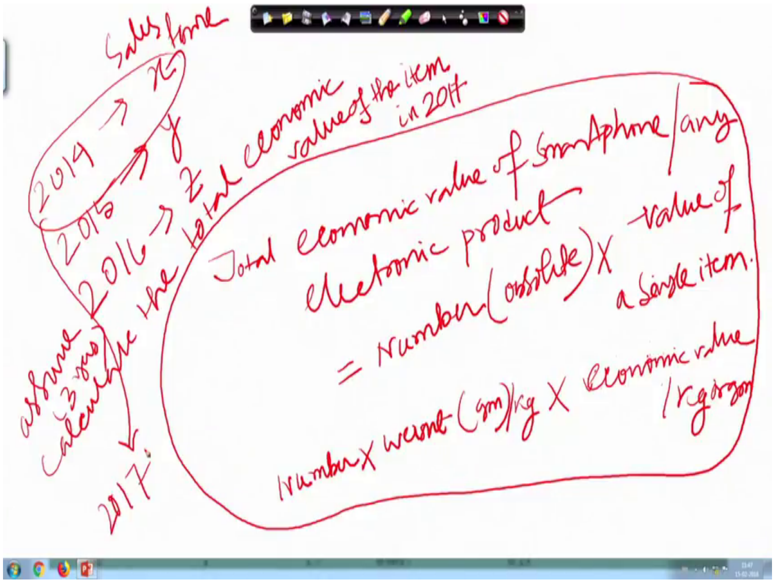

So, total economic value or Smartphone or any other electronics items or any electronic product is 1 is number that is obsolete into value of a single item these I can determine. Otherwise, if you know the number you can number you can multiplied with the weight and you can detect when you multiplied with this is gram or kg whatever may be then, you have to determine the value in terms of money; obviously, economic value economic value economic value per kg or gram ok.

So, these way you can calculate the total amount of economic value from a recycled electronic product from a stored electronic product, the way we want to calculate you can calculate it. So, in the first module what we have done till now first week quantify we have estimated the quantification, quantify the total electronic waste for a city, for a state you can determine, for your city you can determine for your state even you can determine for your country like India..

You can determine for India using a time series model, that parameter major things you should keep in mind that parameters could be change this values are based on the certain assumptions. Next we have not considered that trans founded moment of electronic waste that things can be included in this time series model, with some special features. Next we calculate the how calculate the economic value of an electronics item.

So, this is very simple number into value of a single item or number into weight or economic value per gram of the electronics item, one thing you should keep in mind that in the exam it may be given like these are the data 2014 in this much amount say for x amount items are has purchased electronics item in 2015 it could be y in 2016 it could be z. So, these amount of this is the sales figure. So, while calculating a suppose I have asked we are we have asked you that how calculate the total economic value of the item in 2017. So, what will be the to a total economic value in 2017.

So, say for example, assume lifespan is 3 years. So, which item become obsolete in 2017 those which you have purchased in 2014, do not say that we do not have the data in 2017 because of the item you have purchase in 2014 will become obsolete in 2017 and then you use this value for calculation. So, thank you for the module 1, next we will start module 2 which is related to the health hazards due to informal recycling of e-waste. Here, we will discuss how to calculate different cancer risk non carcinogenic risk, you know what are the different elements related to and we will discuss also different elements related to the health hazards.

So, thank you for the module 1.