Indian Institute of Technology Kanpur

National Programme on Technology Enhanced Learning (NPTEL)

Course Title
Bioenergy

Lecture – 01
Introduction

by
Prof. Mainak Das
Biological Science & Bioengineering &
Design Programme
IIT Kanpur

Good morning everybody and welcome to this course on bio energy I have already give you the introductory video about what the course will cover but today we will slowly start to explore this wonderful world so whenever we talk about energy different kind of thoughts come in each one offices mind we think about oil we think about electricity we think about power stations we think about filling flues like patrol or gasoline or diesel into our cars or when you go to the kitchen we think about the cylinder gas cooking gas and all these things.

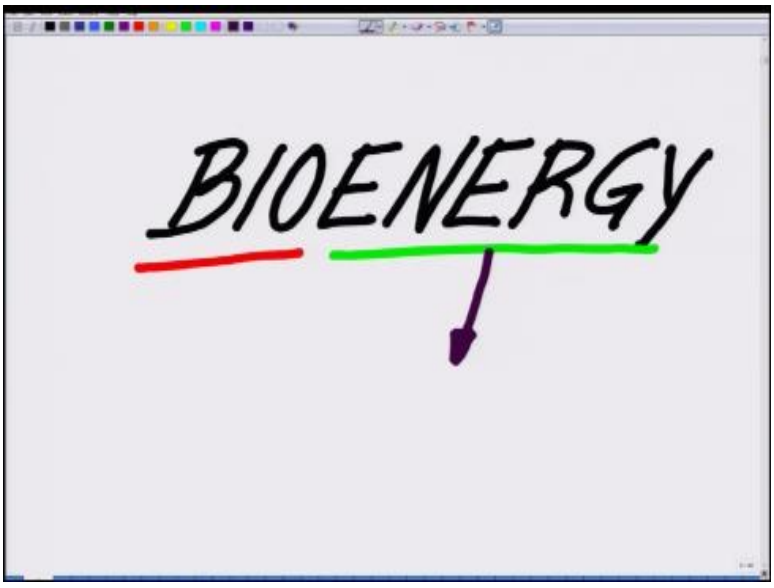
They all are forms of energy as a matter of fact if we think over it our whole civilization our whole growth is a direct function of our energy consumption as a matter of fact it is being always said the development of a country how developed it is decided or the currency which is used for that is how much per capita energy consumption is their most developed societies of the world consumed way more energy as compared to the societies which are not that well developed.

And that has a direct link to the economy of the world and those which are you know developed economies they consume way more energy those which are developing economies they consume less at lesser energy than the developed economies and those which are underdeveloped economy has a scarcity of energy so our life our day-to-day living our national status and our global standard and our global status with respect to other countries is a direct function of energy.

So in this course which is about bio energy first of all we will talk about the global energy landscape so and then in that global energy landscape where bio energy stand and what is this by energy is all about because as you will go through different kind of monograms or different Berg's different lectures all over there is every possibility that one may get confused because there are several aspects of it and to give a holistic view is kind of bit challenging so in this course my aim will be to give my young readers a very holistic view overall view and from that overall picture which server aspect or bio energy in their life they wanted to pursue or even just wanted to get more and more knowledge into it.

They will have sufficient background so they can proceed in that direction so it will be kind of mapping the whole spectrum of bio energy with respect to the global energy landscape okay so in a way you can say so let us start it.

