Carbon Accounting and Sustainable Designs in Product Lifecycle Management

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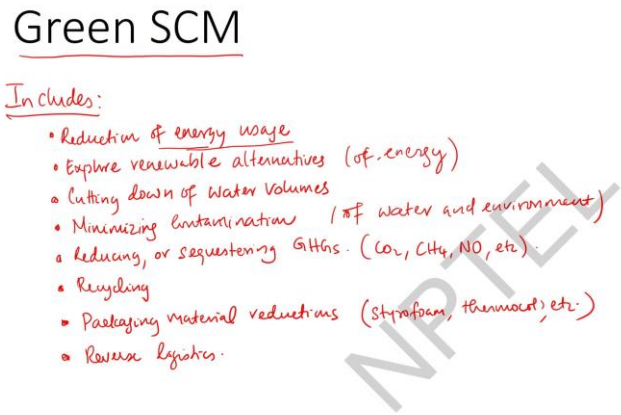
Week 05

Lecture 20

Sustainability and Green Supply Chain (Part-2)

Good afternoon, everyone. Welcome to yet another lecture of the course titled Carbon Accounting and Sustainable Designs for Product Lifecycle Management. I am Prof. Deepu Phillip. I am from IIT Kanpur. And this course is offered as part of the NPTEL MOOCs from IIT Kanpur.

And along with me, Dr. Amandeep Singh Oberoi and Dr. Prabal Pratap Singh are co-teaching this course. Today, we are going to get into this. We have already discussed what we call as the supply chain and the sustainability aspect of it.

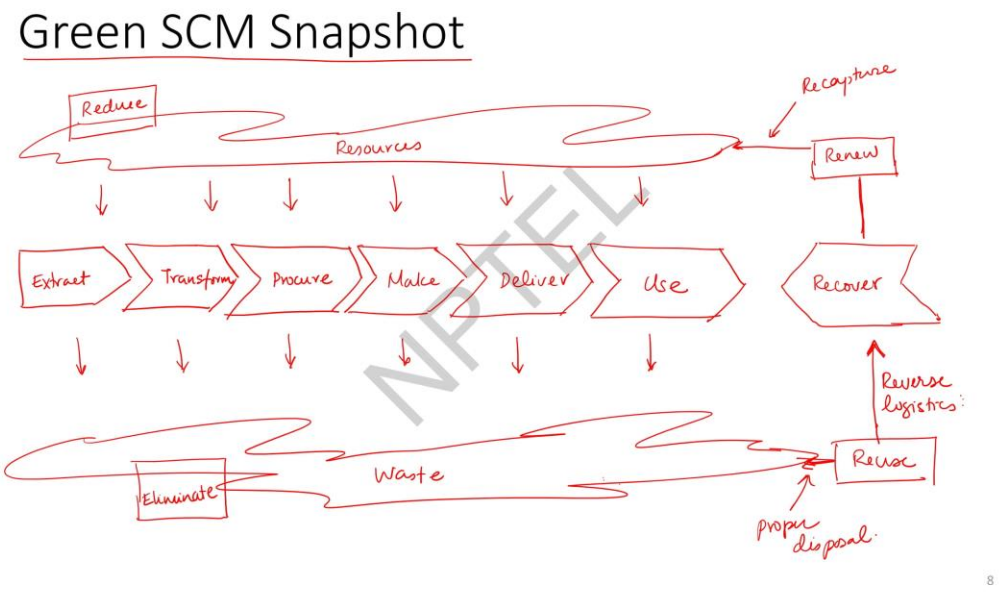


And we have already seen the supply chain system viewpoint. So, today we will now see the green supply chain. SCM stands for ‘Supply Chain Management’. So, in the green supply chain management, the main things that it includes is, reduction of energy usage. So, first thing we would like to do is reduce the energy use. Explore renewable alternatives. Then, cutting down of water volumes or reducing the usage of water and then minimizing contamination of water, contamination of environment, okay.

