Non-conventional Energy Resources
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Lecture - 03
Conventional Sources of Energy

Hello. This is a course on Renewable Sources of Energy or Non-Conventional Sources of Energy. But for us to get a good sense of you know what are these non-conventional sources of energy and how much of an impact they are making to our you know existence, what is the potential that they have for you know making an impact and so on, it's a good idea to get a sense of conventional sources of energy, to see what it is that we are calling as conventional sources of energy and you know how prevalent are they to what degree are we you know impacted in our lives because of these sources of energy. And then use that and also in that context see what are these non-conventional sources of energy doing as of today and perhaps get a better sense of you know what is the expectation on these sources of energy as we go forward.

So, as you can see today's class is on conventional sources of energy. So, that's basically what we will focus on.

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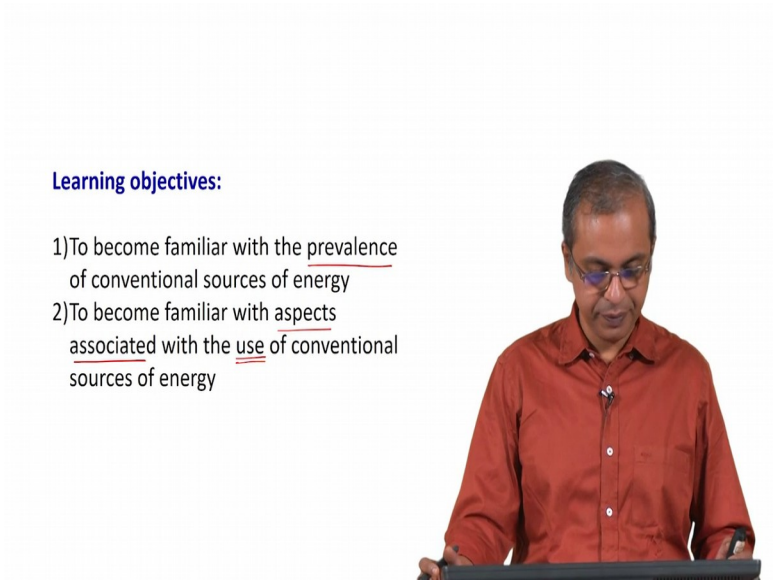

So, our learning objectives for this class are first of all to become familiar with the prevalence of conventional sources of energy which means I would like you to get a

sense for you know how much we are depending on these sources of energy and you know how common they are and also you know what are these sources. So, that is the the idea in when I say that we would, I would like you to become familiar with the prevalence of conventional sources of energy.

And the second aspect that I would like you to look at as we go through the content of this class is to also become familiar with aspects associated with the use of the conventional sources of energy. So, there is always a lot of talk about them and quite possibly you have read several articles about you know you know say global warming or many other aspects associated with it, but I would like to take this occasion to you know formally put across some ideas, some you know points, some information, that exists on these sources of energy and which indicates the aspects associated with this use of these conventional sources of energy and their existence in our you know common commonplace activities that we participated.

So, these two would then be our learning objectives we will as we go over this content we will you know I will try to emphasize these points as we look at these at the content of this class.

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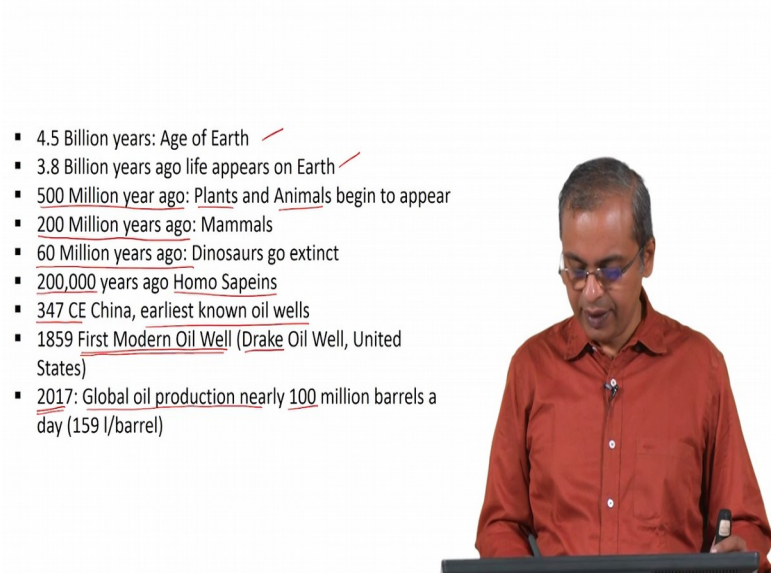

So, to begin with I have put together here a little bit of a timeline and I think it is very interesting to see this timeline for a variety of reasons because again as we talk of conventional sources of energy I think this timeline will convey to you what is that time

frame that we are talking of over which these conventional sources of energy have become a very major part of our existence okay. So, this the information that I have discussed on the slide sort of focuses on that time frame that we are discussing, we are focusing on.

So, it may seem like you know a very large collection of things, but I think it puts things in perspective and that is the reason why I wanted to put together the slide in this manner and so I will go over it in that sense. So, if you see here of course, as you I mean as you perhaps are aware the age of the earth is a huge time frame relative to our lifetimes. So, it's about 4.5 billion years old. So, that's how old the planet is on which we exist as of today.

If you come a little more recent than that about 3.8 billion years ago that is when life first began to appear on earth. Of course, 3.8 billion years ago we were just, I mean if you look back at the in the evolution of life as best as we are aware at that point in time we just had you know single celled organisms just beginning to appear in on the planet and that is considered the you know starting point of life on the planet as we know it. So, that's how things have evolved in a planet.

