Carbon Accounting and Sustainable Designs in Product Lifecycle Management

Prof. Deepu Philip
Department of Management Sciences

Dr. Amandeep Singh Oberoi
Imagineering Laboratory

Dr. Prabal Pratap Singh
Department of Management Sciences

Indian Institute of Technology, Kanpur

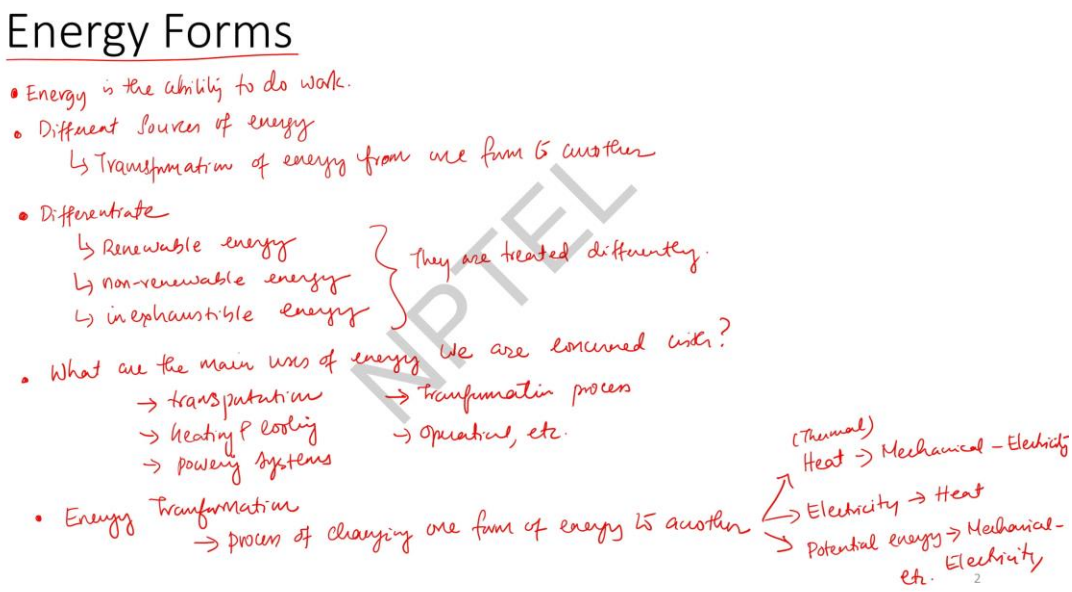
Week 05

Lecture 21

Energy Transformations

Good afternoon, everyone. Welcome to yet another lecture of the NPTEL MOOCs course titled Carbon Accounting and Sustainable Design in Product Lifecycle Management. So this course is offered as part of the NPTEL MOOCs course, which is offered from IIT Kanpur. And I'm Prof. Deepu Philip. And along with me, Dr. Prabal Pratab Singh and Dr. Amandeep Singh Oberoi are co-teaching this course. And I have been doing the first part of this course and today's lecture is somewhat the concluding lecture of the first section of the course.

And today our topic is the energy transformation. So there are so many questions about energy transformation in the forum. So we are going to answer one by one.



So let us talk about Energy Forms first and some of the common premises in which the energy and the calculations and other things are come up with.

So for us, the energy is defined as the energy is the ability to do work. It is the very simplest way of looking at it. And that's what we do. And there are different sources of energy, okay. We know that, right.