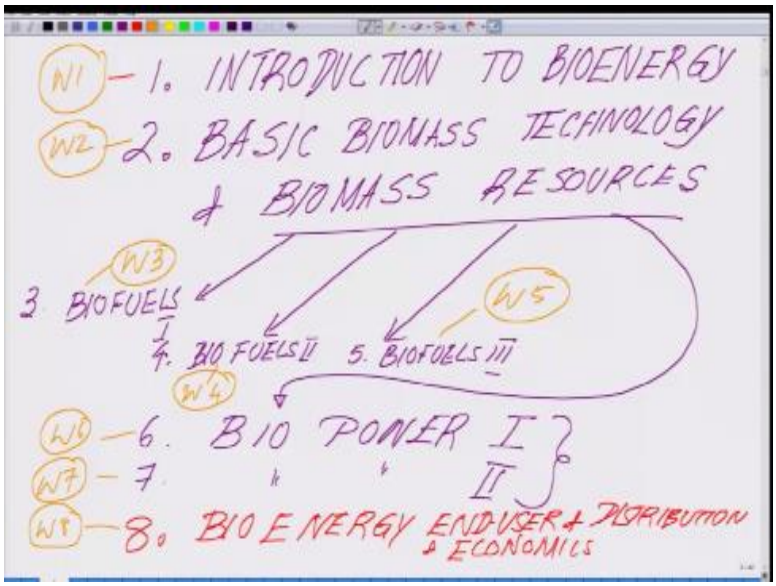
(Refer Slide Time: 03:51)



So this is what is our course title is and if you see this course title it has two parts and one part is this part which is the bio and the second part is this part which is the energy so our initial talk will be on understanding how energy revolves around our life okay so the core idea will be once

you kind of get an idea about the whole spectrum of bio energy you can philosophize the whole subject so keeping that in mind that I have divided the course into five different segments.

(Refer Slide Time: 04:36)



The first segment we will be talking about segment one or module one what you will see is about introduction to bio energy so in the introduction to bio energy which is today is the first lecture of that we will be covering five lectures on it on introduction and in those five lectures we will talk about the whole energy landscape and how in our day-to-day life energy plays a significant role followed by that we will move on to the module to module two we will have basic biomass technology.

Which is essentially how in nature biomass is being produced which will include basic processes of photosynthesis and other route like chemosynthesis by which biomass is produced and the part 2 will give you an overview of how these biomasses are being transformed into different form of usable biomass as a source of energy having said this we will move on to the third part of the course where we will be spending three weeks on it on about different kind of bio fuels which are being generated from this different sources of biomass okay.

So we talked about the biomass now the course will move into three different fragments which are same which is part three which is bio fuel one then we will go to part 4 which will be bio fuel two and bio fuel three so do not get confused the reason to give one to three is just to classify them indifferent categories and kind of you know give you an overall picture of the different sources from with these different kind of bio fuels are being developed followed by this after the fifth section we will move on to the 6 and the 7 section which will essentially will be another route.

Where we will talk about the newer technologies like bio power generation one phase one and Phase two so in this section this is a section where we will be investigating all the different kind of newer technologies where different kind of biomass or bio materials are being converted into different kind of charge storage devices where the crop residues could be transformed into say super capacitors or batteries to storage store charge or different kind of bio resources which may find applications in solar cells different kind of dyes which may be used for harvesting solar energy at the very remote places.

So such technologies which are evolving technologies currently and which I believe that will help you to broaden your horizon about the whole area of bio energy will be covered in those section which is numbered as sixth and seven the last section which is the bio energy induced distribution and economics okay this is the last section which is who are the end user and distribution and of course it will be linked to the economics of using by energy.

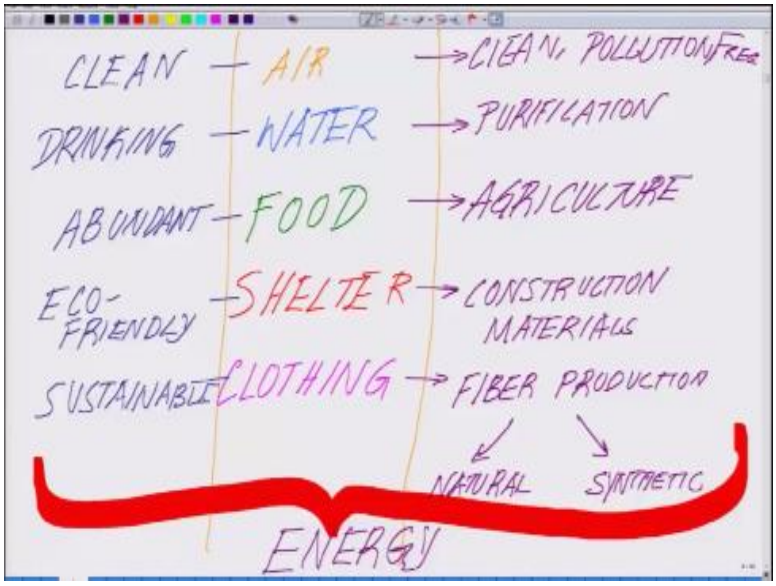
So if you look at the course very carefully you will realize we have distributed the course in 8 weeks so this is week 1what we will be dealing with this will be week to five lectures five lectures each and within the bio section week 3 you have week 4 you have week 5 and then we have the bio power section which will be week 6, week 7 and then we will be concluding on week 8.