If you come much more recent than that we come to 500 million years ago and that is when plants and animals begin to appear. So, based on whatever records are available, based on how people have scientists have been able to extrapolate, it's about 500 million years ago that plants and animals began to appear on the planet and so that's again you know a significantly long period of time. If you come closer than that 200 million years ago, it is when mammals began to appear on the planet of course, we are mammals and mammals are and ancestral mammals appeared about 200 billion years ago. Around the same time that you know the dinosaurs were also present on the planet. So, around 200 to 250 million years ago is when it is estimated the dinosaurs appeared on the planet okay. So, that's how long ago they came and began to exist on the planet.

Again if you historically there has been you know great fascination with dinosaurs and the fact that they existed on the planet and the fact that they disappeared from the planet. In fact, there is a lot of scientific evidence to say that I mean modern day birds are actually quite intricately linked to the dinosaurs at some fundamental level. So, presumably there is at least one school of thought that says that you know in a sense you

shouldn’t say that dinosaurs have completely gone extinct. So, that is perhaps not the correct way to say it, but in any case the general thought process is that what we today consider as dinosaurs or a commonplace perception of what is a dinosaur, those dinosaurs all went extinct about 60 million years ago.

So, I think this number is actually even though dinosaurs is a completely different topic the 60 million years ago is something that you know is of interest you should just keep it in mind. We will sort of come back to this kind of a time frame in a little bit, but this time frame is something of interest to keep in mind. And 200,000 years ago it is when homo sapiens which is you know our ancestors as human beings our ancestors first began to appear on the planet. So, what we consider you know our kind of people are these people appeared on the planet around 200,000 years ago as a part of the evolution process that occurred. So, we trace ourselves back that far.

So, this is all ancient history, this is all you know in fact, even prehistory this is prehistoric stuff we have no records of these we are able to look these up through various artifacts that we find deep inside you know in remote places on earth, that we find artifacts which help us figure out that all these events happened so many 100s of 1000s of years ago, so many millions of years ago, so many 100s of millions of years ago.

So, this is how you know it has happened much more recently as we come towards you know what we consider historic and here where we have historic documents indicating what has been going on our planet, which is only you know I would say maybe less than 2000 years of know existence or the of that order you know. And we have some records of differing levels of degree of what humans were doing, where they were doing and what is it was the end result of that activity.

Of course in all these cases one general you know concept you have to keep in mind is that you know we tend to look at history based on the records that somebody wrote. So, we do not know all their motivations, we do not know under what circumstances they wrote those documents etcetera, but as a collection of documents written by several people across the time frame we get a sense of what was going on at that point in time. So, if you look back in 347 CE or AD the common era or the current era as it is called these days or AD as it used to be called you know not too long ago, we find that there are records for the earliest known oil wells. So, oil wells began to appear into our records

around 350 CE or you know of different kinds or some product of oil actually historically seems to have been used in different ways even little quite a bit earlier than this, but really as an oil well that was actually you know trying to extract oil from the ground it seems to have appeared around 350 CE in China.

Even there you know they had, they used to be they were sort of hand dug, well so to speak and they were considered I mean, but today's you know view of you know, today's technology and the way we go about drilling for oil these days these are considered primitive wells which is to be expected I mean it's such a long time ago and they did not have any technology at that point in time relative to what we have today. So, these kinds of wells are considered to be primitive wells. But there are records of such wells having been around and a lot of different locations in the world they were able to find oil at a fairly shallow levels of depth by this you know simply know digging with hands and you know handheld implements and so on.

So, after about this time of about 350 CE which is when this you know a sort of little bit of a primitive oil well was put together people have been extracting in this primitive sense at various locations, oil has been extracted internationally and used for a variety of different applications including you know some were used for you know making roads sort of the way we use these tar roads these days. You should also understand that at that point in fact, they did not have a good understanding or they were not even aware that you could do some refining of the oil and then you could get it to separate into various fractions etcetera. So, often in those days when they looked at crude oil they basically used whatever came off the ground. So, if it might have been in you know different compositions at different, places or perhaps due to some circumstances already some fraction had separated in some way they never really had any specific control on it they just understood that you know there was this stuff that they could get off the ground and they could use it as some kind of a fuel. So, it was being used in that context. So, that's the way it has been used historically and so that's how it has been used since 350 CE, roughly 350 CE.

If you come down to much something much much more recent 1859 that is you know barely that is less than 200 years ago, right. So, it is just about 150 years ago that you are looking at, what is considered as the first modern oil well, okay first modern oil well and it is referred to as the Drake oil well, named after the person Drake who was instrumental

in setting up this oil well. It's considered a bit modern oil well in the sense that you did not use primitive tool they did some you know serious bit of drilling to go much deeper into the earth and you know pick up this oil.

And so there have been known activities even before this as I said you know some from 350 CE to 1859 it's not like people who are not doing anything, a lot of people had been exploring oil and picking it up and you know using it for variety of purposes, but this was the first implementation of something more you know industrial so to speak in terms of you know just making making a specific dig of a significant depth to pick up the oil and it most importantly it is sort of sparked off this frenzy of you know oil wells.

So, people really caught on so this growth of oil wells in the planet, in terms of you know in various countries suddenly people caught on to this idea that there has this you know resource which is oil that you could get off the ground and then you need to find the location where it is and then you need to dig it, and there is specific specialized equipment that you can use to dig and get the soil and then you can use it for commercial purposes. That whole idea sort of caught on ever since he put this first oil well together and so therefore, from the perspective of say in the petroleum industry this Drake oil well is historic site it is marked as a historic site and it is still available to be seen as a historic site.

So, it really caught on and a lot of people started you know commercially know drilling for oil and you know doing commercial activities with it. So, there was in fact, a lot of crazy even to locate such places where oil was available and then buy that location, so that you buy the location that it falls under your control and then whatever oil is there you begin to exploit. So, significant amount of these activities have happened in the last 150 years. In fact, it has not ended even today you find you know rather unfortunately I would say lot of you know military activity associated with control on oil many times you look at international you know negotiations that are occurring, international you know positioning of people, positioning of nations, the positions they take the kind of you know countries they support the kind of countries they oppose often the accusation on these countries is that they are actually motivated by control of oil.