So, then reducing or sequestering GHG's (Greenhouse Gases), then recycling, then packaging material reductions, and also reverse logistics. So, these aspects where we are trying to reduce the energy, energy usage, we are trying to reduce it. Then we are also trying to explore renewable alternatives of energy. So, we are trying to focus renewable alternatives of energy. It is like sunlight or wind energy or etc.

Cutting down of water volumes. So, reduce water usage. Minimizing contamination of water and environment, okay. And reducing and sequestering of GHGs. GHGs stand for greenhouse gases.

We said CO2, CH4, nitrous oxide, etc, okay. And we already seen what is recycling. And packaging material reductions. Packaging materials like styrofoam, then thermocol, etc, we are trying to reduce it and maybe replace it with new materials or environmentally friendly materials and reverse logistics. And we will see what is reverse logistics in a minute. And that's also a new concept that is part of our discussion, okay.



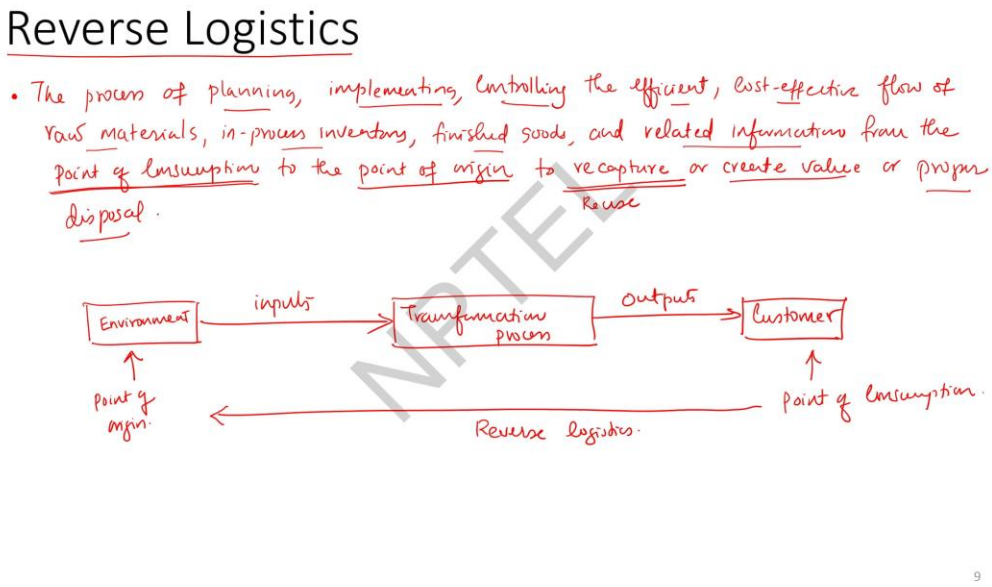
So, let us look at the green SCM in a holistic viewpoint. So, as we drew earlier, extract is the first step. Then transform, make because buy is part of procure, make, deliver, use, okay. So these are the major steps we can talk about, and in all these cases we have resources and the resources keep on going to every step like this, okay.

And one of the other thing along with this is waste. And each process will produce waste. Or each step will process or produce a waste. So the one aspect of the resource is reduce, as one R of the reduce. And then, there is, you know, in the waste, we can think about it as eliminate waste.

That's one other aspect. And then, in between, there is another approach that actually happens, which we will draw here, we call it as Recover. That is after the use, we recover things and then that recover actually goes into what we call as reuse, and sometimes it is renew, okay. So this portion reuse, which some part will go into the waste but otherwise this is this portion where we used to put is called the Reverse Logistics. So, a product that has actually become, that has achieved, what you call as the achieved or reached its end of life, okay.