So what is important here is if you have this map in your brain now this is how we are going to follow it to be very easy for you to know if you miss out any lecture or something you exactly know where to dilate and why to pick it up and what I will do further is once we will go to every

week I will give you kind of an outline how say today's lecture is related to tomorrow's and likewise and so forth so you will have a mind map of all the 40 lectures very clearly in your brain that what is the sequence how I am trying to narrate the story of a very broad horizon called biomaterial by energy okay.

If you look around you will see that how energy is involved in your life we talked about say air so you needed to supply clean air if you need clean air in any room or anywhere you need heavy duty pumps or hepafilters or something to make the room clean say for example its operation theatre or in a very clean room for any kind of manufacturing we talked about water which is another resource ok so let us kind of enumerate some of these things which will kind of give you an yeah how energy is really ruling our life okay.

(Refer Slide Time: 11:08)



So say for example we talked about like I will put three columns which will kind of give you an idea so say for example we talk about say air these are the basic requirements basic needs of all life then we talk about say water yeah then of course food then comes our shelter and then comes our clothing now in order to have these things so we need will always look for clean air we wanted drinking water then we will look for abundant food supply then we need eco-friendly

shelters as you must be aware of government has promised that by 2020 each one of us will have their own home or housing then we need sustainable clothing.

For all these things if you realize if you see the other side the all demand certain things in common now one of them for that we need clean pollution-free here that in requires energy in order to clean the air pollution free here then water you need the purification that requires a lot of energy input so if you look at all the big water cleaning plants all over the world in the cities in other places if you kind of you know see they will replace where all the water is being collected and goes through a series of filtration assemblies which consumes a lot and lot of energy to maintain over a period of time and that consumes a lot of electricity.

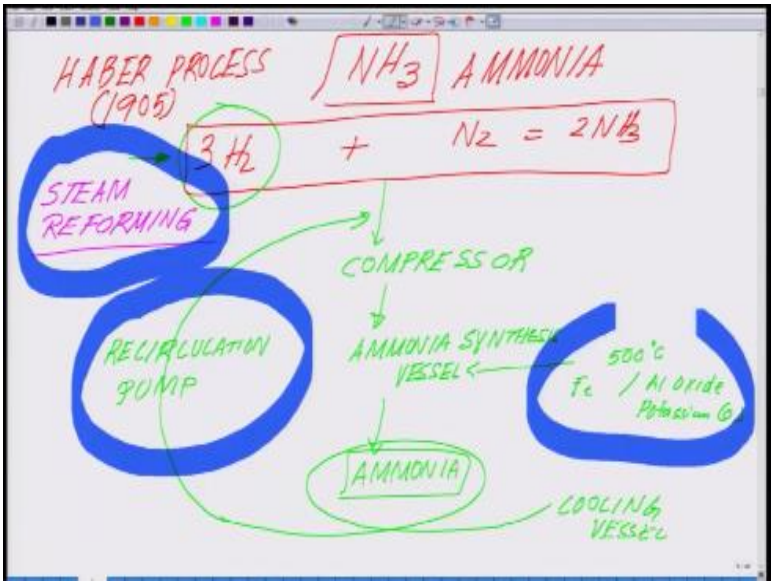
Then comes to the food if we talk about the food production in terms of the agriculture we will talk a little bit more in our next slide on this thing so those of you who are from village background and those of you are not you all are aware about that ammonia is being used for all the agricultural purposes will be surprised to know that the amount of energy which is consumed for ammonia production is phenomenal and we will take this as a case study in our next slide.