So, they want control over the oil and for that they are willing to you know sometimes make compromises that's sort of the unfortunate reality of you know geopolitics as it is

called and my point being that that is not ended with the 1859, 1859 is not very far not long ago it is 150 years ago. But even today the most recent wars that have been fought on the planet have all been have many of them have been linked to control on oil and that's the unfortunate reality of the industry associated with you know this production of oil. So, in any case 1859 is the first modern oil well and then we have had just you know oil wells all over the place there are very specialized kind you know industries and companies which exclusively focus on oil production and they set up these oil wells at various locations on the world around the world, there is a lot of you know mix of politics industrial control companies is trying to become very large based on this and so on.

Of course, in the end this is all happening because we use that energy, right. So, this is all happening because of that reason. So, at some fundamental level yes in terms of lifestyle existing current lifestyle, in terms of current life style these oil wells are necessary because they are supporting the production of energy and we are using that energy, the general public is using that energy. So, at some fundamental level this seems to become necessary and that is the reason why and, so in other words I put it this way at some fundamental level there is demand, there is demand for this energy there is a demand for the energy and currently that energy when we talk of conventional sources of energy. The conventional source happens to be this oil and therefore, oil is being produced it is being produced in large quantities.

So, at some fundamental level governments and companies which are producing oil are actually doing some service to the public because there is demand from the public for it. Where it becomes an issue is that there are lot of other control aspects associated with it because often there seemed to be accusations that you know local populations are not being treated well and so on. So, that's a different I mean there is a lot of it is there is a lot of complex issues there is what I wish to highlight in terms of you know the politics and the surrounding you know parameters associated with this whole production of energy. So, it has always there it is significantly there in the background because this touches something very fundamental to us. Because everything we do our ability to you know travel somewhere, our ability to get entertained, our ability to live in a comfortable you know environment even though it's like very hot outside or it's very rainy outside all those things seem to be linked with energy.

And in fact, we have gotten so intricately related to energy in our existence if there is a major power shutdown which basically means major energy shut down the entire cities come to a complete halt, there is nothing that almost nothing that seems to work I mean your telecommunications goes down your you know ability to travel to any location goes down, your ability to get entertainment goes down, your ability to get information goes down everything goes down in a matter of hours if you have a power shut down. And you know cities experience extremely difficult and you know very extremely difficult circumstances and are often completely unprepared for a major power shutdown. So, if you would complete any any major city in the world if it has a complete power shutdown for even two days it just descends to complete chaos. I mean the amount of chaos that that city descends to you know in terms of all services that are present, they are all essential services get affected almost immediately and that seek reality today.

So, energy has become a very fundamental aspect of our existence. We are no longer living in olden times where you know basically we just lived the day from the time that sun came there was sunrise to the time that there was sunset. A lot of our ancestors basically did that they had just a day from sunrise to sunset and once the sun sets doesn't matter when maybe it might be nice it may be 6 in the evening or 7 in the evening or eight in the evening depending on you know which part of the world you are in they would have all just basically retire, I mean just put some you know put a set up of fire to warm themselves, watch the night sky and then retire and that's how you know actually a lot of astronomy even started because people watch the night sky because they had nothing else to do.

Now, it has become very different we don't let the outside environment affect us. So, it may be extremely cold you may have extreme winter, minus 30 degrees C with wind chill outside and people will believe in come perfectly comfortable lives inside the building. Just you know 10 meters away from you there is a minus 30 degree C here you are sitting in very comfortable conditions or you could have the opposite condition you could have you know 35 degree C outside approaching 40 degree C outside extremely hot temperatures for our human comfort levels. But you would be sitting in an air conditioned environment and perfectly while going about your job.

So, we are we have reached a state of development where we no longer care what is going on in a natural sense outside our four walls. We are able to artificially control our

comfort level inside a building and all of this is directly and totally related to our ability to harness energy. This energy is used in various you know devices which help in our comfort of our life and that is the way we lived our quality of life. So, if you go to any country and you ask them for what kinds of parameters that in any family any human any other social setting you ask them for what it is that they consider as their you know comfort level in their existence, what are the things that they are looking at you know to feel that they have a good quality of life, invariably most people will express that is their initial thoughts will be along the lines of you know a comfortable home, comfortable environments and so on and all of them are all intricately related to energy.

So, extensive energy being used and so in that sense our you know behavior is linked to this energy usage and therefore, I mean control of energy supply of energy are all very very critical aspects at a international level. Nations can go to war based on it, nations can make treaties based on it, so that is how serious and significant this issue is and it has all happen in the last 150, 200 years okay. So, we are looking at 150-200 years of you know oil production usage on earth and so on, usage in our society and so on.

To give you a perspective of what's going on today if you look at the year 2017 which is just the year just that recently concluded global oil production is nearly 100 million barrels a day. So, they use this term barrels per day a barrel is actually 159 liters. So, that's the quantity that is used in the energy industry oil industry you tend to see this terminology barrels per day and a barrel refers to about 159 liters of crude oil. So, it's sitting at around 100 million barrels a day. There are, usually what happens is there is there is capacity to produce more, but here also there are a lot of you know political posturing that goes on, there is a lot of political posturing that goes on in the background, different countries have you know specific reasons why they would they may want to increase the oil production at a certain point in time or decrease the oil production at certain point in time.

As you know I mean from basic economic you know ideas, economic principles if you decrease the production of some you know essential commodities such as oil because it is necessary for energy and the demand still remains whatever it is then the prices go up. So, naturally some countries who are you know who have control on it actually get more profit for less oil so that is the thought process. At the same time there may be other countries which feel that you know it is you know it's necessary to put out so much oil at

this point in time and they may even do some political posturing where you know they put in too much of oil bring down the price of oil and that affects other countries who are only dependent on oil as a product for making money.

