Sustainable Materials and Green Buildings
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Lecture 04 - Fundamentals of Sustainability

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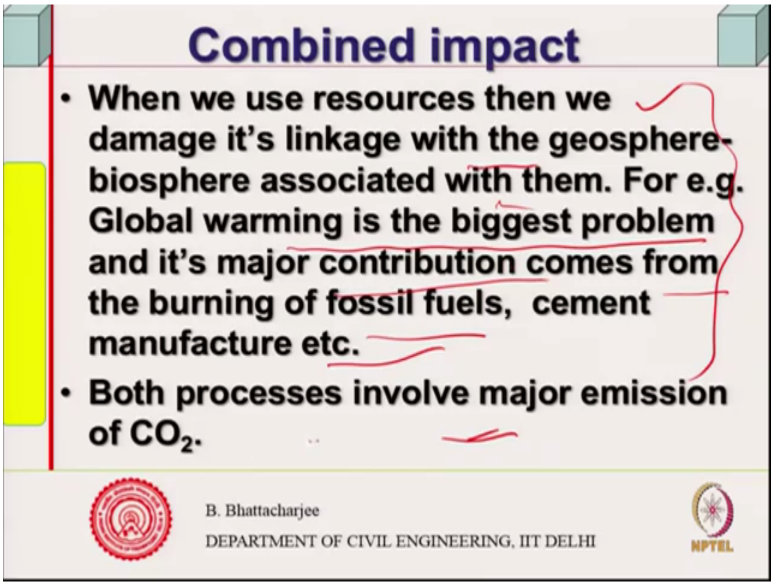

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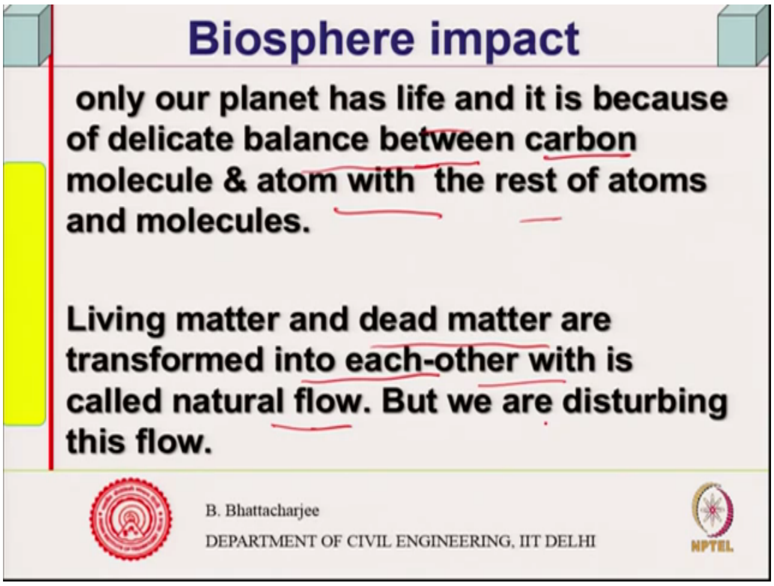

Okay, so that is what we said that carbon dioxide emission is a major problem, so far to our understanding this is the only planet which has got life and it is because of delicate balance between carbon molecule and atom with the rest of the atoms and molecules. Polymers, everywhere you have, sea is the main thing, living matter and dead matter are transformed into each other with its natural flow but if you disturb that flow, there is a problem.

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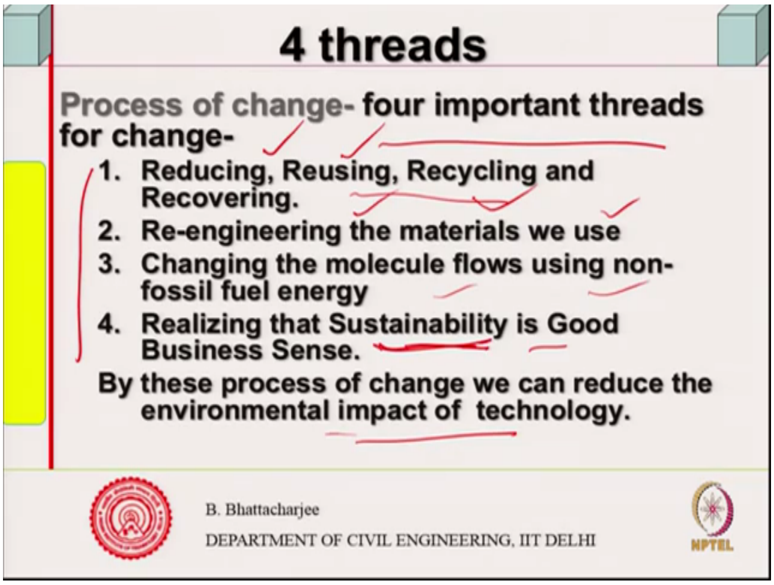