So before that let us finish this chart out here then we talked about the shelter so we talked about the eco-friendly shelters so then for that we need the construction materials which has to be developed okay and in terms of the clothing you can we have the fiber production and these fibers has could be natural as well as synthetic and if it is a natural fiber than we are talking about a form of biomass we will talk later on that and if it is synthetic then we are transforming some certain things and this all demands a huge and amount of energy input.

So highlighting word is energy so you may appreciate that for the bear requirements of our whole living we are completely dependent on different kind of energy sources and most of our energies are being provided by either by the fossil fuels or partly by solar very little though and these fossil fuels are used to produce electricity which runs our whole life whether it is a air-conditioned room whether in a very cold place you have to run a heater or your other option is that you burn woods which is nothing but a biomass.

So all our life is nothing but I energy economy now from here I will take a very simple example to kind of give you an idea in our next slide okay I told you that we will talk about a little bit about the agriculture okay so let us move on to the next slight where we will talk about.

(Refer Slide Time: 16:07)



So for the ammonia is so this is the molecule of ammonia NH_3 okay this is the case study we are looking at so ammonia is actually produced by reacting hydrogen plus nitrogen which is abundant okay by a process called Haber process and this Haber process was developed more than a century ago in1905 now if you see this reaction this reaction seems very simple I mean there is hardly anything which cannot be achieved in it okay but here is the catch for this reaction.

This reaction has an input of significant amount of hydrogen and from where you obtained this hydrogen so this hydrogen which is provided by the natural gas which is why I steam reforming there is a process called steam reforming steam reforming you can go and check into all the habits process and all these things you will realize so this steam processing so as a matter of fact the largest in agriculture the largest consumer of fossil fuel in modern agriculture is ammonia

production for fertilizer of course via the Haber's process and this is of course we know that how essential it is for intensive agriculture.

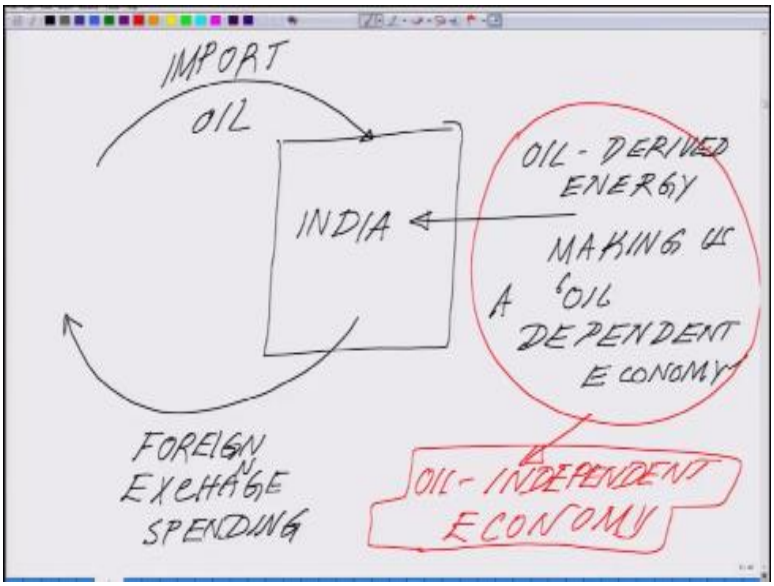
And the specific fossil fuel input to fertilizer production is primarily the natural gas and this natural gas is the one which helps in the production of the hydrogen and from here once this is produced these are put in a compressor in the compressor from the compressor this is moved to a ammonia synthesis vessel and in the ammonia synthesis vessel this is a second source of energy expenditure ammonia synthesis vessel has to be heated at 500 degree centigrade with a catalyst like iron aluminum oxide, potassium oxide likewise.

So these are the different catalyst which are used from here the ammonia has to be removed you kind of kind of see that where all the energy is being used and then there is a cooling vessel which is involved here and this cooling chamber this is re circulated like this through a recirculation pump.

Now what I will do I will highlight all those places where energy is being consumed in order to run the recirculation pump steam reforming and this is the third zone so even it is it is most simplistic form if you look at the whole process you will see there are at least three different places where you have to consume significant amount of energy in order to produce the most or on the very key fertilizer for production of food.