So, if you read recent articles on why the prices of oil keeps fluctuating in various ways you will find interesting information and I will touch upon that again in a little bit when we talk about price of oil. So, I think the main purpose of that I wanted to convey through the slide which is what I mean I would like to emphasize is actually the fact that we are really looking at a very short period of time, here, of which really only this 1859 to now, that's only 150 years. So, only 150 years of existence of this planet we have suddenly got onto this oil thing okay. So, we are just totally into this oil production, consumption and all the aspects associated with this oil economy, so to speak is all in the last 150 years. So, that's a very very very very small fraction of time if you look at this entire time frame that I have shown you here okay. In this entire time frame that has been.

So, what I think the point that you have to you know notice here is that if you look at the overall you know progression of you know activities on the planet progression of life, on the planet, progression of anything else on the planet it has been extremely gradual okay extremely gradual things that have slowly evolved you have looked at you know first cells that have appeared there, those cells have slowly evolved to more complex creatures, those more complex creatures have grown big you have had plants evolved, the atmosphere on the planet has evolved very very very gradually over billions of years and so on.

So, all this has happened extremely gradually the point in it happening very gradually is that it gives every aspect of the of the planet to accommodate for any changes because any small change very gradually counter forces appear and they take their time to balance things out and slowly the evolution happens okay. So, that's how everything has happened on our planet for billions of years and 100s of millions of years to billions of years, that's exactly how things are happening in our planet.

What we are doing is significant usage of energy in the last 150 years and usage of energy is by itself not an issue I mean if you can use whatever energy you wish as I mean it may be just any one of those things that we do. So, just because we have been using

energy in the last 150 years that doesn't automatically make that habit a bad habit. The issue is that as we have seen in our previous class the manner in which we use the energy and the products of that energy usage are such that they are impacting our environment very rapidly. That is the reason there is an issue there. Otherwise there is actually no real issue in using energy you can use whatever energy you wish I can use whatever I can wish based on what is available.

But the point is in the in the short period of time that we are using this energy the manner in which we are using that energy is dramatically changing our environment. And that dramatic change as I said is happening in a very short period of time we are looking at 100 years, it maybe even less 50 years, 100 years, 150 years that time frame is extremely short in the grand scheme of you know how life has evolved on the planet. So, in that sense it is drastic, it is extremely drastic, in fact drastic is a major understatement I mean we are doing something which is unheard of in the evolution of the planet, we are doing something in a very very very rapid time frame very significantly altering the environment.

We are first of all putting out a whole bunch of things into the environment and we are also affecting the plant life which can control it by cutting down that plant life. So, we are actually hurting ourselves two fold. So, that is a very difficult situation for any you know system which has evolved over such a long period of time to handle. And in fact, chances are the repercussions will actually have to be dealt with by us ourselves. So, this is something that I wanted to highlight.

So, the time frame is what I wanted to highlight with this slide. So, I hope that is something that is you know now will stay with you that it we are really doing all this in the in the space of about 150 years.

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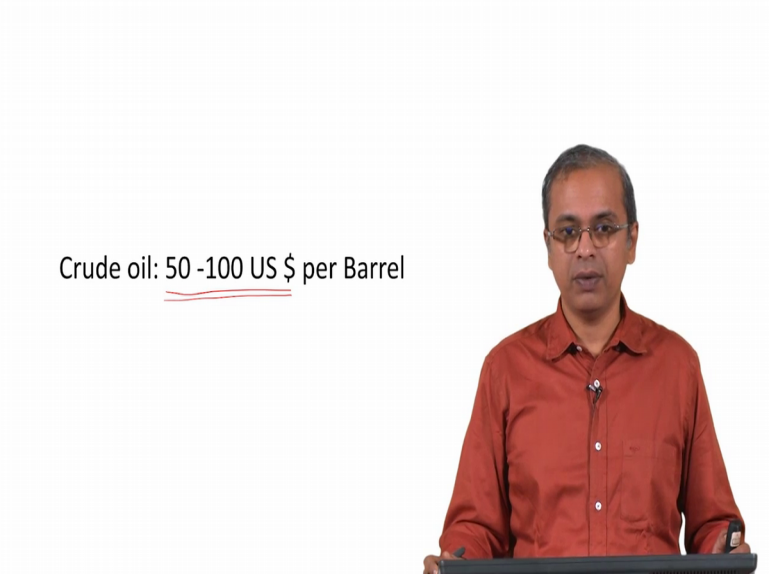

Okay so, now I said I will talk a little bit about this price of oil. So, we have this interesting price here. If you look at you know what is been going on in the say the last few years last three four years for example, the price of oil has been fluctuating okay. So, right now it is somewhere between 50 and 100 US dollars per barrel and that has been fluctuating as the year goes by it seems to climb up or climb down or go down and so that is been all, right. So, as I told you there is lot of political reasons for this and you have to ask yourself, how do they arrive at this price, first of all how do they arrive at this price. So, when they arrive at this price there are various factors that are involved.

At an economic level there is a basic issue of demand and supply. So, all of us around the world are you know utilizing energy. So, we place some amount of demand saying you know this much amount of oil that, we need this much amount of all the countries in the world all the people in the world all the industries in the world require energy and. So, we are all asking for energy.

So, there is some demand then there is a supply side, supply side consists of all those countries which have oil wells and all those industries which have oil wells which generate the oil. Now, if you flood the market with plenty of oil generally the economic you know view of the situation is that the price of the oil will drop because you have plenty of oil available in the market relative to the demand. So, as I mentioned there is a lot of political posturing and geopolitics involved here in terms of you know how you

will control the oil and why will you control the oil, okay? So, why will you price control the price of oil and how will you go about doing it; so the why is actually basically profit.

So, there are two reasons here there is profit and there is politics. So, the profit part of it is that you know any country which is dependent exclusively on oil. So, typically is let's say, many Middle Eastern countries are dependent on oil as their primary source of income. Naturally they would like to have better income and so therefore, they feel that you know if you would reduce the production of oil the price of oil will go up. So, for the same barrel of oil you actually make more profit. So, that's the logic that they would use.

