Non-conventional Energy Resources
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Lecture – 28
Biomass Usage and Issues

Hello in this class we will look at biomass, we will look at usage of biomass and also various issues associated with biomass. As we discussed in some of our early classes when we looked at you know the range of possibilities that exist with respect to non conventional sources of energy, with respect to renewable sources of energy biomass is a very significant contributor in that picture.

And lots of people in it is fundamentally considered as a renewable, we are going to look at the those details its fundamentally considered as a renewable resource, and potential for you know significant dependence on biomass is actually very high. Because there are many aspects which drive economies and nations towards the biomass you know idea and the set of activities associated with use of biomass for energy.

Even many companies are quite comfortable with the idea. At the same time there are concerns relative to relating to what exactly are we doing if you start using biomass, and what is the perspective with which we need to look at it, are there issues that we should be cautious about concerned about and so on. So, in this class that's basically what we are going to do? We are going to just look at what is biomass, what are you know aspects associated with its usage and what are some important issues associated with its usage. So, our learning objectives will be as follows we will begin by describing what is biomass?

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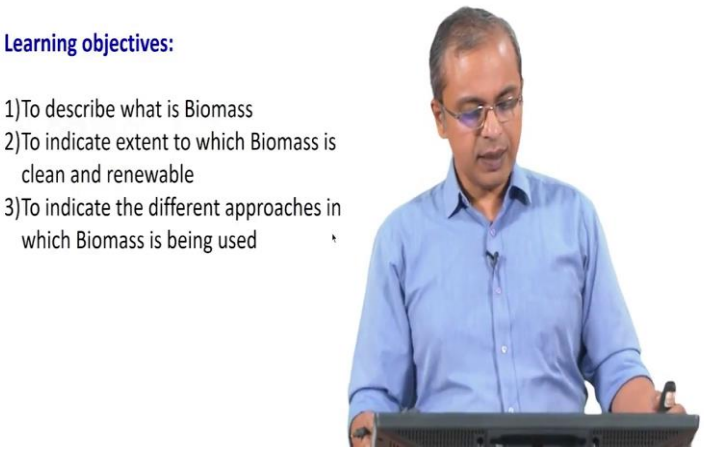

So, that we have a common you know sort of understanding on what is it that is being referred to as biomass. And then we can make our you know look at data related to it and then make our judgments on what is relevant with respect to it. We will look at the extent to which biomass is clean and renewable. So, this is something that we need to consider and think about and discuss a little bit.

So, that's what we will look at and we will also look at the different approaches in which biomass is presently being used. And in that context we will get a more complete picture of how how much it has penetrated or how much potential is there for it to penetrate into our you know energy mix so, to speak. So, these our major learning objectives for this class.

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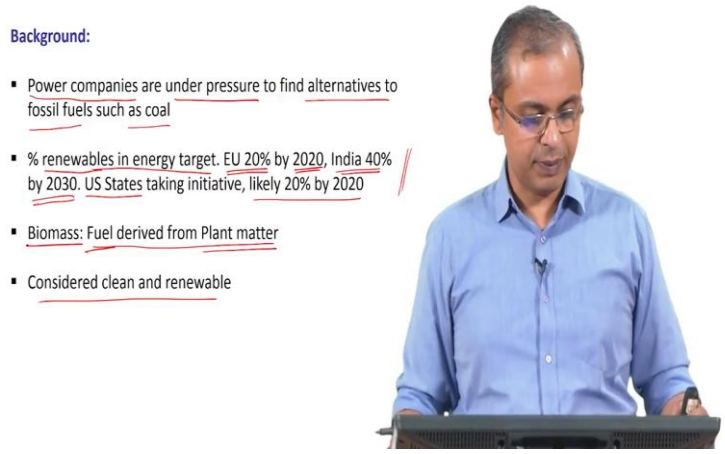

Alright so, to give you a background, first of all power companies company these are companies that are generating the power for us and you know we consume them. So, in our office offices or in our schools or in our homes, we are consuming power. So, the power that we get at our; I mean at our home or office or school comes from a variety of sources.

So, we actually are only seeing the electricity that is that we are getting from the switch, but where did that electricity come from, what sources were used to produce that electricity is not something that we have direct access to or we are directly aware of we simply get the electricity. So in fact, over the course of a month or over the course of a year, the electricity you receive in your house may be from a variety of different sources.

So, there may be you know say some months where you are getting it from primarily from some dam somewhere, another some few months where you may be primarily getting it off of some coal fired plant somewhere and so on or some other months you may be getting it from a nuclear plant somewhere else.

So, this is because there are some seasonal variations associated with this, there are some demand variations across the you know across the country, across the state etcetera. And there are multiple sources from which the electricity is being supplied. So, so that the electricity supply has a mix associated with it, and what we get is some part of that mix.

So, we can sort of say you know the electricity that comes to our house is say 20 percent from nuclear energy, say 60 percent from thermal power plant, 20 percent from hydal power plant. So, some mix like that would be there. So, that is the mix that we are getting.

So, power companies which are the companies that produce this power and then supply it to us, also have a mix in their you know what it is that they control. A particular company maybe only been taking care of thermal power plants. So, then they have only control on that particular source of energy. So, most of those companies are under pressure to find alternative fuels to fossil fuels such as code.

So, typical thermal power plants, a significant amount of energy that is that we are using in India is coming from thermal power plants. So, they are basically using coal and coal is a fossil fuel. So, it has issues a major issue is the fact that it is shortened I mean there is a limited quantity of it, we have stumbled upon it and we are using it up at a certain rate. So, it's a matter of time before we run out of it. So, you know so there is a deadline that is coming up at some point ahead of us.

Based on what is possible with technology etcetera, we may be able to push the deadline some more because that is what has happened with many oil fields for example. Many oil fields people abandon at some point in time saying that it is no longer profitable to extract the oil from that that field, then later they found new technologies which said that you know even though there is only less amount of oil remaining there even that can be extracted and that is still a significant amount.

So, they figured out a way you know revive some oil wells and then get more oil out of it. So, this process goes on. So, in every fossil fuel maybe we think that you know 10 years down the line we may run out of fossil fuel, then we find that 10 years down the line people say no another 20 years we can use the fossil fuels and so on.