That time, if you take that and recover what is useful out of it and whatever is remaining, you throw it into the waste and whatever thing can be taken out and can be added to the resources If you do that, then you do the Reduce, Reuse, Recover and so that way you

will end up and Recycle. You will actually end up doing the or achieve the green SCM as part of this. So, if you look into the whole system, this is the one way of looking into the green supply chain as part of the topic.



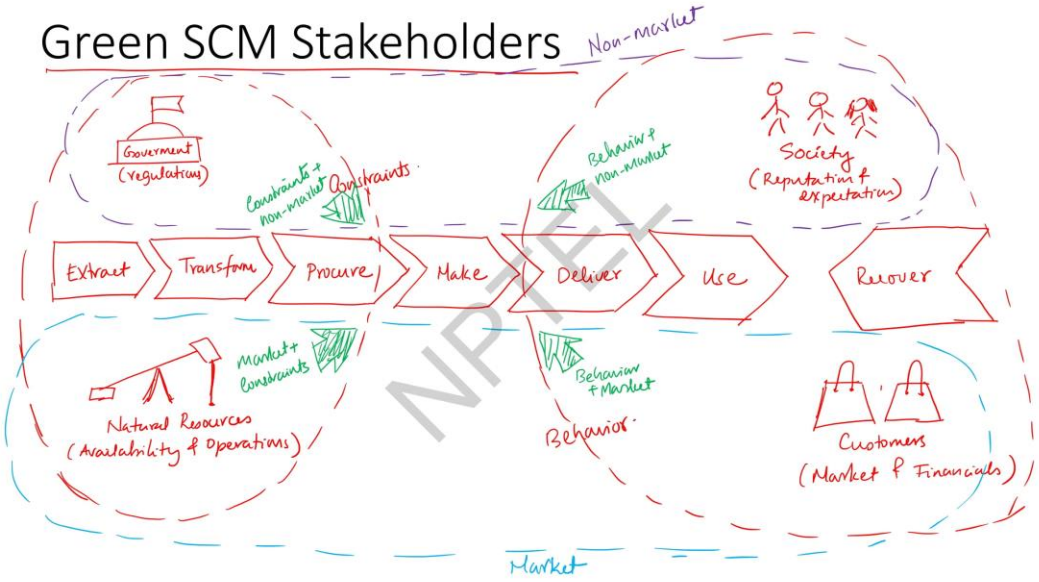
Now, let us define Reverse Logistics because, we just drew it in systematically and we are going to define this term reverse logistics is what we are going to define, okay.

So for this course, we can do it as the process of planning, implementing and controlling the efficient and cost-effective flow of raw materials. In process, inventory, finished goods and related information from the point of consumption to the point of origin. To recapture or create value or proper disposal. So, the definition says the process of planning, implementing, controlling the efficient cost-effective flow of raw materials, in process inventory finished goods and related information from the point of consumption, that is a critical aspect the point of consumption.

So if you think about it, is inputs our transformation outputs and you have the customer, so this is the point of consumption, okay. And to the point of origin the point of origin is can think let's call this as the Environment. This is the point of origin, okay. So, the flow is from point of consumption to point of origin, okay. This is where the reverse logistics comes into picture.

So, if you go back in the previous diagram that we did, we are talking about this is the point of consumption, okay. And this is the point of origin. So, the efficient cost-effective flow of raw materials in process inventory, finished goods and related information from consumption to the point of origin. And why do we need to do that? To recapture, okay.

Or what we say here is Reuse, Recapture, or Reuse, or create value by not reproducing it again, or proper disposal, if it is not necessary. Then it goes into proper disposal, as part of the waste, so this will be your proper disposal, okay. The other one is recapture, okay. So, this one is the recapture, which is going into the resources. So, you do not have to make the resources again, okay.



So, let us now also talk about the stakeholders of the green supply chain, okay. And this is critical because depending on the stakeholders, things actually change. So, bear with me until I draw this diagram once again. So, we have the first step as Extraction. The next step as Transform.