And it also means that you know they can use this oil for a longer period of time they can keep selling oil for a longer period of time because oil is there as a limited resource it is there and in the underground, but they have some limitation on how much oil is available there. So, you can extend this profitable period you can continue to get more and more profit for a longer period of time. So, therefore, for countries which are dependent on oil as the primary source of income it makes sense to do things to keep the price of oil up okay.

Then there are other countries which may have various political reasons why; everyone would like to have more profit for their oil, but there may be a lot of political reasons why you know having a slightly lower price of oil make a difference. So, there may be a situations where you know some country feels that you know if I keep the price of the oil low then countries that depend on oil for profit will get less profit right and therefore, their ability to influence international behavior decreases because they are not getting enough profit, they are not able to put their economic might to control world opinion. So, there's a lot of you know aspects in the background which are not really associated with the petrol that you put into your vehicle which are affecting the price of the petrol that you are putting into your vehicle okay. So, this is all going on in the background.

So, currently it is somewhere between 50 and 100 US dollars a barrel and it is fluctuating all the time. Every day the price goes up or comes down and then based on over and above this you will have some you know taxation in your name, in your country, various policies economic policies in the country that finally, this basic price plus those policies

together constitute the price that you pay when you go to a petrol station and then fill up petrol or diesel in your vehicle. So, this is the thing going on in the background.

In over and above this politics political aspect associated with this pricing there is also the basic aspect associated with the industry that does the oil drilling. So, there is going to be cost associated with the you know the all the hardware that has been put together at that location, cost for that land, cost for that hardware cost in the pricing the salaries that they pay all those engineers when they come there to you know say be at that site do the drilling, work with all the you know staff that are working at that oil rig or oil you know platform and then know generate that oil.

So, there's a lot of actual you know salaries that are paid maintenance cost, hardware cost, infrastructure cost all that associated with this you know installation which is generating this oil which picks up the oil from the ground. And then there is also the refining, refining costs of you know converting going through this process by which this oil gets the crude oil is then split into various fractions and then it is shipped to various locations. So, there is a shipping cost also associated.

So, they all these other costs that I just mentioned here effectively form like the base price. So, at least these costs have to be covered otherwise no industry is actually even going to get into this business. So, first of all these costs have to be covered that's the infrastructure cost, the people cost, the transportation cost and all of that and then over and above that you have all these political decisions which affect the amount of profit that you will get on this oil and any other taxation which decides the price of oil on your as you go into the petrol station.

So, it's a complicated you know several factors are involved is my is the point that I wish to convey, in the arriving at this price of 50 to 100 US dollars per barrel which seems to be the range over which the price is fluctuating as of now okay. But there are some other parameters that I would like to draw your attention to, so that we will see here.

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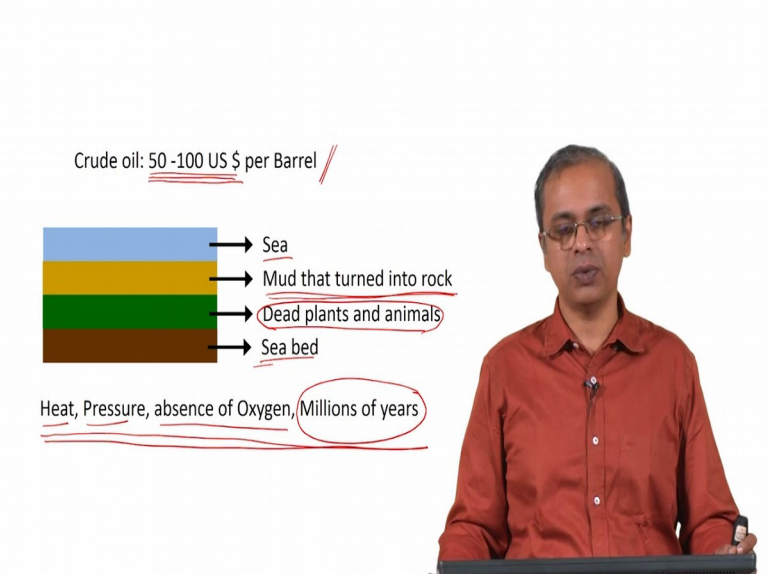

So, when you look at this 50 to 100 US dollars per barrel just please keep that in mind we will come to that in a moment. Let's take a step back and see how did we arrive at this oil this crude oil that they you know just dig up and pull off the ground how did we arrive at this, this oil. And to understand that you just have to see these you know sort of the layers of what are there on the earth, at least within the within the scope of our discussion there is the sea, then there is a mud below the sea and usually what has happened is that you know in at least with respect to this oil production over millions of years ago, over the over the last several millions of years plants dead plants and animals plants that lived out a life and then basically died. Some of them or several of them slowly got buried and they went into the sea they got buried, they settle down at the base of the sea and then they got buried with the sand over that particular region.

And so when I say millions of years ago it could even be you know you would be basically would not be basically when we talking of the dinosaurs or any of those animals that have lived in the last you know tens of millions of years that have gotten buried and then got covered with mud then due to the pressure of the sea a lot of that mud has over a period of time turned into rock okay. So, this is basically generally what has happened over millions of years or millions of years tens of millions of years this is gradually happened.

So, you had you know natural life that died and then you know got buried at various locations, several of them got buried under the sea and then there there was you know sand that got that covered them and that sand again over millions of years under the pressure of the sea and other conditions that they are under slowly turned into rock. That put even more pressure on the maybe the content that was believed beneath it the decaying content that was underneath it which was all these dead the plants and animals.

So, there was this layer of dead plants and animals covered by mud that then turned into rock and below that was the seabed. So, this is sort of the set of layers that are of interest for us in this discussion okay. So, this is how you have you have the sea, you have the mud that turned into rock, the dead plants and animals that got buried below that mud before it turned into rock and then the seabed.