So carbon is very important from that point view. So therefore what should we be doing? Four important threads: reduce, reuse, reduce resource consumption whatever you are taking from mother earth. Recycle and recover as much as possible. Right? Re-engineering the material that we use, so reuse, sort of changing the molecule flow using non-fossil fuel energy if there is a possibility. Right, using non-fossil fuel.

And then realizing sustainability is a good business sense, realizing is that this is important. Okay? So with this we can actually reduce the impact on environment, impact of technology on environment. With this kind of understanding these four principles you can look into, then we can, so these is four R's actually; reduce, reuse, recycle, recover. Then re-engineering, changing molecule flow using non-fossil fuel energy like, various kind of attempted solar energy, wind and things like that and then you must realize that sustainability is a good business.

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So it is a goal, now I will define this, what is a goal? The built environment offers enormous opportunities for re-engineering, right? And improving sustainability, reuse, reengineer the material. By re-engineering material we can reduce the volume of take from the waste. So whatever is waste if you can reuse it, re-engineer the same thing, then we are reducing down the volume of waste production.

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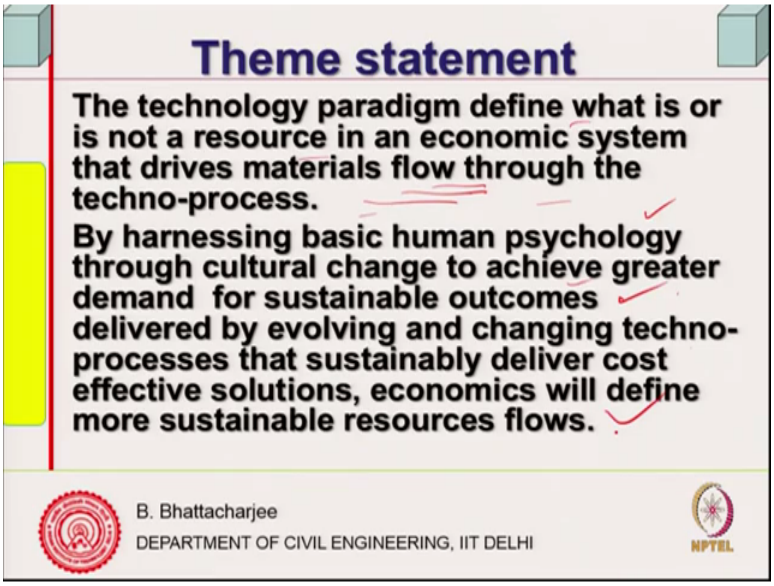

The technology paradigm define what is or is not a resource in an economic system that drives material flow through the techno-process. You know if you see the civilization, many materials were there for millions of years, nobody used them because they did not know how to use it. Gradually, human being learnt to use let us say coal and materials like iron, Iron Age and so on.

Silicon was not at all, I am just digressing a little bit, silicon was not at all so much of an important thing, it is so much there in the crust. It is one of the after carbon, silicon will be abundant. That is the material which is abundant in the earth crust. And that material was not so important till possibly semiconductor came into being. Right? It was a transistor 1948, around that, John Bardeen, Mackley and somebody, there are three scientist in Bell laboratories they came out with these semiconductors.

So semiconductors are silicon, germanium et cetera, et cetera. And these are the ones which becomes very useful and the corollary to that very interesting is since silicon came by I do not know I have mentioned this in some other class or something, silicon came by, they wanted to produce silicon, Ferro silicon alloys or silicon. They started producing what is called condensed silica fume.

Because they will heat up quartz to produce, quartz will be heated up to produce Si, you know silicon metal and in the process very fine fumes comes out or silicon oxide comes out. So it is a fine material, and that is condensed silica fume, extremely reactive with lime. And that is what has led to production of high strength, very high strength or reactive powder concrete. You would not have any concrete of 100 ampere strength but for semiconductors.

Because the silicon was very much there, nobody realized its importance so much till possibly semiconductor comes into being and today all of us are carrying lot of it. Everybody carrying everything, lot of semiconductors solid stuff all over there, so that is the thing.