The third step happens to be Procure. Then comes Make. Then Deliver, Procure, Make, Deliver. You have Use, okay. And as I said, as part of this is the reverse logistics, okay.

That's the recover, okay. We'll draw it only this much, okay. So, one option here is, let us call this as the, okay. So, this is the government and government means what?

Regulations. So government puts in regulations and then there is also something like, let's call this as the easiest way to do this is, okay.

Let's call this as the, this is like you are mining things from the earth. So, natural resources, okay. Availability and operations, okay. So, these two, okay, They put in the extraction, transformation and procurement.

In that area, we draw a circle or an ellipse, okay. And this ellipse, we call it as the, let us call it as constraints. So, the operations and availability of the natural resources and the government regulations, what they typically do is they add constraints to the system, okay. And similarly, in the other CIDs, you have constraints. So, let us call this as the society.

And society is the, so they have what you call as expectations and reputation and expectations. So the society has a reputation, like for example, the Japanese society is very much, you can see that they even go to the, after the football games, they clean up all the mess behind them. And you have also, let's call this as the customers, okay. The customers focus on the market and financials, okay. They are worried about the market and the financials.

So, they, these two do something close to this. They make another bubble which is associated with the delivery and the recover, okay. This bubble is actually called as the behavior bubble, okay. So, they influence the deliver, use, and recover aspect of it, okay. Now, the, these two people, the government and the society, okay.

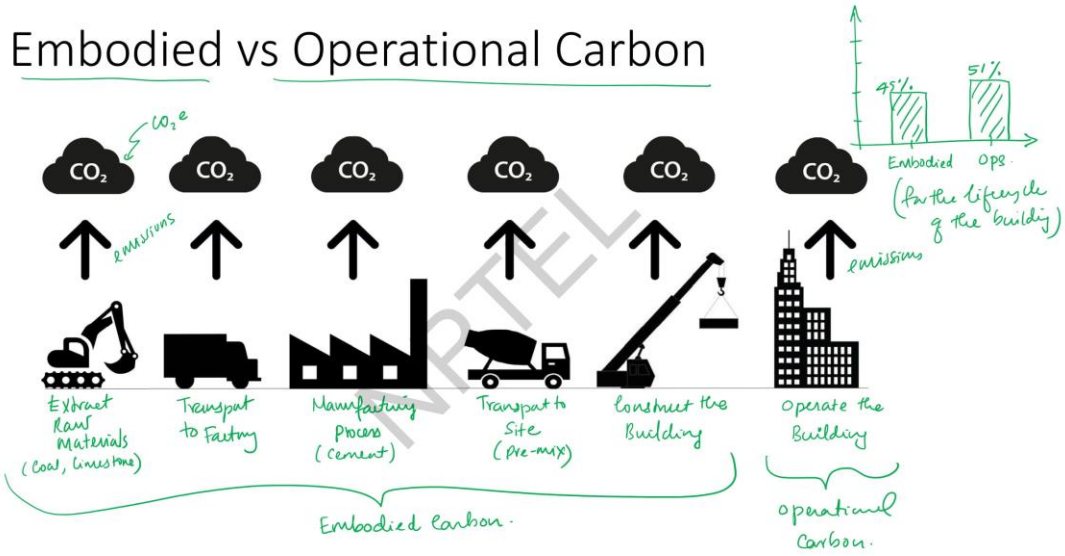
Let me put a different color here. It may be easy to use purple. These two form a, this bubble is called as the Non-Market bubble. There is not a, it's not a Market bubble. It's a Non-Market bubble.

The society and the government. Whereas the other one, the natural resources and the other one, this is called as the Market bubble. So, the constraints and if I draw it in a better fashion, then I am just using the green color. This, the market, the natural resources and the constraint, the government regulations, they will cause a strain in this area, okay, they will push the bubble right there and same way the government and the the non-market and the constraints, okay. It will also have its push right here in this area same way, the society and the behavior, the non-market and the behavior will have a push right, okay.