And under these conditions where there was heat, there was pressure and there was absence of oxygen; heat, pressure and absence of oxygen and time which is what millions of years. Heat, pressure, absence of oxygen and millions of years, this is what was the conditions were the set of conditions that these dead plants and animals were subject to okay. So, heat, pressure, absence of oxygen and a time frame of a millions of years under which these materials were subject to these conditions. Under those conditions this combination of conditions gradually these dead plants and animals got converted to what we are now looking at as crude oil okay.

So, this is a very slow elaborate process that has taken millions of years with a huge number of dead plants and animals which died millions of years ago tens of millions of years ago, right. So, actually when you go to the fuel station petrol station and you pour petrol into your car it is very likely that you are actually pouring something that is a dead dinosaur, right. So, you could be I mean you may not have thought of it that way, but some dinosaur and some other creatures which died long ago became that petrol which is what you are actually pouring into your vehicle okay. So, you don’t realize it you just see one know somewhat clearish looking liquid some faint coloring in it coloration in it just going into your vehicle, but that is the origin right.

So, the question we have to ask ourselves is that when you come up with this price of 50 to 100 us dollars per barrel where is the price for all of this, what is the pricing, where in this 50 to 100 dollars, 100 US dollars per barrel did you account for all of this. If you ask

this question you find that the answer is nobody ever accounted for this, right. So, in some ways what we are doing when we come up with this kind of a pricing of 50 to 100 us dollars per barrel we are neglecting lot of fundamental aspects here. I mean imagine this heat pressure absence of oxygen in millions of years where is the pricing for this.

Supposing you take out I mean right now we are simply looking at the cost for digging it up and pulling it out I mean that's a very highly unreasonable way of looking at the cost of something. So, any resource that we when we put a price to that resource we have to ask ourselves you know maybe from you know economic parameters concept you can come up with a price for it, you do have to really ask yourself as a society we have to ask ourselves if that is the right way to price something if that's the only aspect that you should look at when you price something,.

So, now the other way to look at it is supposing we consume all the petrol right we completely consume all the patrol all the diesel and whatever all the crude oil we completely consume. What is the cost that will be involved in recreating that know resource where is that cost, where is the cost in any of the pricing that we put. It turns out that strangely we don't seem to be interested in it or we have not even paid any attention to it, and therefore this factor completely does not appear in our costing. There is no price for the dinosaur that died to get you your barrel of oil there is absolutely no price, it's priceless and we have certainly not included it here we have treated it as priceless and therefore, we have treated it as you know that whoever as priced it has actually put the price of zero on it. And therefore, you are looking at 50 to 100 dollars per barrel.

So, the point being that you know human beings sometimes do strange things, in fact, maybe all the time we are doing strange things and at least to me it appears that when we price things resources of this nature which are you know very you know unique resources which are not going to just show up from somewhere. Now, if you look at rain, rain flows down it comes down it goes as a river it goes into the sea again there is evaporation you get back rain. So, this is a cycle that is going on all the time, right.

Oil is not like that it's not like you know you burn the oil and it will rain back oil at you when you and you can just pick it up from a pond it doesn't work that way once you burn it, it is gone, it is not renewable and that's the whole point in calling it not renewable it is gone once you finish it has gone. So, how many other barrels of oil you generate. Once

you burn them all they are all gone. So, they are gone for good. And therefore, it does not make sense that you are not even accounting for what it will take to bring back that barrel of oil and unfortunately in today's pricing that's what we do.

And in fact, there are other things that we do I mean. So, that's something that's that's one point that you should keep in mind and also you should also remember that you know there is a lot of technology involved in getting this barrel of oil and in fact, the pricing looks at those things. So, it doesn't really look at all of this you know fundamental philosophy.

So, for example, they have been looking at ways of you know they look at the drill oil from a well and they just consume all the oil in that way using the existing technology and then they abandon that well saying you know we can no longer get oil out of this way. But increasingly they have now found new ways to look at old wells and actually extract some more oil out of those wells. So, that is the direction in which we have moved. We have tried to see you know we have taken a resource we have exhausted it can we extract a little bit more. So, that that is the sort of the approach we have taken that's the approach of you know, much of the industrial society towards the resources and that's the approach we have taken.

What we have missed is this idea that you know if we have to replace that resource that must be if, that is essentially impossible in our timescale unless we figure out some other way of dealing with this okay. So, that's something I wanted to draw your attention to.

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Okay so, one was the time scale of our usage of this resource these conventional resources of energy. So, that was the first part of what we were discussing in the class. The second part that we discussed is the pricing of this resource. So, the timing is one thing, the pricing was the other thing. And the third part that I just wanted to highlight as part of this class is the impact on the environment.

So, we did this as a separate calculation in our earlier class and, so I wouldn't go into the full calculation that calculation we just went over. But the point I wanted to highlight which is the conclusion of that class was that we are through this you know usage of this conventional source of energy this you know non renewable source of energy that we are doing which we are doing extensively in the last 150 years, this usage of this conventional source of energy due to that we are significantly changing the composition of the environment. So, that is as we saw in our calculation, in a time frame of 100 years or much less even based on our you know demand supply on our usage of energy we can change the composition of carbon dioxide by a factor of two.

So, you can double the amount of carbon dioxide in the atmosphere. It is a small percentage, but you have to remember that the overall system is has reached some equilibrium with that percentage, right. So, many things are happening in the in the ecosystem and you know everything from you know how much sunlight is you know penetrating through the dust that reaches of reaches our ground how much of it gets

trapped in the environment lot of things are happening, how much rain is produced how much drought is there many things are happen are all intricately related and they are all happening with you know based on what is there in the atmosphere.

So, when you take that you know delicate system and then you take one component of the delicate system and suddenly double it in a time frame of about 100 years which is laughably small in the time frame of you know existence of life on the planet. You know that kind of time scale when you suddenly do it you are doing something dangerous, potentially dangerous. I mean it may be that it means nothing, but in this case every evidence suggests that we are doing something potentially dangerous, right.