So, this deadline has been shifting; more specifically with respect to fossil fuels people have always been saying in the next you know say 10, 20 years we will run out of fossil fuels and that seems to be continuously extending. But the truth is the quantity that exists in terms of fossil fuels is limited. So, at some point in time we will run out because we are continuously using it. So, at some point in time we will run out of fossil fuels. So, that is the exact date is the only thing that's in question and it is not very far off that's the

point that we need to remember. Chances are within one generation we are going to run out of it. So, by the time most of us are old people chances are most of the fossil fuels will be out of. So, given the rate at which were using it; so, the power companies are under pressure. So, they know that you know if you have to continue providing power, you have to do something about the fuel that you are using that they. So, they are under pressure to find some alternative to the fossil fuels such as coal.

There is also national and as well as international you know thought processes and sort of agreements and peer pressure so, to speak. To try and increase the amount of renewable energy sources in the mix that is being used to provide energy in within every country. So, in because they all understand the same thing, they all are and that we are going to run out of fossil fuel we will do something about it.

So, many countries have adopted targets and so, for example, at which they have imposed on themselves which they have publicly agreed to and they are going to enforce on themselves. For example, European Union has agreed that 20 percent of the energy that it uses will come from renewable sources by the year 2020 okay. So, that's the kind of agreement that they have indicated. There are reports that India has said that they will go up to 40 percent by 2030. So, so everybody has given a different date and what kind of target that they are going to keep and so on.

So, these kinds of numbers are there, you may be based on which report you read you may see slightly different numbers and so on, but the general trend is of this, this order you are looking at somewhere between 20 and 30 and 40 percent variation in what is going to be done and you know in the next so, 10 years or so, 10 15 years is the timeframe we are looking at.

As far as we understand for example, the United States has been hesitant to publicly as a nation to publicly accept a particular target, they feel that you know it impacts them in a negative way and so on. And there are political issues there they are not comfortable the political parties there are not comfortable making public I mean agreements, that they are going to curtail energy use in any way or even change their energy usage pattern in any way.

However many of these states which are there within the united states have been much more active in agreeing to some targets, and they are also likely to achieve 20 percent

conversion to renewable energies by the year 2020. So, a lot of people are doing this. So, there is interest in finding ways to enable more renewable energy sources to get included in the energy mix being used by the country, and they are actively looking for various such things. In that context biomass takes up a significant importance okay.

So, it is basically because it is fuel derived from plant matter ok. So, in a in a sense it is no different than you know people in olden days people used to burn wood to you know light their stove, we had you know people who didn't have access to wood fuel even now we in based on cities and towns that you go to you will find people who may not have you know enough income who are basically collecting twigs from various places, and using them to burn set up a fire and cook their food on it right.

So, that essentially is biomass, you are taking some plant matter in this case it happens to be twigs and you are using it as fuel; this is biomass. Now we are talking of this in a national scale okay and not people who are you know struggling for facilities are pushed into a corner and taking twigs and you know trying to manage their lives, that is not what I mean we are referring to in this context. We are referring to an entire nation taking the initiative to you know collectively not necessarily collect twigs, but do something of that of that nature, which is basically to use plant matter to generate power this is the basic idea. It is considered clean and renewable.

So, this is something that we will discuss; we will discuss what is this idea of clean and renewable in the context of biomass but that's the background. That there is a push towards more renewables just because we are running out of fossil fuels and biomass happens to be a source of fuel, which is considered renewable certainly and also considered clean by many and therefore, people think that this is the way to go, it seems to be something that many nations are more ready to include in their mix.

It is also a relatively more convenient and easy to include it in the mix that's the you know reason why this push is there towards biomass. So, with that background we will progress to understanding this potential source of energy a little bit better.

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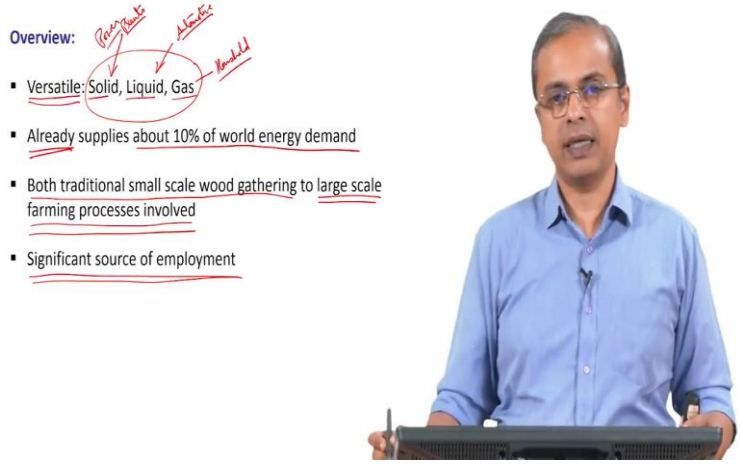

Okay so, in terms of overview the biomass as I said you know you can use twigs to burn of stove and we can do some variations on it. Some of the reasons why biomass is of interest is that first of all it is very versatile you get biomass in variety of forms and that is very convenient, because we use energy also in a variety of forms. So, more specifically you can get it in solid form, you can get it in liquid form or you can get it as gas and that is really with three states of matter that three most common states of matter are right there and that's all the fuel that we need.

So, that is all the forms in which we need the fuel for the most part. So, you may need gas for cooking which is typically cooking and sometimes even you know heating of rooms or spaces based on where you are located, we typically need liquid fuels for automotive applications mostly we are set up for that kind of a situation and of course, we need solid fuels to run plants big plants it turns out to be much easier to do it that way.

So, if you look at a large pattern of you know energy requirement and how we generate that energy and put it into our system, these are really the three different ways in which we will require it, this is more household, this is automotive and this is power plants. So, those are three different major categories under which we will use it, but of course, all of these can be used across you know across each other sectors that are along the lines of

what I have explained here these sectors are not rigidly tied down to these categories, but I just to give you an example I have told you this.

And interestingly it already supplies as of today already the biomass is being used to supply about 10 percent of the world energy demand on average across all nations if you take about 10 percent of the world energy demand is already being supplied by biomass. So, that's quite significant 10 percent of the worlds energy usage is quite significant which means it has already made its presence, it means there is an you know you know infrastructure and economy and processes all that is there behind the scenes its already in place to support 10 percent supply of the world energy demand.

So, it is already a significant player and has great potential to become a much more significant player. So, therefore, it's a good idea to have perspective on it. So, when we said biomass I said you know that you one example is people using you know wood based stoves and using twigs for running the stoves, and the other is to have large scale processes to do this. So, actually when you say biomass, how it is coming in to the energy sector from the fact that it is something that is a farm related sector or you know natural resource that is sitting around.

In from there, in terms of how it comes into being part of the energy sector which is what we are using in terms of energy really two major ways it happens, it happens both due to traditional small scale wood gathering which gets converted to you know fuel in different places or also due to large scale farming processes. So, just the way you have agricultural crop this is agricultural crop, but this is farming done exclusively from the perspective of energy demand helping assess the energy demand situation.