It will have a push right here and this place also. It will have a push right here, okay. So the behavior and market, okay. So this will be the behavior market, okay. This is the behavior plus market push.

This will be the behavior plus non-market push, okay. This will be the, this one will be the, the constraints plus non-market push. Whereas, this will be the market plus constraints push, okay. So, these four type of pushes will also act at the green supply chain. So, sometimes the government will come up with the regulations, but the market may oppose it in a different fashion, okay.

So, this existing system, this kind of an overall or system that we just talk about green supply chain, opposing forces or different type of aspects would actually create different type of pushes or forces in the market, which actually would market or the society, non-market, which actually would influence the behavior of the system, okay.



So, now let us talk about the new topic called the Embodied versus Operational carbon, okay. And what it is and let us talk about that. So, every activity that we talk about in the chain will end up producing CO2.

And when we are saying this is CO2 means this is CO2e (Carbon Dioxide Equivalent), okay. That is what we are talking here. So here the first one that we talk about the the Poclain or the earth mover excavator model that you hear is this is extract raw materials.

Okay. And then this one you can talk it as transport to factory, okay. This is the manufacturing process.

It is not the transformation. It's a transformation process, but manufacturing because you probably won't have a factory for a services industry, okay. So, like these things, you can think about as the transformation, the raw materials and other kind of things as part of it, okay. So, then this you can see it as transport to site. Maybe think about as a cement factory.

Here you have raw materials. Let's think about the raw materials here as coal, limestone, etc. Then here is the cement making. And the premix is being transported to the site. And here we are talking about construct the building, okay.

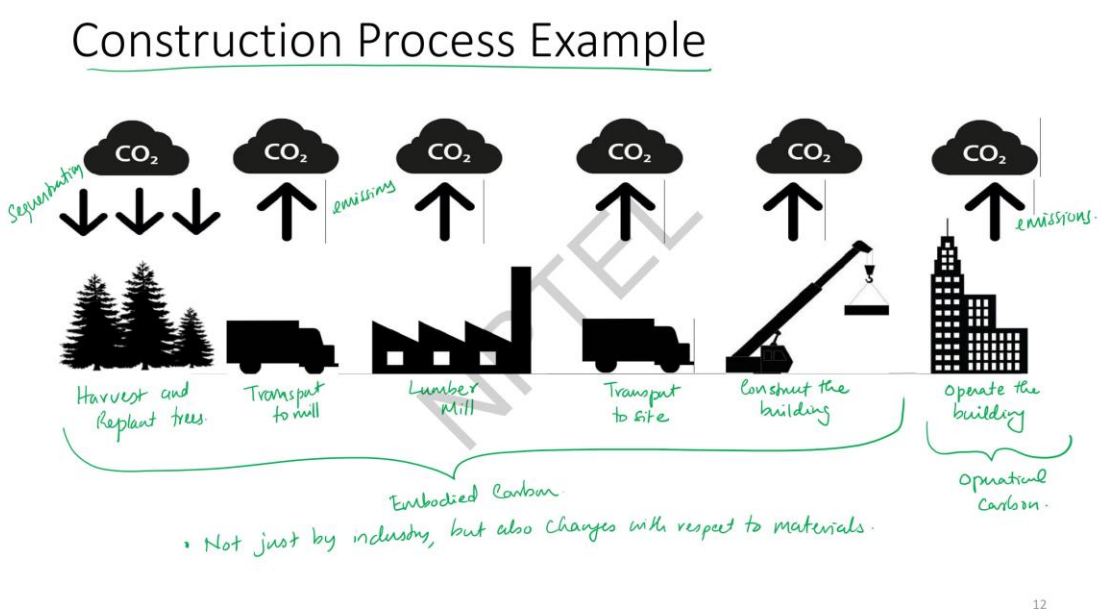
So it's like a premix. Let's think about this way. And construct the building. We are building this, okay. And then once the building is ready, then what we do is we operate the building.