So therefore, so resource also, resources goes on change and you find out resources, so what is not a resource that drives the material through the techno-process. So silicon was not in the techno-process, it came into techno-process. And basic human psychology through cultural change achieve greater demand of, obviously you should demand for more sustainable outcomes and delivered by evolving changing techno–processes. So we should look into techno-process changes as that you know cost-effective solutions, economics; that should define sustainable resource flow, material resource flow.

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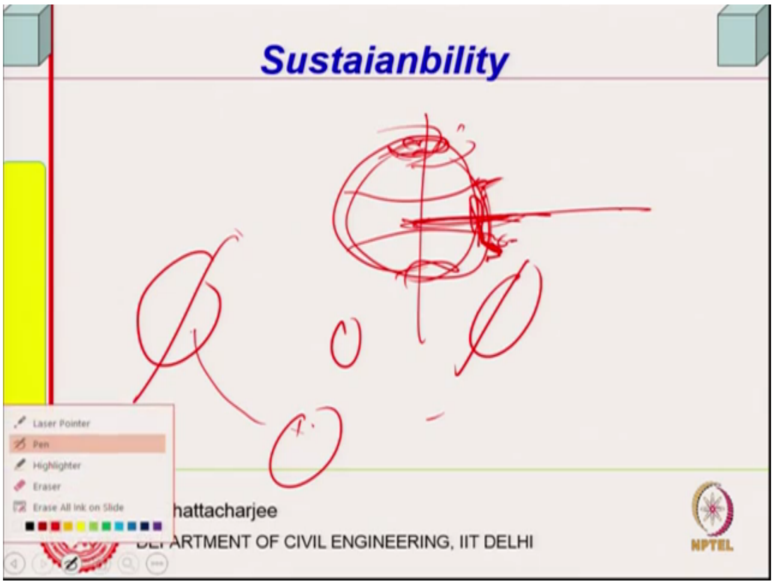

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So we can define now sustainability, it is the capacity to endure or support. That is how it is has been defined, capacity to endure or support such that sustainable material shall meet the current needs and requirements without compromising with the ability of future generations to meet their own needs.

You satisfy your own needs but it should not have any impact on need of the future generation. Do not consume all the resources from the mother earth so that your planet equivalent is too, so you are using whatever being stored previously and future people may not have, they may not be, nothing resources should be available.

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So sustainable materials uses the resources, uses the resources like, energy, material itself and water with increased efficiency for production and induction. While reducing impact on human health and environment during the life cycle up to demolition and disposal and recycle. So two aspects; first it must use the resources with higher efficiency, maximum benefit out of the resources that you are using. And also minimize the impact on environment, human health and environment during the cycle, up to its demolition or disposal or recycle.

So that is how we define sustainability and sustainable materials, that is what it is. Sustainable development then would follow automatically. For example, sustainable urban system would also minimize the use of resources what are et cetera, et cetera, produce less least waste and keep the atmosphere you know harmless.

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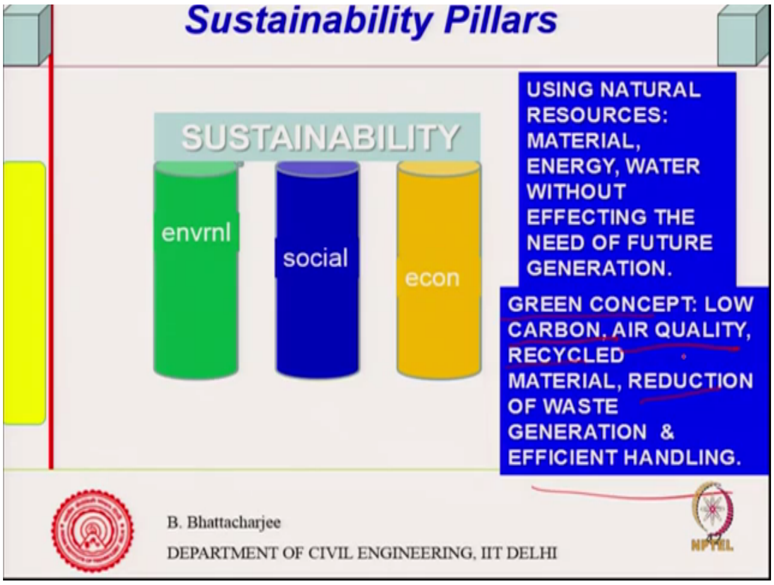

Three pillars; sustainability is supposed to have three pillars like, environmental is one of them and the social aspect is also important, and you cannot really get away from economy. So these are the three pillars of sustainability; environmental, social, and economic pillars, right? Socially also it should be acceptable. Not only it should be acceptable the society self should be sustainable. So that is what it is.