So, these are two different you know range of activities from which you can pick up a biomass and put it into the energy mix and both have seem to be happening at this point in time. And also from an economic perspective from say a political perspective or a social perspective, biomass is also very important and you know significant contributor to the societies in structure in the sense that it provides a significant source of employment. I mean supplying 10 percent of the worlds energy needs is a significant you know quantity significant impact.

So, if you have 10 percent of the worlds energy demand being supplied through this process, all the people who are involved in this process are being employed by it right.

So, are being employed by it so in fact, it is a significant source of employment in various places in the world, which addresses employment at wide range of you know training levels or you know skill levels etcetera.

So, this is a great source of employment. So, it is not just about energy, there is a multi dimensional aspect associated with biomass and therefore, it is sort of here to stay at least in the short term it may stay in the long term also I mean there are enough drivers to keep it on for the long term and it may even stay in the long term. So, the that much more it is necessary for us to have a you know deeper thought process involved in the in understanding this biomass.

Okay so, when we say I told you that you can have large scale farming process involved in creating biomass.

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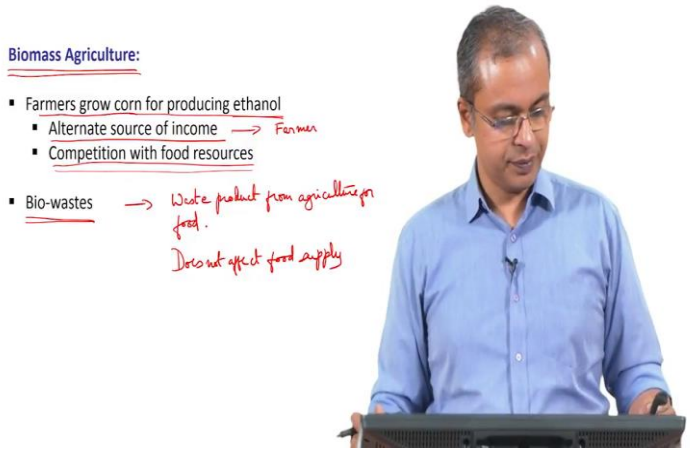

So, if you look at biomass agriculture. So, this is just the way you know you would grow tomatoes or potatoes or whatever it is you grow on your farm, this is agriculture meant for the energy sector. So, as it is farmers are already growing corn for producing ethanol ok. So, this is already a process that is on. So, there are many huge farms that are now generating corn based product primarily for the energy sector, because that corn is not going to be sold in the market for us to consume as food it is going to be converted to ethanol and then that is going to be used as a fuel. So, this is already on.

So, this provides an alternate source of income to the farmer all right for the farmer this is an alternate source of the income for the farmer this is an alternate source of income and therefore, pricing is very critical right. So, if the farmer can sell the corn as food for a price higher than he or she can sell that corn for fuel than they would put it in the food market they would not put it in the fuel market.

But if it turns out that by taking this corn converting it to ethanol, you will actually get a higher price for on a per kg basis of corn, then the farmer will more readily sell this corn to the company which is going to convert this to ethanol right. So, there's a very specific economic decision here, which is how this whole biomass idea or concept impacts the society and enters into other aspects of the society which we don't immediately understand right.

So, we are simply looking at it as fuel that goes into a vehicle or fuel that goes into a power plant, but it has repercussions. The moment you say that that fuel is coming from the farm then you are telling the farmer that he has an option that he or she can make grow food for consumption as food or grow food for conversion into fuel and that's fine I mean everybody should have options. So, there is absolutely nothing wrong in a farmer having options. It is just that society as a whole needs to step back and see what are the implications, does it mean that we are going to have a shortage of food because we are now focusing more on the fuel or what are the other ways in which you can handle it.

So, I mean to the extent that you can handle it this itself is not a major issue, but you can think about at least you need to apply thought in the process right. So, so that we know that we are not pushing the society into a corner, where suddenly you may have a shortage which you may not be able to control in the short term and food is something that we need on a daily basis. So, even if you have a sudden shortage of food for let's say 2 months or 3 months, that's not something that you can easily handle for a large population right.

So, that is something that is significant. So, it is in direct competition with food resources that's the point we have to remember right. So, its in direct competition with food resources especially when you do farming of this nature, exclusively for the sake of the energy industry. So, there is a competition with food resources. So, we have to be aware of it aware of the say the extent of it the magnitude of it so, that we can keep it

manageable and still be say secure both from the energy perspective as well as from the food perspective.

There is also some biomass agriculture is one aspect of it, the other issue is also that you can use bio wastes. So, as part of normal agriculture, so if you were to use bio waste then you are not really impacting the normal agriculture; normal agriculture in the sense agriculture for the perspective of food right. So, agriculture for food this is a waste product, from this is waste product from agriculture for food.

So, to the extent that it is only a waste product from the agricultural process it does not affect the food supply chain okay. So, it does not affect. So, it does not affect food supply because you have grown some crop and you have harvested that crop. So, that crop has already been harvested and sent you to the food cycle for people to buy, it is going to you know wherever the wholesale distributors are etcetera it goes that way.

So, that is not being affected, but after the cross main part of the crop is gone, do you have a lot of waste associated with just regular agricultural process. So, that waste you can actually use as a bio fuel, in that case the first issue that we were discussing off which is competition with food resources is not an issue ok. So, that is something that we can look at.

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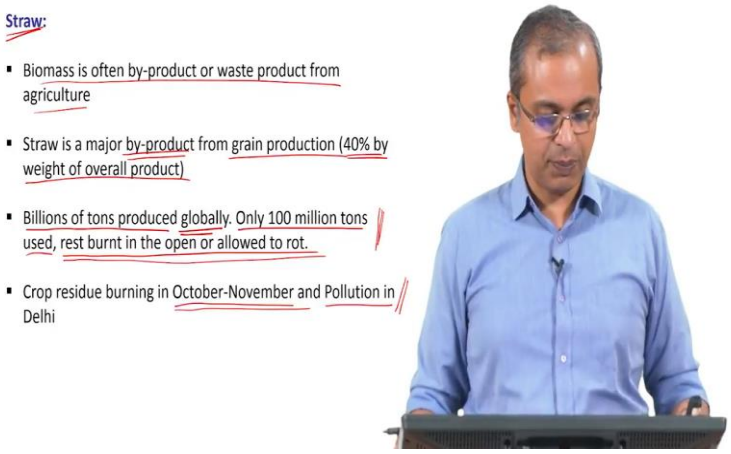

So, for example, straw that would be an excellent example of this bio based. So, to speak. So,. So, as I said you know biomass is often a byproduct of or waste product from agriculture. So, straw is a major by product straw is a major by product from grain production ok. So, any grain you produce you have plenty of straw that comes along with it. So in fact, if you look at the weight percentage, that is very significant you look at this weight percent almost 40 percent of the weight of the overall product is the straw.