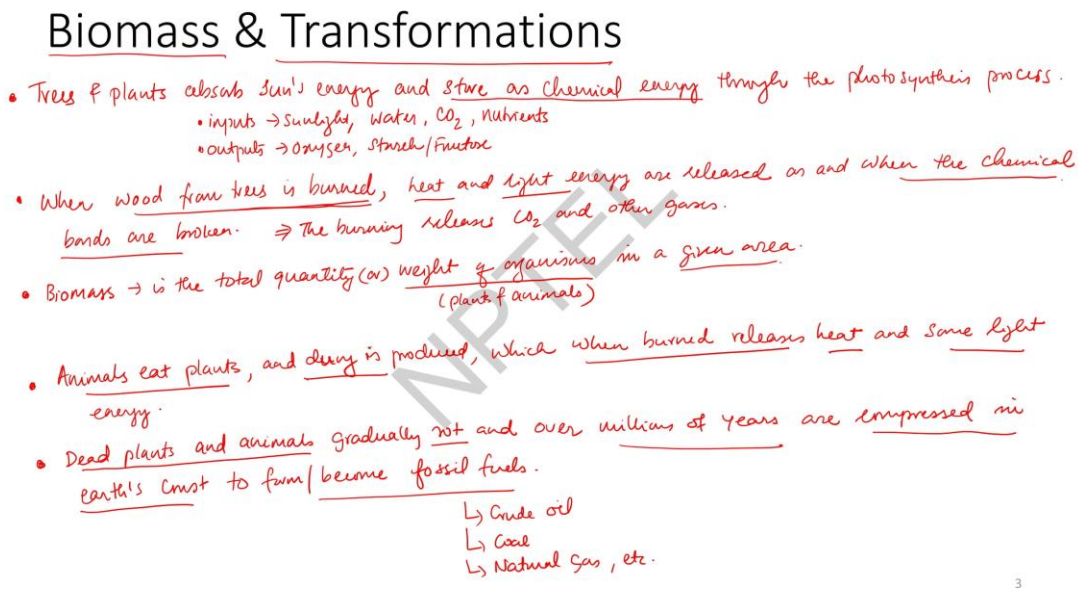
And so what happens is then transformation of energy from one form to another, okay. So, heat energy to electricity or motion, etc, like that, okay. Mechanical energy. We had already seen that we studied in various courses, right. We also differentiate which other faculty members will teach in this course.

We'll talk about differentiate between Renewable energy, Non-Renewable energy and Inexhaustible energy, okay. So these three forms of energy will have its own, okay. They are treated differently, okay. So, the other part is that, what are the main uses of energy we are concerned with? Many people said there is no limit to what usage energy is concerned.

But in our case, we are talking about the main uses will be transportation, then heating and cooling, powering systems. We also talk about transformation process, operational, etc. So, the many uses, there are like sometimes we may not be worried much about

charging one mobile phone. But we may definitely be worried about how much it would require to charge the mobile phone of all the people in the country. So, that kind of a thing.

So, we probably would be, the remaining models of this course, we will be looking at the larger usages of energy. And when we talk about Energy Transformation, it is the process of changing one form of energy to another, okay. And most of the time, it is heat to mechanical, to electricity, then electricity to heat or cold whatever it is or thermal. We can call heat also we can think about as thermal thermal energy. We can think about as potential energy to mechanical, to electricity etc. These are all different ways of transformation of energy from one source to another.



So, we had discussed this concept in many places and then people had this question about Biomass and then Transformations. So, let us talk about that. So, one way to think about is trees and plants absorb sun's energy and stores chemical energy through the photosynthesis process. So what they do is they use sunlight, water and nutrients from the soil and they absorb the carbon and then fix the carbon and release oxygen.

So if you think about it, the inputs are sunlight, water, carbon dioxide, nutrients, outputs, oxygen, starch, or fructose, etc, okay. And the hydrogen gets stored in the, so in another way to think about it is, this is also in another way of replenishing the oxygen in the atmosphere, okay. Now, these, where do you store this chemical energy? It is basically

stored in the stem of the plant or the fruits of the plant. So, when wood from tree is burned, when you burn the wood from the trees, heat and the light energy is released and when the chemical bonds are broken.