So using natural resources, material energy, water without of the need of future generation, that is what we said. And then comes the green concept which goes together with it; low carbon, good air quality, recycled material, reduction of waste and generation of generation and efficient handling of the resources.

So we have defined sustainability, we talked about sustainability pillars et cetera, et cetera and the green concept goes together with it. So they go hand in hand, that is what it is. Whatever is sustainable is green. So should have low carbon emission, air quality you know better recycled material as much as possible, reduction of waste generation and efficient handling et cetera.

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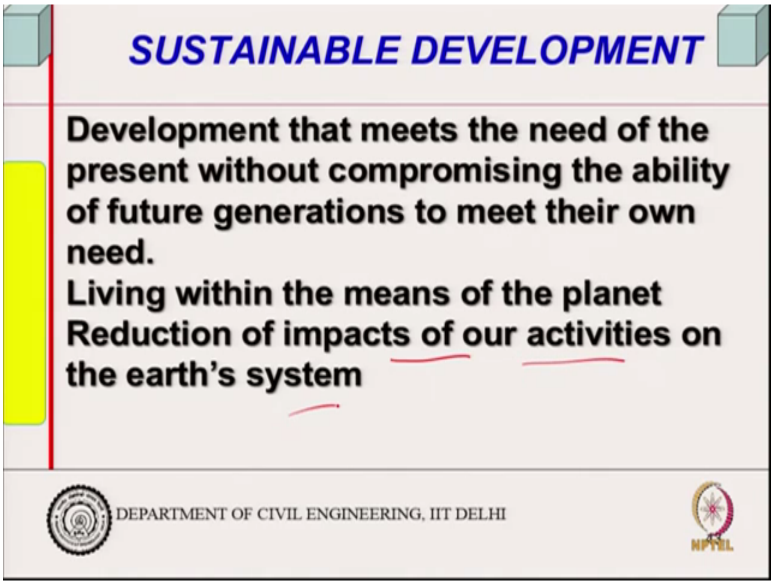

So development that meets the need of the present generation without compromising the need of the future generation is what is sustainable development, that means living within the means of the planet. Living within the means of the planet. So reduction of impacts of our activities on earth system that is what we should be looking at.

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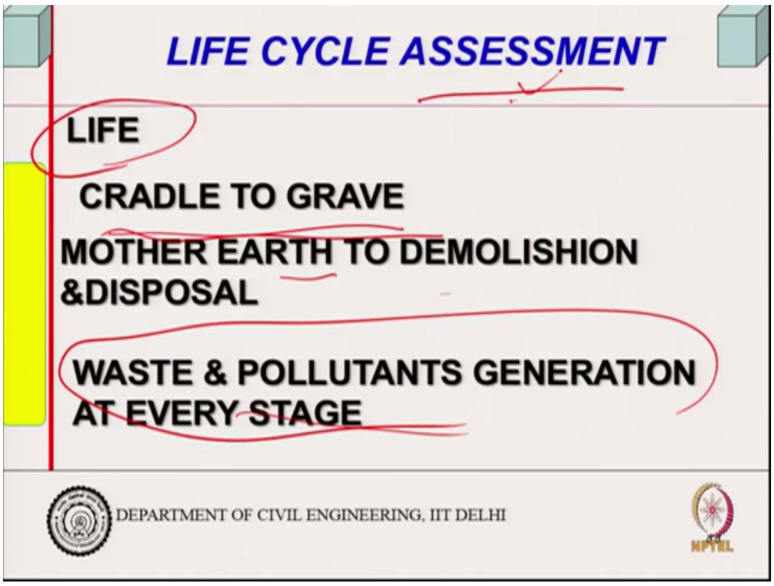

And in that context lifecycle assessment becomes important, right? So, what we call cradle to grave for any material or system, so you should look into during when you are looking at sustainability we cannot avoid looking into what is happening in during the life. One is the production part of it, making it, then while using also it should not generate waste, for example a system like building let us say.

A building when it is in use, after all it is for human habitation, there may be many functions. For example, this is a classroom, its function is to hold the class and it can generate waste in the process, consume resources like energy and so on. So life cycle assessment looks into the whole thing, whole life of the system or even for a material or anything you want to see, for a component even.