So, all these things, this is the embodied carbon. This is embodied into the process. Until the building is built, this much of carbon will be emitted as part of all the things put together. And this is known as the Operational Carbon, okay. So, if you want to find out the carbon footprint of a building, most of the time people focus on the Operational Carbon, not on the embodied carbon.

Because embodied carbon is the carbon that is part of the process or such. How much is this? Okay. So, if I use, if I put it on an XY axis, I have two things, that is, one is the embodied carbon, and the other one is the operational, and this is the, if I have different things like this here, I would have something like this one will be, the operational will be slightly more. So, this will be approximately 49% and this will be 51% age.

So, they are almost similar in this case. The embodied and the operational in the lifetime or the life cycle of a building. If you assume this as for the life cycle of the building. For the life cycle of the building, the carbon emissions for the embodied and operations are almost the same. Remember, we have already discussed this in the class also with the help of automotive because we said that the carbon footprint that is required to manufacture the automotive,

which is that embodied carbon, is equivalent to that of the same as that of the emissions through its lifetime from the tailpipe, so similar thing, okay.



Now let us talk about the Construction Process Example, okay. Just as we mentioned here earlier, okay. So the Construction Process Example in this case is in previously I was just talking about extracting raw materials. But now let us think about the wood also.

Let us add into this picture. So this is the we call it as harvest and replant trees. So, in that process, it is Sequestration. These are emissions. So, you have a harvest and replant tree.

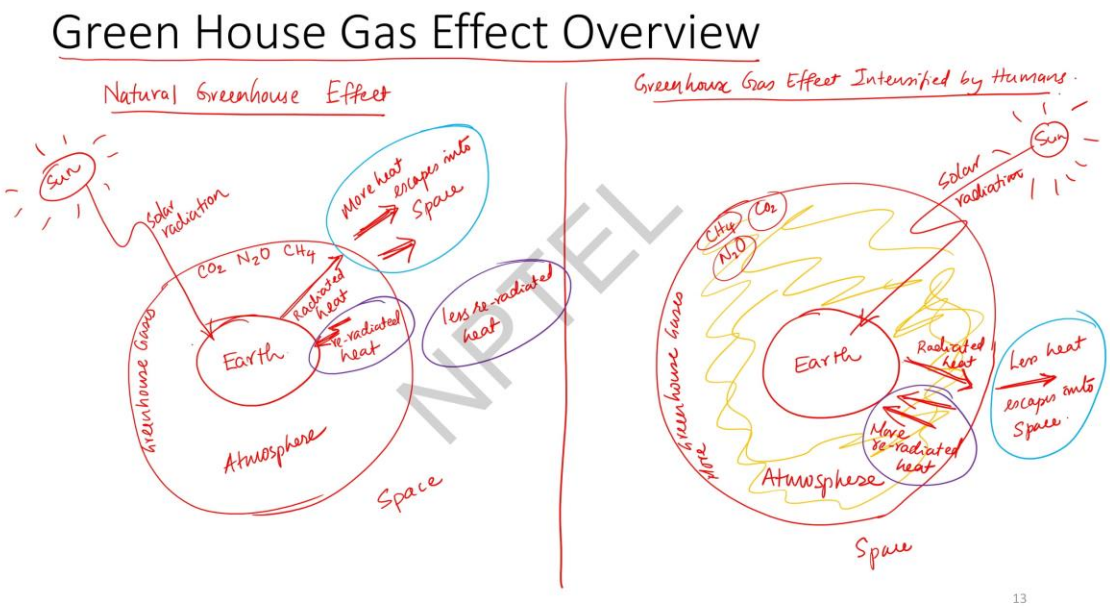
So, you are cutting down the trees and you are replanting them. Then you are transport to mill, wood mill. And here is the lumber mill where the wood is converted into blocks of wood, okay. Then we have transport to site, okay. Then construct the building.