So, we are changing the composition of the environment quite significantly in a very small period of time which is of the order of 100 years. So, this is something that I was the third point that I thought I should draw your attention to in the context of the use of conventional sources of energy, right.

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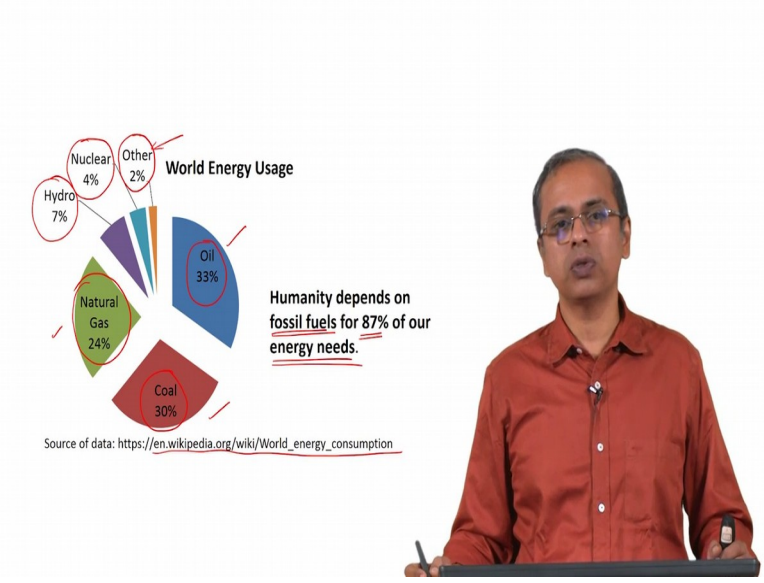

So, now let’s look at this image here I have picked up this data this is the source of this data here and I have taken the data and re-plotted it, this data is the original data is available at that site and you should we can just take a look at what are we doing with respect to energy.

So, the point of this slide which is what I would like to you know highlight as I discuss the slide is that if you look at research today in the field of energy there is lot of interest in doing non-conventional sources of energy to create non-conventional sources of energy to nurture them and to actually deploy them non-conventional sources of energy or renewable sources of energy. So, you hear a lot about it, you read a lot about it there are. So, many articles I mean in magazines and newspapers on the internet you know messages forwarded to you on social media etcetera so much of discussion of this topic. So, that is good I mean it is a nice direction to go in, but it is also of interest to actually take a pause at this moment and see what where is it that we are right now, what is our situation as of today, so ok.

So, if you look at it that from that perspective you see a situation which is not very flattering and definitely a situation that is causes us gives us a lot of reason for concern. So, you look at what is the current energy usage and more specifically what source of energy we are using to handle our existing demand for energy.

If you look at it that way oil is about 33 percent. So, that would be you know something like you know petrol and diesel etcetera those kinds of things, provides 33 percent of the energy that we use or rather the energy that we use 33 percent of it is in this form. So, all the you know transportation that we do any other industrial machine we are running which is running off of diesel or something like that, all that is essentially consuming about amounting to 33 percent of energy that we use as a society.

Coal is another 30 percent that is very significant. Coal is 30 percent coal is actually many thermal power plants internationally, certainly many thermal power plants in India are all running based on coal. So, coal is extensively being used in thermal power plants and, so that is why you see this thirty percent of coal and that generates electricity and that electricity we are using in our house in our homes.

Then there is natural gas that amounts to 24 percent used for various purposes actually. If you look at European countries it is a significant need for heating in their homes okay. So, we use this for cooking, we use this for heating and so on natural gas even for some automotive applications, but significant usage in that is cold countries where they need heat, they have moved away from you know putting logs of wood and lighting a fire. So, that’s not really the way it’s done, but they do have heaters in their home which are often

based on this natural gas which is being piped into their homes. So, in many European countries you know unlike maybe other countries developing world certainly in India and all you get this cylinder of gas which gets delivered to your house, in Europe in and also in many places in the United States for example, gas is piped to the house. So, there is a pipe that brings the gas to your house and there is a meter. So, just like water is piped to your house you get gas in a pipe and then you its metered based on your usage and one of the applications is used for this household heating.

So, in terms of from the perspective of household heating, from you know cooking requirements and also some element of transportation requirements you get a fair amount of usage of natural gas and it's about 24 percent of the energy demand that we have is being met using natural gas.

So, if you see here these three, that you see here which is oil, you see coal and you see natural gas. So, between the three of them these are all sort of you know based on hydrocarbons based on you know something that you are getting off the ground in terms of you know crude oil or something or some you know modification of crude oil or some refinement of crude oil let's say. So, these three are sort of coming from at this in general from that source. You are looking at a total of 87 percent, so 33 percent. So, this is 63 and 87 you add 3, the 3 of them you will get 87. So, 87 percent of our energy needs is essentially being met using fossil fuels. The fuel that we get from all those dead animals that got buried a long time ago which are the fossils and then and, so therefore, we call them fossil fuels. 87 percent of our energy needs today as of today as we approach the year 20-20, 87 percent of an energy need is being met for met using fossil fuels.

Now, look at everything else we talk of hydroelectricity there is a so much of you know controversy even with respect to hydroelectricity because you need to build dams. And today the thought processes is that you know an environmentally friendly way to build a dam is to actually build micro dams, small small dams along the you know flow of the river rather than to build one massive dam. So, there are huge dams in say in China and India and many other countries and there's a lot of people who oppose the construction of those dams because it seems to have a major impact on the on you know wide range of things close to the dam in terms of you know what it has done to the vegetation there, what it has done to the people there etcetera.

So, there seem to be a lot of you know resistance to such large dams, but there is also you know some other know aspects such as the urgent need for energy which requires seems to require the construction of these dams and there is also of course, some sense of prestige associated with it maybe a false sense of prestige. But in any case there are these again complex issues associated with the hydroelectricity, but then and, but hydro electricity is a part of our you know source of energy and we do use it. But you see here that for all the talk that it appears in our news that amounts to seven percent 7 percent of our energy supply comes from hydal sources from dams that we built.