So, if you have a 1 ton total product that you make right. So, 1000 kilograms you make total product. So, of which 600 kilograms would be the grain, 400 kilograms will be straw. So, for every you know ton of the total product 600 kilograms is the grain which we will take for eating purposes 400 kilograms of straw is just going to be sitting around right. So, if you can use that 400 kilograms that's a great thing to do so. In fact, if you look at it globally if you look at it globally billions of tons are being produced every year of straw billions of tons of straw is being produced every year globally.

However, only 100 million tones or so, roughly about 100 million tones is seems to be getting used in the form of biofuel or in the form of a biomass that is this you know 100 million tones of straw or any other ways that is being generated is getting converted into a fuel that is then being put into the energy sector.

The rest very unfortunately the rest of it is being burnt in the open or allowed to rot ok. So, this is a huge waste I mean we just burn it or you allow it rot. So, when you burn it you actually do damage in two way two different ways, first thing is you are releasing you are burning it and you are releasing carbon dioxide into the atmosphere right in carbon dioxide many particulate matter a lot of stuff is being released into the atmosphere, when you burn the you know straw.

Most importantly and very unfortunately in this case, you are not even using that energy you are just burning it in open that's it you are just burning it, destroying it, throwing the energy throwing the waste, throwing you know particulate matter everything into the atmosphere and nothing you are gaining from it only all the negatives you put together and handoff to society that's basically all happens when you just burn it out in the open without any other purpose being served.

So, this is what is happening unfortunately internationally. Only about 100 million tons is being used properly to generate energy and you know billions of tons out of the

billions of tons that is available all the rest of it is just being destroyed in a manner that is a highly self destructive for us right. So, that's something we have to really look at. So, for example, in India one of the things that keeps coming to our news very regularly, every year we have this thing coming to our news that if you look around October November you will see that pollution in Delhi shoots up right pollution in our capital shoots up in a very significant way.

Pollution in Delhi goes up in a very significant way typically you will hear this news around October November. Now and there will be a major spike and the pollution is really bad we are not just talking off slight increase in pollution, we are looking at situations where the amount of particulate matter in the air is 16 times ok. So, 15 to 20 times the upper permissible limit ok.

Is the upper permissible limit itself is a high limit, but they say you know up if you cross this limit it is no it is fairly dangerous to the health. Now you are not crossing you are not just. So, most of the time you want to be well below that limit, you don't want to cross say 10 percent of the limit or some such thing you want to stay well below that limit. Now not only you are not staying below the limit you are crossing the limit you are crossing it by an order of magnitude more than an order of magnitude.

So, you are crossing it by a factor of 15 or 20 that's a huge you know you have you have suddenly change the scenario of a place from being you know livable city to something that you know is extremely toxic, you cannot be there extremely dangerous. So, many times in October November last few years we have the situation that you have major shutdown in Delhi okay.

So, schools are all shut down many things are shut down, people are asked to stay indoors a people are asked to use some kind of mask to cover their noses and so on and even staying indoors, I don't know to what degree it helps because ultimately the ashes comes in. So, that tissue is there, but you have a lot of particulate matter at least if you put something or around your nose to that extent you can avoid the particulate matter, but this is happening, why is this happening?

A very significant reason this is happening is that there are a lot of agricultural activities that go on in areas that are neighboring Delhi ok. So, in states our neighboring Delhi, you have various places where there are lot of agricultural farms and it is this season when

they change from one crop to another crop and when they have harvested a crop, there's a lot of the waste of the crop that is sitting there in that form, and they need to clear that waste and then start the next crop.

So, it turns out that for many of them it economically and time wise it works out very conveniently if they just like the fire, and then they just burn that burned the place down burn the farm all the waste in the farm is just burnt. So, unfortunately the economic reality and the you know convenience of quick disposal creates this situation, where the large number of farms that is burning their waste and this seems to be fairly well documented.

They seem to be lot of reports saying that at that point huge number of farms were burning, and its a strictly there are rules which prohibit this kind of an activity, but unfortunately the ground reality is that you know due to economic reasons you know pressures various pressures etcetera this seems to be the ground reality that many people are burning their the waste in the farm.

And as a result huge amount of pollution comes up and this is dangerous even for those people, because whatever you may say even though may be the wind eventually takes the pollution into Delhi, wherever those farms are wherever that burning is happening with all these farms neighboring farms burning, people who live in those places their families they are all breathing that highly toxic air I mean highly injurious here they are breathing for several days.

So, there can be nothing good about it and maybe it is a you know a lack of understanding of the situation that and also the circumstances their circumstances that even if they understand it is not good for the health, they are in a corner where they need to really do something and they end up doing this and this is a pretty bad situation and lot of efforts have to be made to know educate them to stop this kind of burning and give them not just educate them, to give you an avenue give them an avenue.

So, for example, the straw that is the waste material that is generated there, all the you know by product of this the farming process that is lying there. So, most mostly mostly in the form of straw for example, that can easily be bundled and sent off to a plant where it can be burnt in a controlled manner and you can generate huge amount of electricity right. So, this can be done, but for that to happen this has to be economical. So, many

times the report suggests that you know if they have to actually bundled this up and take it and go and give it to a plant which will accept it, that process of bundling it the process of transporting it and going and selling it will cost them a lot more than what the companies are willing to pay them for right for that.

So, you take one kilogram of the straw and go and go and hand it off, if they are only going to give you a 100 rupees for it, but it is going to take you 500 rupees to know make that bundle put it on a truck take the truck to that place and hand it off. So, you are going to spend 500 rupees delivering it and they are going to give you 100 rupees for it. If nobody who is you know running any kind of business we will see this as economically viable and so on.

So, clearly governments need to assist them in some process to you know take care of this kind of waste disposal and and then try to do something more you know effective with respect to this. But the point being this is a reality not just in some remote international location this is a reality in our country in our nations capital ok. So, it affects our nations capital every year and in a manner that is very dramatic very visible and affects a lot of people every year you are going to see I mean you see a you end up seeing this just you will see newspaper reports that you know it is just full of smog full of smoke particulate partner matter.