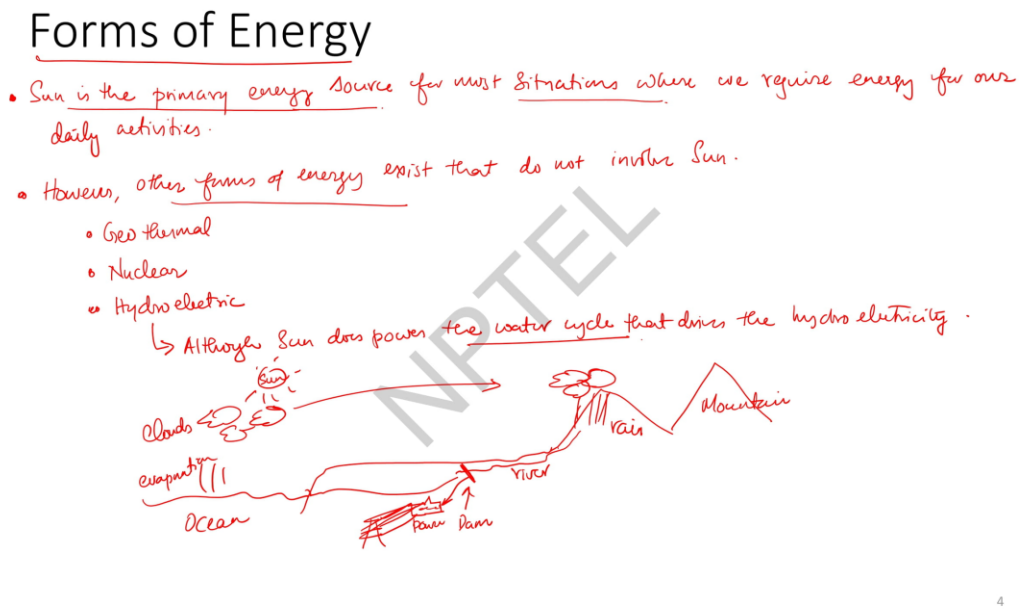
So, when you break the chemical bonds, this chemical energy that is stored in this, when those bonds are broken. That breaking happens through the process of burning. Then that happens, we emit heat and light energy. But along with this, we also release. So, the burning releases carbon dioxide and other gases.

So, that is also the disadvantage of the burning process. Now, if you look at the word Biomass, what does Biomass mean? It is the total quantity or weight of organisms in a given area, okay. For a given area, for a particular area, it is the quantity or weight of the organisms. This includes plants and animals both, okay.

So, it's a total quantity. That's called as the biomass, alright. Now, we mentioned animals. So, how do animals get into this picture? So, animals eat plants, okay.

Animals eat plants and dung is produced. Like cow dung is produced, which when burnt releases heat and some light energy, okay. So the animals eat the plants, then they produce refuse or dung. And when you burn that dung, then it releases heat and some light energy. So that's how the animals also become part of this biomass cycle, okay.

Then one more thing is that dead plants and animals gradually rot and over millions of years are compressed in Earth's crust to form or to become fossil fuels, okay. So, the dead plants and animals, they gradually rot and over millions of years, the compression, the pressure that is applied on their crust, that becomes fossil fuels. Fossil fuels includes crude oil, coal, natural gas, etc, okay. These are all part of the biomass and the energy transformation.



So, now let us talk about the forms of energy, which are relevant to this course in this case. And many of the discussions you have seen, we have talked about sun, atmosphere, earth, carbon cycle, all those kind of things. So, sun is the primary source, energy source for most situations, okay. Where we require energy for our daily activities. So, sun is the primary energy source for most of the situations where we require energy for our daily activities. So, primary source of energy is sun.

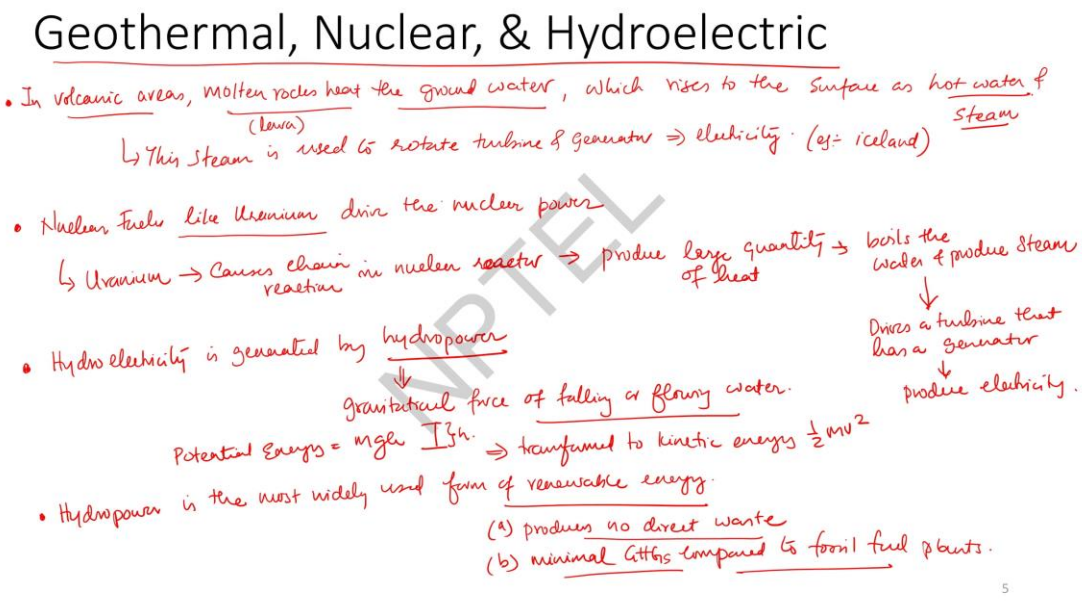
However, other forms of energy exist that do not involve sun. There are other forms of energy. So, couple examples, not too much. Number one is Geothermal. Number two is Nuclear.