For example, you have a computer, if you look at it during its life period it may use some energy which is very minimal but then later on when it to be disposed off electronics waste, how does one dispose off? All these things should be taken into account when we look into lifecycle assessment. From the mother earth to demolition or disposal, from mother earth, so cradle to grave is this kind of you know terminologies are used, and somewhere the waste and pollution generation should be minimal, right?

At every stage, so that is why the lifecycle assessment is important, so the life cycle assessment is important. That is why the life cycle assessment is important.

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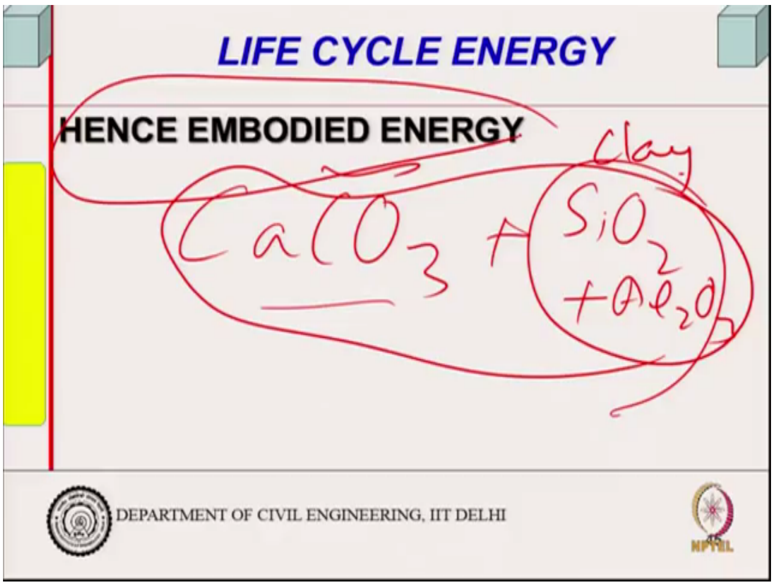

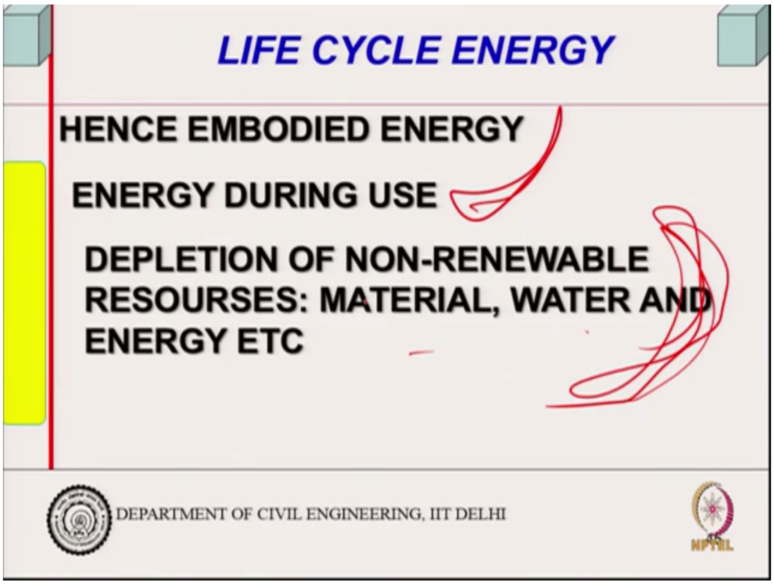

So in the context of, we looked at everything. Now if you look at energy there are certain types of energy, just let me first come to this, oh no, no here. Ok, next class possibly we will talk about but life cycle energy we should look into, the energy is classified into, you see some of them are primary energy and some of them are secondary energy. Electricity for example is a secondary energy, because either you use, some of that energy convert into electrical energy which can be used efficiently. So the secondary, some definitions I will give you later on.

But there are some other issues like something we called embodied energy, now this energy is the energy that has gone in when it came into the system. A material or system when I produced it, how much energy has gone into it? So this would encompass production energy, energy for production.

So an example of if I take concrete or steel let us say, the materials that use, now energy of concrete first there is a component, the cement is there, the proportion of the cement. Now if you see the process of production of cement which we will look into some time again it starts from the coir, right? They select the limestone coirs with appropriate proportions of lime and silica because cement is produced from this plus this, SiO_2 clay or Al_2 et cetera, et cetera. Some of them come from the process itself because this is more from clay I will say, clay right? So you start from coir, from the coir you collect the rocks, the material. It is minimally processed because you do not want the cost be increased.