Nuclear energy again a very controversial topic because it is in some sense clean because it's there is no carbon dioxide coming out of it. But in some sense extremely polluting because even if you have tiny amounts of radioactive waste which have even low grade radioactive waste it is something that can you know damage a region and the damage stays for a very long time you are looking at several thousands of years before you know that that radiation there will drop to a level that is safe.

So, nuclear energy has a various other aspects associated with it which people are not comfortable with. And as of today that amounts to 4 percent of the supply of energy to our for our daily usage, so 4 percent is covered there. So, through nuclear energy there are nuclear power plants in various places in the world and there is a lot of opposition even to the construction of nuclear power plants.

So, if you now remove all of these you remove the oil, the coal, the natural gas, the hydroelectricity and the nuclear power generation if you set aside all of these you are left with 2 percent okay. So, that is a very small number. 2 percent of the energy that is being used in the world today comes from other sources. So, what are these other sources? Those are these renewable energy sources or non-conventional sources of energy that these could be a variety of sources such as wind you know I have many other sources we will discuss them in greater detail as we go through solar power, as wind power etcetera. But as of today that provides only two percent of the energy that is being used in our society, right.

So, therefore, the there is both I mean reason for concern and there is reason to have you know very nice expectations out of this situation because it means that there is a huge scope for growth, there is huge scope for growth of this technology and to the extent that

we invest in these technologies to the extent that we invest in the development of these technologies. We have a scope for you know greatly impacting on the entire energy usage scenario and the impact of that usage on the environment. So, there is great scope for that. So, that is the good news that we have.

But the reason that we need to be concerned is that we are only doing 2 percent as of now. So, we have to do something urgently to increase the amount of you know non-conventional energy usage in our lives so that we can you know gradually move away from this situation where you know 87 percent of our energy is coming in a manner that is extremely harmful to the environment. 87 percent is coming from fossil fuels we are just dumping a whole amount of carbon dioxide into the atmosphere and that's just not the right way to do things.

We have enough knowledge that we should do better than this, that's the bottom line you know we can always argue about what is the convenient things to do, but we have enough knowledge and enough capability that we should find a better way to handle our lifestyles, to handle our energy needs.

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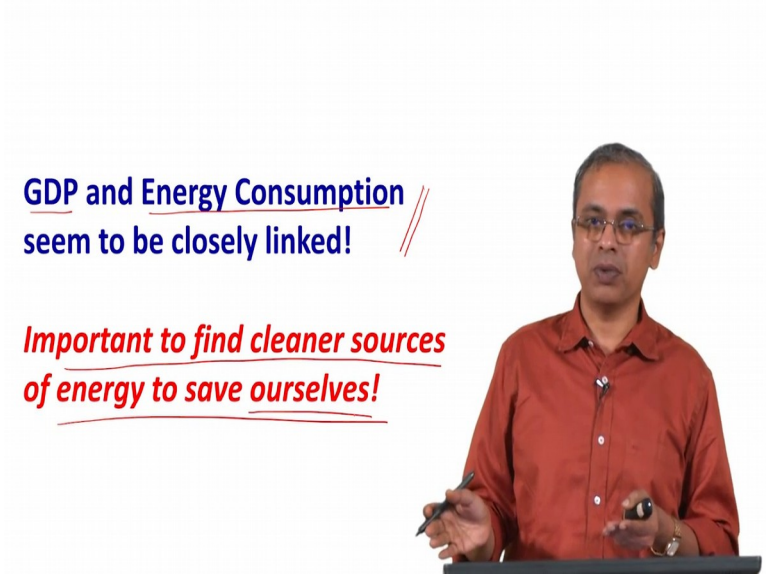

So, so that is the point I wanted to make here. So, I will close with this slide that is the point that we should also keep in mind. The other major reason that we have to be concerned about is the fact that the development of societies which is often measured using GDP is it turns out seems to be very closely related to energy consumption.

So, generally, and it makes sense because you say a place is developed it means there are lot of industries there, there are lot of companies there etcetera and all those industries and companies therefore, consume I mean naturally consume a lot of energy. So, now, if you step back and just take the amount of energy and how the place is economically developed naturally they are linked.

So, this puts a lot of political pressure to against you know controlling the use of energy. So, if you go about saying don't use so much energy there is a lot of political pressure to resist that idea, because it means when you stop using energy you are affecting the jobs and livelihoods of people. So, it is all the more urgent that we find renewable sources of energy and clean sources of energy to satisfy our energy requirements so that we don't affect the GDP we don't affect the livelihoods of people and we get good political backing to actually deploy these technologies and allow people to live you know good lifestyles, happy lifestyles, comfortable lifestyles, but also do it in a clean manner.

So, this is something that we need to look at and therefore, it is very important for us to find cleaner sources of energy to save ourselves. More than anything else to save ourselves we need it. We cannot really be in a you know a you know a sense of denial saying you know nothing is wrong, nothing is wrong, nothing is wrong, there is something wrong we really need to do something about it and we have an opportunity to do it and therefore, it is nice to try to do it, ok.

So with this I would like to conclude this class. I hope you have now got a sense of you know what are these conventional sources of energy, what kind of time frame we have been using them, what kind of impact it has and you know what are various aspects associated with this use of conventional sources of energy.

Thank you.

KEY WORDS:

Conventional Energy Sources; Oil Wells; Oil Price; Fossil Fuel; Non – Renewable Energy; Coal; Natural Gas; Hydal Energy; Nuclear Energy; Renewable Energy; Non-Conventional Energy Sources;

LECTURE:

The Lecture gives an idea about the conventional sources of energy, the time frame of their usage, it’s impact and various aspects associated with its usage. The pricing of such resources and various factors affecting its pricing is stated. The impact of world’s conventional energy usage on environment is delineated and extrapolated into the futuristic consequences.