Here you are talking about the wood ass from the, and then you have the operate the building. This is also emissions. So this whole thing is the Embodied carbon. And this is the Operational carbon. While the previous example, we were talking extracting coal, limestone, etc. to make the cement, where almost all of them are emissions only.

When we take the wood as an example, then there is a sequestration also part of it. So, not just by industry but also changes with respect to materials. So, in one case, the wood, in case it is cement, and both the cases, the things have changed significantly as part of this. So, this is a good place for us to stop the lecture for today because, now we also have two quick questions in the previous class about, what is the Greenhouse Gas effect?

How do you understand Greenhouse Gas effect and also there is another question is, what is the carbon cycle? How the Earth's carbon cycle happens? Both of those things I can actually give an overview in the coming class or the next class as part of this. But this will actually this much explains the total concept of how the green supply chain and how do you use or think about sustainability, the emissions, the recovery, reuse etc.

All comes into the part of the transformation process from the upstream to the downstream, so if you look at the slide today's slide is called Greenhouse Gas effect overview.



So I'll try to use a diagram to explain this let's think about it in two ways the first one is the natural greenhouse effect. So understand that this exists no matter what, okay. Naturally this effect exists. So let's call this as the earth, okay. And you have something like I'm drawing it in an ugly fashion but for the time being let's call this as the atmosphere, okay. Earth and this is the atmosphere.

And then here is the sun, and the from the sun we get solar radiation. So the atmosphere what I am saying here and in this atmosphere you have like around greenhouse gases. So, the greenhouse gases in our term is carbon dioxide, then nitrous oxide, then methane, etc. They are all there. So, what happens is when the solar radiation hits the earth, the heat gets out like this. So, it escapes into the, let us call this a space for the time being.

So, this is, we call it as the radiated heat. And so the logic is that the amount of heat that escapes into the atmosphere. So we can say that more heat escapes into space. And some amount of the heat in this which is the radiated which comes back. So this is we can say re-radiated heat.

The heat that is radiated by the atmosphere from the atmosphere back into the earth. So we can say that less re-radiated heat is the aspect in this regard. So, the re-radiated heat, which is the heat that is reflected from the atmosphere back to the earth, is less. And the logic here is that more heat escapes out of the, into the space from the earth's atmosphere. So, let me put atmosphere here, so that this diagram looks somewhat understandable.

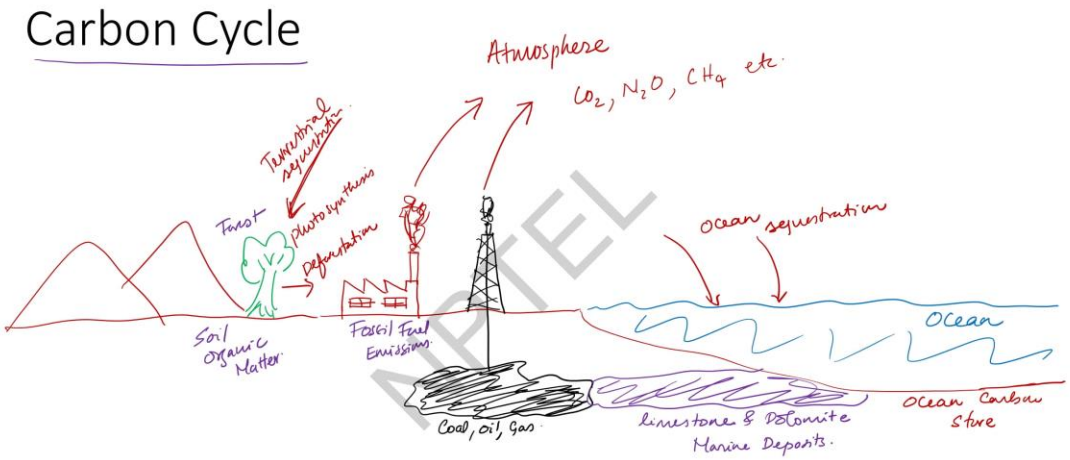
Now, let's look at the Greenhouse Gas effect, intensified by the human beings, okay. Let us see how the human activity intensifies this, so we will try to do the similar diagram this time my earth is coming out to be somewhat more circle. So this is the earth and we have an atmosphere, okay. And in the atmosphere, we have again, as I said, greenhouse gases, okay. So, let us call it as more greenhouse gases, okay.