But it is homogenized, homogenized means mix up from here and there, do quartering, take something from here, take another place, mix them together, divide them into two and again some sort of, so homogenization is done so that your point to point variation of the raw material does not vary too much.

So there some energy goes there as well, so little bit of processing, even if you do little bit of processing some energy will go there. First is quarrying it out, so there will be energy, then this is will be the energy, this will be transported where they might be crushed, the rocks might be crushed to appropriate sizes. Then you prepare the rock pit, so every stage there is an energy.

Then you heat it up, so there is again the energy. So all this will become part of energy, embodied energy, right? Till it is actually put it into the bag or into the truck or what you call bulkers, big vehicles which can transport pneumatically put in there and they are transported in a large quantity, right?

Even sometimes it is done directly through ships. For example, in India there is a cement factory in Ambuja Nagar near Gujarat. So it is in the seashore, so what they do is directly from the plant it is pneumatically transported to the ship and this ship travels to the sea to different you know western coast or even to eastern coast, anywhere they want to supply like Mumbai, Surat; so they directly supply there.

So this must be, so basically transportation, so there is first is the production. Once it is bagged or loaded production is over. Then the transportation takes place. So some energy is consumed on transportation also, right? If the trucks are taking them the trucks, the energy gets consumed there. So this has got a component of production energy, transportation energy and then there be another component if you are mixing it with other things, aggregate et cetera.

So there is a mixing, energy would go in mixing a production energy of the material system now. First is the production energy of the material, component material, transportation and then production energy for the element or system, right? And if you are transporting it, then again transportation. So every component of the concrete system you can isolate in this manner, find out their embodied energy of production, embodied energy of transportation and that is what would fully give you the embodied energy.

So for any material, any system you can find out the embodied energy, that is embodied into it, it has gone into it. Right? Till you do something about it, after its use you are not able to recover it. Now some cases during the production process also, I mean during its use also, we might actually use some energy.

Maintenance for example, if I am repairing something, right? So same element that I have produced I have an embodied energy and then some time later on I repair it. So I again use material, I add embodied energy to it. These are called gray energies because they are not easy to measure. Some might require energy during its useful life also, where you know like energy is required for its functioning.

So that will become operational energy depending upon, in building this is very clear. Building, it is extremely clear. So that is what it is. So, embodied energy is this, so energy during use, that is what I am saying, the other energy during use. Depletion of, this is, so these two we will have to look into when we look at life cycle and this might lead to, you know depletion of this might lead to material, water and energy, depletion you know resources might, the depletion might be associated with it.

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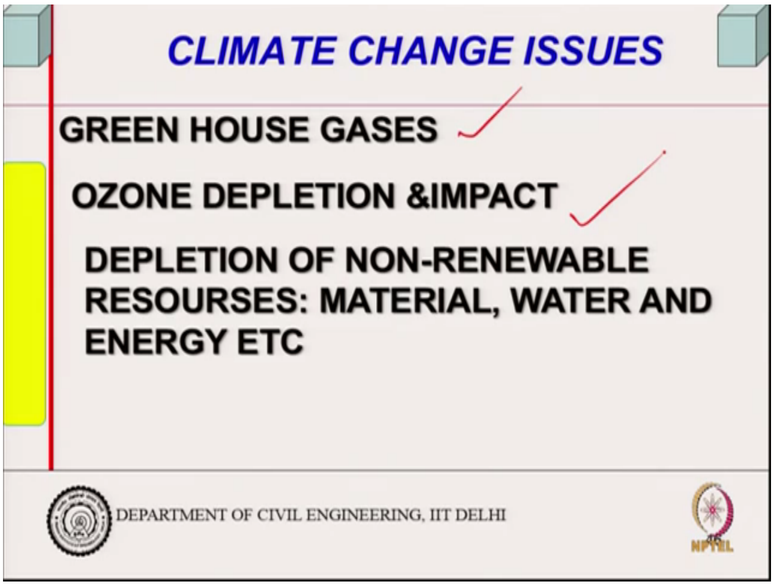

Greenhouse gases production, that is what we should look into. Ozone depletion and impact, that is what we should look into and overall that is what we have looked into so far. So I think we will continue with that in the next class, from here we will continue and go to more, so that is kind of an introductory last, previous lecture and this lecture tells you what is sustainability, what are the components you are looking for. So, whenever we are using either it is a building or even materials system, infrastructure or anything, we should look into these issues together, not only the economy, initial economy, okay? I think that is it. Thank you.