Number three is Hydroelectric. In my opinion, hydroelectric, even though people say that it does not involve sun, but although, sun does power the water cycle that drives the hydroelectricity. So, what is the water cycle? In this regard, if you think about it, this is the ocean. And we assume that here is sun, okay.

So, the water, this is evaporation, okay. And it forms clouds, okay. Clouds go to mountain, okay. So you have rain. This is mountain, and then this water flows, okay.

And this is a river. And you have a dam that stops the flow of the river. It goes back into the ocean. But then from here you have a river You have a powerhouse where this water is used to generate electricity.

So this cycle, this evaporation and formation of clouds is driven by sun. So hence you can say that the hydroelectricity sun does play some part.



So let us talk about this Geothermal, Nuclear and Hydroelectric quickly so that we can conclude this topic. So, number one, in volcanic areas, molten rocks heat the groundwater, okay. So, wherever active volcanoes are there, the molten rock, it is also the lava that heats the groundwater, okay.

Which rises to the surface surface as hot water and steam, okay. So, if you have hot water and steam, then we say this steam is used to rotate turbine and generator. The generator is coupled to the turbine, electricity is produced, okay. I would request you guys is example, read about Iceland, okay. Where they use a lot of geothermal energy, okay.

Then nuclear fuels like Uranium, drive the nuclear power. We have read about this. So what happens is uranium causes chain reaction. In nuclear reactor, this produces large quantity of heat. It boils the water and produce steam.

The steam drives a turbine that has a generator that produces electricity. So, this is the logic by which the nuclear energy is produced as part of, everybody knows about this. But I just was giving you a quick recap because there are some questions. So, Hydroelectricity is generated by Hydropower, okay. So, what is Hydropower?

So, hydropower is the gravitational force of falling or flowing water, okay. So, the water is flowing. So, you have use a dam stops the water and then you make it flow from a height. So, you know that potential energy is, okay. So, potential energy is mgh. h is the height, okay.

Transformed to kinetic energy. 1/2 mv^2, right. So if you have high you stop water at a very high rate that height will translate to the velocity, okay. So that velocity will go and then run the turbine okay the flowing water will run a turbine or heat impeller.

And that impeller will drive a turbine, that will drive a generator and produce electricity okay. Hydropower is the most widely used used form of renewable energy. Solar comes only after that, okay. It is renewable because why it is renewable? A, Produces no direct waste, okay.

B, minimal GHG (Greenhouse Gases), compared to fossil fuel plants. It does not produce any direct waste and minimal GHGs (Greenhouse Gases), in comparison to fossil fuel plants. Fossil fuel includes coal, naphtha, that kind of plants. So, with this, we come to the end of this lecture, which actually gives you a quick idea about energy transformation and the forms of energy. Specifically other than sun, which is hydropower, nuclear and geothermal.

And also, we have discussed what is biomass and how biomass acts in this whole business and what is water cycle as well. So, these things will be used in the coming sessions when you are building models, energy models and estimating carbon footprints, etc. So, I will see you sometime later down the course with some more additional topics based on the request that is coming from the audience. Until that time, please continue to read the content and materials and enjoy learning.

Thank you very much.