So, more greenhouse gases are there. So, the logic here is that we will have the greenhouse gases of CO_2, CH_4, N_2O, all those things. And we have the sun here and obviously, the sun produces radiated heat, it comes to the atmosphere, okay. So it is the solar radiation, and what happens is that, the re-radiated heat, I am just going to draw that re-radiated heat, okay. This is what it is and we will draw this way.

So, it is called as Radiated heat, so here what happens is less heat, this is space, less heat escapes into space, okay. So, that is the aspect here and we call this as the more re-radiated heat, more heat gets re-radiated. So, what actually happens is, since there is more greenhouse gases, since these quantities have increased significantly, that is why I drew here with the yellow color to show that more greenhouse gases are there. So, it reduces the less heat escapes.

So, the major points that you need to understand here is that, the first one is the less heat escape compared to the earlier scenario where more heat escapes into the space and the other aspect that we need to also consider here is that, the more re-radiated heat compared to the re-radiated heat, which is less re-radiated heat. So, the idea here is that as the greenhouse gases intensifies, it prevents less heat escaping into the space, thereby warming the atmosphere much more higher than what is expected. So, I hope this makes sense to you guys.

So, now let us talk about the next question that we had, which is what we call as carbon cycle.



And what is carbon cycle and how this is being taken care of? So, so it is like, okay, and then something like this, let us call this as ocean, and you have trees, then we go back to what we call as we have a factory kind of a thing. It's like smoke coming out of it. You can think about it.

And there is somewhere you have, I'm going to say, okay. Let us imagine that this is in the ground, and this is coal, oil, gas, natural gas, and we have a drilling mechanism, and then we have, so this is you're extracting the stuff from the atmosphere. And then we also have something like, so something like, let's call it as limestone and dolomite. Mostly that's called as Marine Deposits, okay. So the Marine Deposits are right here and then we have what we call as the, here is the forest and we have soil organic matter, okay, that's here.

And then we have here is also like what we call as fossil fuel emissions as part of this. And then we have what we call as, we have our atmosphere, okay. And the atmosphere is, all these burnings will actually move things into the atmosphere, the emissions. And the trees will capture some of these emissions through photosynthesis. And that will get captured into the soil later, as I said earlier.

And then if you cut down trees, then there is something called, some of this you can think about as Deforestation. And that causes more issues here. And then some amount of carbon dioxide goes into, this is Ocean Sequestration. And in the ocean, what we call is that this is where the ocean carbon store will be. It will actually go and sediment at the bottom of the ocean and it will be there.

So what happens is from the atmosphere, so there is emissions. So this is also Terrestrial Sequestration. Okay, so then you can say I just drew the mountains, but there will be trees around mountains and stuff like this. So they will all end up capturing carbon from the atmosphere. So you have CO_2 into CH_4, etc.

So this kind of a system where we some of the stuff gets actually carbon dioxide gets taken and put it in and then it gets put moved back again. So that is the carbon cycle that we are discussing as part of this course or some people have asked this question. So, it is emission and then some sequestration combined together and we go from there. So, if you look into this, then you will see that it is a cycle, but as you emit more, then the balance of the cycle goes away and then it becomes a bigger issue. So, I hope this makes sense to you guys.

So with this, we come to the conclusion of this particular topic. These two main questions had topics that you have asked before. And we conclude this lecture and we will have Energy Transformations about which you guys have different questions. We will do that in the next lecture and that would complete my section of this course.

Thank you.