You take a photograph you can barely see you know 100 meters ahead of you. It is so, heavily ridden with we smoke that has come into the city. So, this is clearly something that needs are just argent addressing, and it has got to do exactly with this idea of biomass right. So, this biomass in this case being destroyed recklessly being destroyed we just because the circumstances are like that and so, something needs to really be done about it.

And so so in terms of bio waste straw is there, unfortunately it is not being used. So, if you choose to use bio waste and you can find a way to do it economically, at least you won't affect the food supply you can actually stick to waste. I mean in a more comprehensive way you can use the entire cycle of the agricultural process from you know end to end. So, this is something that we need to keep in mind ok.

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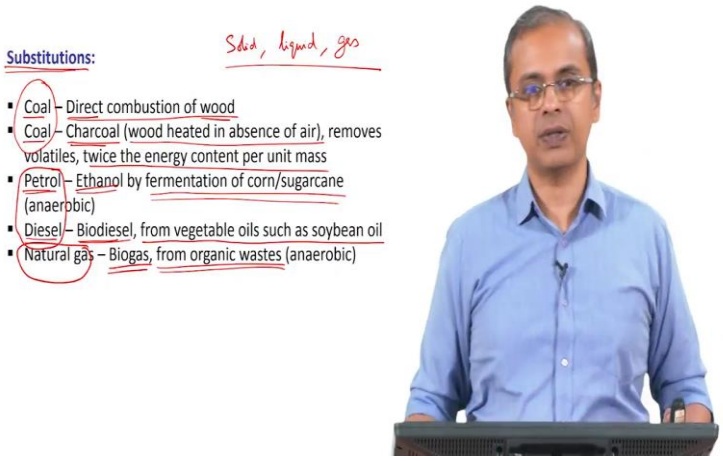

So, what kind of substitutions are people talking about when we talk of biomass in what ways is biomass being used. So, that's something that we will briefly look at. So, we do know that coal is being used extensively in thermal power plants. So, many times biomass is used as a substitute for coal and in fact, this is a major activity, because as I said the power industry is where the pressure is to say that you know we have shifted to renewable because then that can be something that is reported.

See the general public if you have somebody who is I mean poor and is using some twigs to do some cooking, it is difficult to document to what degree they are using what and then see if to what degree it has affected our power sources so, to speak whereas, the major part of our power comes from power plants. So, if you impact the way in which the power plant generates the power, that is how you report that you know you have made a change to the energy sector and you have made a change to make it cleaner or whatever it is that you are trying to project.

So, the governments put pressure on power plants and power plants find this is a nice way to proceed. So, they use coal instead of coal where they had been using previously coal, they can now additionally add wood and add. So, you have some percentage of coal some percentage of wood. So, to the extent that they add wood they have now added say 20 you put 20 percent of by mass of wood then 20 percent substitution you have done with a renewable source.

So, we will we will talk about this idea of renewable shortly, but you would treat it for the moment that it is renewable. So, we put it in as 20 percent substitution. And again as a substitute for coal instead of directly using the wood instead of directly using the wood, you can convert wood to charcoal which is basically wood heated in the absence of air. So, you first heat would in the absence of air, it will remove lot of volatile materials from it various other unnecessary things should be removed from it, what will remain would be primarily carbon and it is twice the energy content per unit mass ok. So, you can get much higher you know energy in unit mass and therefore, that is much more useful for us when we try to get you know some useful power out of it.

So, therefore, you can convert. So, you can either use the wood directly as a substitute for coal or you can take the wood convert it to charcoal and then use that as the substitute. So, this is this is way in which we are dealing with solid, solid fuel coal either as char coal or wood is the substitute. Then we have liquid form which is petrol or diesel. So, for petrol typically ethanol is used as a substitute and this is largely obtained by fermentation of corn and sugarcane anaerobic fermentation.

So, again absence of air. So, fermentation of corn and sugar is done and from that we get ethanol, and that ethanol can be used as a substitute for petrol and people have demonstrated and in fact, many patrol mixes that are out there usually have some maybe 10 percent of ethanol already mixed in it. So, each government has you know put in some rule from how much of this kind of ethanol should be there already added to the fuel, and to that degree reduces dependence on incoming supply of petrol right. So, so far petrol the substitute is the you know biomass substitute is ethanol.

Similarly, for diesel there is something called biodiesel, which is which can be derived from vegetable oils such as soybean oil. So, large amount of it is coming from vegetable oils, soybean oils, some animal fats etcetera you can all be used to create the biodiesel and this can be used directly in you know as a substitute for diesel. So, with varying levels of percentages, you can use you know this ethanol for petrol biodiesel for diesel etcetera and therefore, to that degree you change the mix of the fuel.

So, this is. So, petrol and diesel in this case our biomass being used in I mean biomass substitutes are being used for petrol and diesel. So, that is biomass substitutes in the form of liquids and then finally, you get you have natural gas which is being used by many of

us. So, that can be substituted by biogas. So, biogas can be used to substitute natural gas, and this is also derived from organic wastes.

So, we have many biogas plants, many you know farms will have biogas plants many places you can have biogas plants it generates biogas and that can be directly used for cooking in various ways. So, as I said you know solid liquid and gas in all these three you know common states of matter you can get your biomass supply you with some fuel and then you can use that. So, these are the kinds of major substitutions that are being done with respect to biomass.

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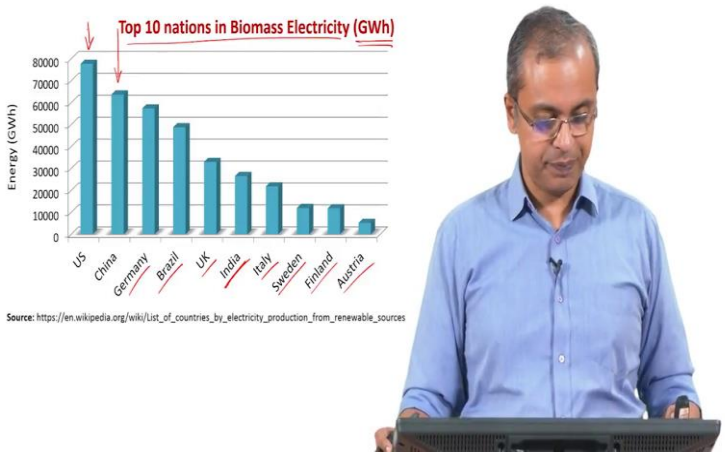

So, if you look at the top 10 nations in terms of biomass electricity in gigawatt hours. So, the usual suspects are here, United States is here, you have China then you have Germany, Brazil United Kingdom, India is also there Italy, Sweden, Finland and Austria. So, you can see a large number of nations are trying to introduce biomass and this is in you know capacity in gigawatt hours. So, of course, you have to see this as a fraction of that energy that they use.