Now the question comes other way if for one ammonia production which is a case study we have to use that much fuel or that much energy has to be expended so you needed that much amount of supply of natural gas or some other form which will produce that amount of steam reforming hydrogen steam reformed hydrogen okay now if you look at it for an economy in the world wherever it is you can classify why I was telling us let us say for example let us take the case study of India.

(Refer Slide Time: 20:51)



If this is our this box represent India okay now we import oil all of you are aware of we are all importer okay and in order to input oil we have to use lot of our foreign exchange foreign exchange spending now so in other word this is what I was telling you in the beginning we are basically oil derived energy making us a oil-dependent economy and if we are on oil-dependent economy it means either we should have sufficient oil for us or we import oil from other places where oil is produced in abundant like Middle East like in Latin America and all other places.

So what is the challenge so challenge is here good so it is coming back to the slide could we become from oil-dependent economy to be a oil independent economy and how we can become oil independent economy and where lies our real hope so in today's lecture I will close in here with this question that how India from an oil dependent economy can become an oil independent economy now having said this let us summarize what we talked today first we talked about that this course is aiming at giving you a overall picture of my energy with respect to the complete global landscape of energy sources of energy okay.

And consumption of energy then we discussed how a country is being position or it is triple position with respect to their energy consumption if you are a high energy consumer you fall

underdeveloped countries if you are a moderate energy consumer then you fall under developing countries and if you are a low energy consumer then you fall below almost you can call it something like a poverty line or energy line you can draw imaginary energy line if you're below that energy line of consumption then you are really underdeveloped.

Okay then we talked about how we have distributed this course in a way so that this course will give you an overall picture so that at any point of your life you want to explore anything you exactly know what is the map of all the developments which has happen and which are about to happen in next 50 years or so and then we talked about how we need day-to-day life whether it is a clean air whether it is a water whether it is a shelter whether its food or whether it is clothing how energy is directly involved in your day-to-day life okay.

And then we took a case study of ammonia production by have a process and if I showed you or rather we shared with each other that for such a simple molecule which is NH_3 which is so very broadly used the amount of energy which is being consumed so that from there we talked about we are energy-dependent economy and our another the oil-dependent economy how we can become an oil from an oil dependent economy to and our oil independent economy could we really put our thrust on by energy production because that is where lies lot of our hope being a country which in turn is up very close to the tropics and subtropics zone.

Where there is abundant biomass production all over the nation could we really make a difference in that area so this is the overall spectrum so apart from it what I will do all these lectures what you are saying what I am drawing in front of you I will scan some part of my own notes and I will just put them as power point for you people you can also go through them okay that will kind of give you an overall idea and I will send you all the references which will also help you to refer to the right kind of books and most importantly it is a very important that through these small lectures you try to philosophize the subject it is very important because that is the most important thing.

It is not informative thing it is most important you should have a philosophical bent to realize that okay what really needed to be done to address one of the most challenging question could

one day we become a oil independent economy and we should be so powerful enough that we should be able to you know give energy to others so with this I will conclude my first lecture in the second lecture we will pick up the topic by looking at the global energy landscape where we stand and where lies the advantage of beings own uniquely positioned close to the equator and in a very sub tropical zone where we really can have enormous biodiversity to support the cause in which we are working towards called bio energy okay thank you.

Acknowledgement

Ministry of Human Resource & Development

Prof. Satyaki Roy

Co-ordinator, NPTEL IIT Kanpur

NPTEL Team

Sanjay Pal

Ashish Singh

Badal Pradhan

Tapobrata Das

Ram Chandra

Dilip Tripathi

Manoj Shrivastava

Padam Shukla

Sanjay Mishra

Shubham Rawat

Shikha Gupta

K. K. Mishra

Aradhana Singh

Sweta

Ashutosh Gairola

Dilip Katiyar

Sharwan

Hari Ram

Bhadra Rao

Puneet Kumar Bajpai

Lalty Dutta

Ajay Kanaujia

Shivendra Kumar Tiwari

an IIT Kanpur Production