So, that we are not really looking at this point, but this is significant amount of energy that is being generated and potential is there for this to increase dramatically because many countries can get into using this not right now not every country is actively pushing it. So, they may actually end up pushing it further and so, potential for this to grow is quite significant. Within India so, this is the overall global perspective. So, we

are you know sort of sixth. So, to speak in this list of currently you know the users of biomass as part of the renewable energy mix.

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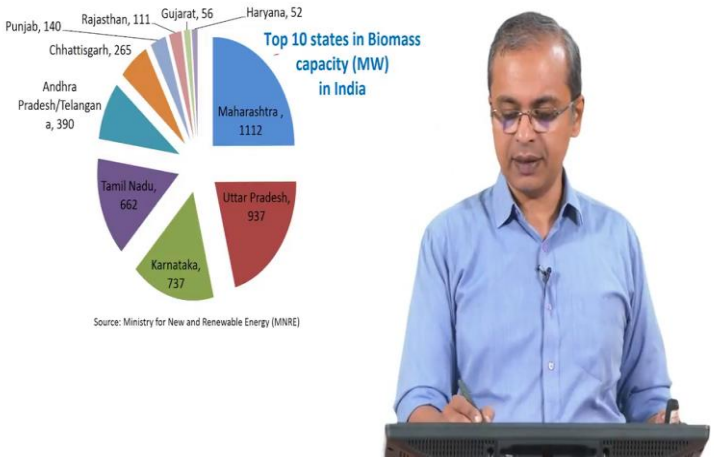

Within India if you see if you look at the top 10 states in biomass capacity in megawatts. So, we have Maharashtra second highest is Uttar Pradesh then we have Karnataka and Tamilnadu. So, Maharashtra, Uttar Pradesh, Karnataka and Tamilnadu have are 4 states that have significantly pushed in the direction of usage of biomass, we have a lot of other states also who have done some activities in this context. Andhra Pradesh and Telangana together have done you know essentially after that, Chhattisgarh, Punjab, Rajasthan, Gujarat, Haryana. So, these are all the states that are the top 10 of you know energy usage.

So, again there's a lot of variety here just the way we saw across nations, wide range of different nations contributing significantly or less significantly to the use of biomass similarly amongst the states also there's lot of variety. So, clearly here also there is room for you know significant changes or in terms of demand for biomass based on how the other states also you know look into this idea see some benefits in the idea and build on it. So, for example, Punjab and Haryana have lot of fields where they have a lot of hay so, if they want to look at it and then that is something that they can consider. So, this is what it looks like across the nation.

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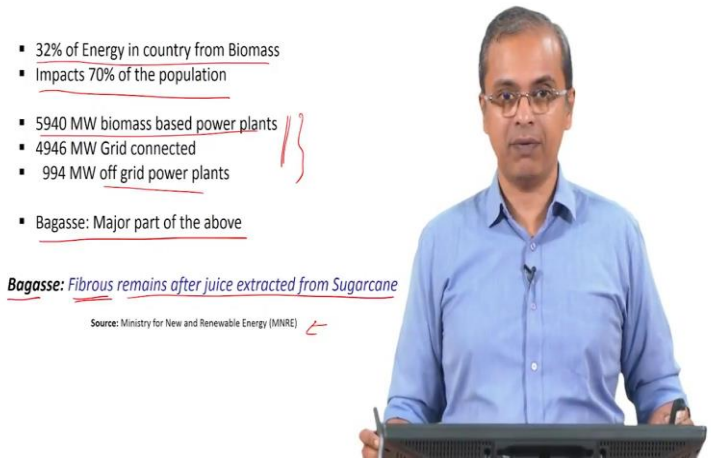

So, for example, in India Iin fact, 32 percent of the energy in the country is already coming from biomass or something like that some reasonable 30 percent of less is coming from biomass and it impacts 70 percent of the population both in terms of you know people being involved in the process people utilizing the energy etcetera.

70 percent of the people are directly or indirectly connected to this biomass usage. And we have various now kinds of plants which are either connected to the grid or you know off grid kind of plants this being the total being generated from the plants. And in all of these Bagasse is a major part of this supply.

So, what is Bagassse? Bagasse is simply fibrous remains after juice has been extracted from sugarcane. So, this is actually very interesting if you actually speak to several of the people who are involved in the sugarcane industry, who make you know who extract juice out of sugarcane and you know supply sugarcane and we use that for generating sugar or supplying it as juice etcetera. The interesting thing you will learn is that for many of them. In fact, the sugar that they get out of the sugarcane is actually a by product.

So from an economic perspective from an economic perspective sugar from sugar cane comes across to them more as a byproduct whereas, the waste that comes after you have extracted this you know juice out of the sugar cane that wastes which then they supply to the energy industry actually gives them more money from the for the overall product. So,

for say whatever you know 100 kilograms of sugar cane plants that they create, the money they will get for the sugar that they will extract out of these 100 kilograms of the plant is less than the money they will get from the waste being of those same 100 kgs of sugarcane plants being supplied to the energy industry. So, this is a very nice win situation for the sugarcane industry, because it means more parts of the plant are being effectively utilized from an economic perspective.

So, they grow a sugar cane nothing is being wasted, they get juice out of it the juice can be sold as juice the juice can be used to create sugar and what whatever waste remains it doesn't just sit there in the field, they are very happy to gather up this waste and then send it off to power plants and they get paid for that also. So, that is and they get paid more for that. So, they are very happy to do that and so, this is what is happening in our country. So, this is the source for this are MNRE. So, this data is available in the in the MNRE website.

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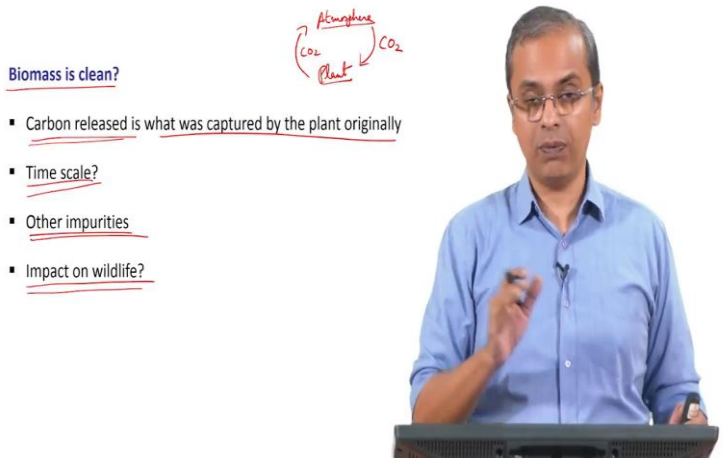

So, now let's look at this question is biomass clean ok. So, the reason people think biomass is clean its because the carbon that is released see basically you are burning something right you are burning wood, if you burn wood that has carbon it burns and it becomes carbon dioxide.

So, in that sense from a fundamental perspective, you are just putting CO_2 into the atmosphere and therefore, from that perspective alone you cannot think of it as clean you

are just burning wood and putting it out in the atmosphere you have putting carbon dioxide into the atmosphere.

So, when you supply wood to a thermal power plant, and they substitute some of the coal using wood they have not actually changed the release of CO_2 into the atmosphere CO_2 is still being released into the atmosphere. In fact, they may be releasing even more CO_2 into the atmosphere we will think to talk about that in just a moment. So, in terms of CO_2 release you are not making any difference, I mean you are actually still releasing, but the big difference is the carbon that is released the thinking the thinking is that the carbon that is released is what was captured by the plant originally. So, this is thinking slightly in the reverse cycle so, to speak.

So, we are normally saying that there is carbon dioxide in the atmosphere, we should grow plants to capture the carbon dioxide and that way we will clean up the atmosphere. So, here the thinking is reverse; that the thinking is that you take a plant that plant already captured a lot of carbon dioxide right. So, in the in the process of it growing into being a plant into a tree it already captured a lot of carbon dioxide.

So, when you now burn the plant and release the carbon dioxide you are not releasing any new carbon dioxide into the atmosphere you are only releasing the carbon dioxide that the plant originally captured from the atmosphere. So, in terms of a cycle. So, you have a plant and you have atmosphere. So, you can think of it this way. So, we are saying that this is a cycle, you take plant you burn it you get CO_2 into the atmosphere that CO_2. So, it depends on where you are starting the your cycle you can say that CO_2 was already in the atmosphere the plant captured it.

Now, you burnt it and released it back into the atmosphere. So, you have done no damage ok. So, CO_2 was already in the atmosphere this plant was grown it captured all the CO_2 and so, now, when you burn this plant you are not releasing any new CO_2. So, you are not damaging the atmosphere that is the thought process that is involved, but there are some issues first of all what about other impurities ok.

So, when you burn a plant you don't just get CO_2, you get other impurities also that are released we will see that in just a moment. So, you have more impact on the environment and just CO_2 the second thing is a time scale ok. So, what kind of time scale are we talking about that we will see in just a moment and impact on wildlife? See when you

destroy trees its not just trees that you destroy there is a lot of wildlife that depends on the tree right. So, it could be anything it could be squirrels, it could be birds, it could be any number of creatures that live on these trees which have taken years to you know get used to that ecosystem and then you just go you cut those trees down and you make wood and you are only talking of the CO_2 cycle, you are not talking of all the side impact that it causes.

So, that's another thing that you need to keep in mind when you look at the bigger picture of biomass because when you say biomass and you say this is going to help in nations energy supply, then you are talking of a large amount of biomass you are not talking of an assorted one twig being cut here or one small branch being cut there etcetera which itself may be an issue.

But what I am saying is it is not small scale we are talking of entire forest being cut down for some activity and then maybe some new things being planted there etcetera. So, you talk of something massive. So, then you have to really think look at all the impact associated with it. So, if you are going to do a large scale disturbance to the wildlife in that area there is simply by cutting down trees in a massive way, replanting them re cutting them down and so on then that's again something you cannot ignore it, you have to understand what you are trying to do on what you are doing.

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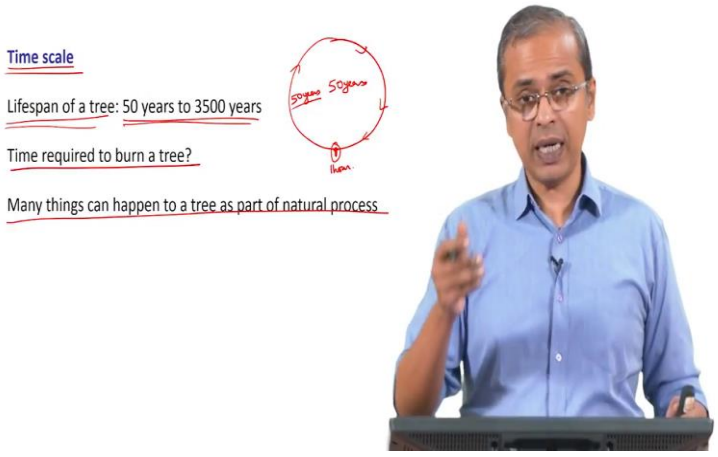

So, that is something that we have to look at. So, time scale let's look at the time scale, lifespan of a tree is anywhere from 50 years to 3500 years it based on the type of tree that you are looking at, you will find the trees have lifespan of 50 years to 3500 lives. So, when you say that the tree or you know we tree captured the carbon dioxide, it took 50 years to capture the carbon dioxide.

Please do understand even at the lower end of the spectrum lower end of the spectrum it took 50 years to capture the carbon dioxide. So, now, let's look at it, you have the life cycle of a tree let's say the circle represents 50 years of life ok. So, you start at some point and you go through this you know past the number of years, you come back it is 50 years you complete the circuit right how much time is required to burn a tree? You can burn a tree in like maybe I don't know an hour you can burn a tree in an hour.

So, you take a tree that took 50 years to grow and you burn it in one hour right and one hour one hour is barely a dot on the circle right. So, whatever carbon dioxide it captured in 50 years you release back into the atmosphere in one in one other. So, you can argue that you know the argument that is made is that many things happen to the tree the natural process it dies it rots and. So, many things can happen. So, it may anyway release some carbon dioxide into the atmosphere, that that question is always being made.

But the point is when a when a tree dries naturally in the environment, many things happened and many of the you know constituents of the tree are consumed by other creatures and therefore, it's not released into the atmosphere so, directly right. So, only a small fraction of that only a certain fraction of the carbon dioxide associated with that tree, carbon and carbon dioxide are associated with the tree gets released into the atmosphere as part of the natural you know life cycle of the tree after it dies at least in the immediate context, whereas, here within one hour you release all the carbon dioxide possible from the tree into the atmosphere.

So, we have to understand that time scale is a very important thing in the grand scheme of you know environmental protection, it doesn't matter, if you look at the urgency of the situation when you say that you know carbon dioxide content is going up faster and faster and faster in the atmosphere, we need to control the carbon dioxide content now right. So, it doesn't help if you say I will come figure out a process that after 300 years,

something will happen to the carbon dioxide which would be slightly better than what's happening now that's not how it works we would not do something now.

So, if you were looking at it from that perspective, this is actually not helping you are putting excessive amount of carbon dioxide back into the atmosphere now, you may attempt to clean it up later, but that is not now right. So, so this is something that we have to keep in mind that the time scale is important time scale is something that is not being acknowledged significantly in this process.

So, if you want to capture this carbon dioxide back within one hour right. So, you spend to it you took one tree it took 50 years to grow, and then at the end of 50 years in one hour you burned the tree you released a huge amount of carbon dioxide back into the atmosphere. Supposing you want to recapture that carbon dioxide also in one hour I am just giving one hour as an example you may be able to burn a tree down in 10 minutes also said that's not the point, I am just giving an idea that one never seems to be sufficient amount of time to burn down a tree.

So, let's assume that you burnt a tree down in one hour and you used the energy. Let's say I am not saying you just burned it to uselessly you used the energy for something, in the process all the carbon dioxide associated to that tree was released back into the atmosphere. What do you need to do to recapture that carbon dioxide in one hour that is the point you have to keep in mind?

So, if you say I am going to plant more trees to capture the carbon dioxide and therefore, it's all fine, how many trees will you put in place so, that you will recapture that carbon dioxide in one hour? We never think of it that way we simply say I burnt a tree I planted a tree. So, that tree that you are planting today will take another 50 years before it can capture the same amount of carbon dioxide you just released this hour right because that has also got to grow fully and for that it is going to take 50 years, at the end of the entire lifespan of 50 years it will capture back this carbon dioxide you released in one hour.

So, that is not at all helpful that is not at all helpful in the grand scheme of things. So, its like saying I mean. So, therefore, if you really want to say this correctly you have to say that I burnt one tree, I have planted like 500 trees or whatever some 5000 trees. And these 5000 trees will capture back this carbon dioxide in 1 hour. Then you are really actually getting close to an equation that makes sense okay maybe that may be an

extreme view of looking at it, but I am still saying pointing out the idea that you cannot just say I burnt a tree I will put a tree in and in 50 years from now it will all be that is not how it works.

So, it is in the context of time scale in two particular ways in that biomass people question you know the cleanliness of biomass. The first one is the time scale because the time scale with which you are going to release that CO_2 is nowhere close to the time scale in which you can capture it back right its so, much faster to release the CO_2 so, much slower to capture it back that is number one.

And number 2 lot of the impurities other impurities from the tree which are not there in the atmosphere will also going to be released.

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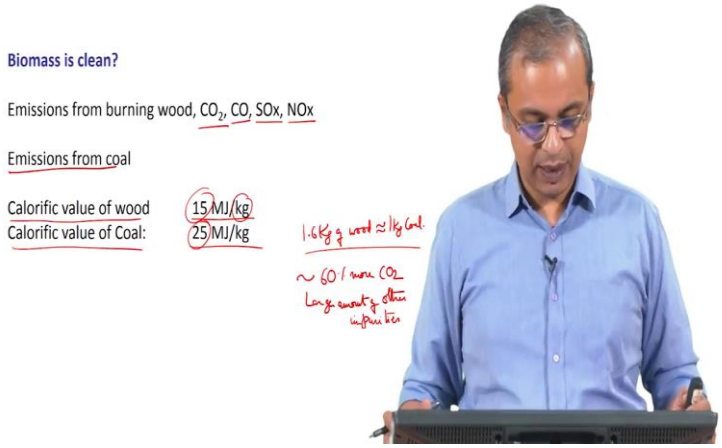

Such as you know you are going to get CO_2, you are going to get carbon monoxide, you are going to get sulfur oxides, you are getting nitrogen oxides. So, these are other gases that you are putting into the atmosphere which could be even more harmful than CO 2, and those are all coming from the tree. And also you have to understand if you are saying it is clean, you keep saying it is clean you have to understand what is the context again if you look at it the calorific value of wood is significantly less than the calorific value of coal.

So, it means if you are going to substitute some coal you are going to remove some coal from the mix of fuel, and then re substitute that with I mean substitute that with wood saying that you know I will remove 10 percent of coal I will substitute back with I mean 10 percent of coal I will remove I will substitute that with wood you cannot substitute back with 10 percent wood you have to substitute back with almost say 15 or 18 percent wood, to make up for this difference this 15 versus 25.

Right. So, if you removed 1 kg you have removed 25 mega joules, you cannot put one kg of wood you have to put more than one kg of wood you have to you might have to put about 1.6 kgs of wood. So, 1 kg 1.6 kg of wood 1 kg coal right in terms of energy. So, 1.6 times will get you that you know another 10 mega joules roughly and that will get us to this 1 kg coal. So, if you burn 1.6 kg. So, 60 percent more or something like 60 percent more CO_2 or some it may not be exactly 60 percent some number some larger amount of CO_2 is going to be released to get you this same amount of energy right. So, so you are and 60 a certainly larger amount of other impurities as well.

Something some 60 may not be exactly 60 percent, maybe some other number because you may have to account for various other aspects associated with it, but some number. So, it's going to be higher that's the point right so. So, therefore, when we say it is clean you have to question it from a number of perspectives and these are perspectives that are very relevant perspectives to look at.

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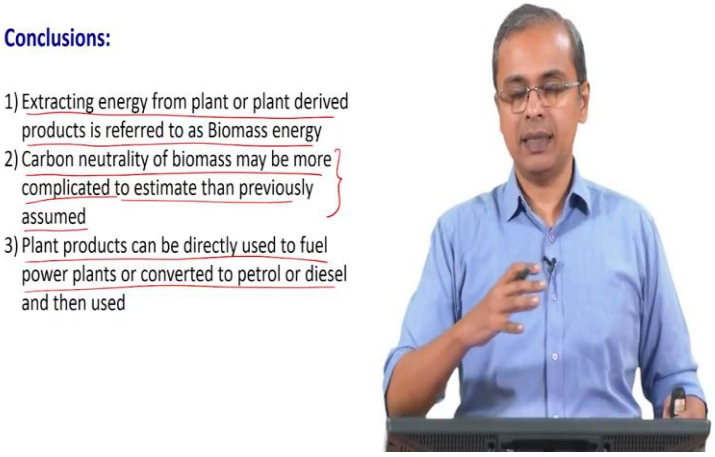

So, in conclusion extracting energy from plant or plant derived products is referred to as biomass energy and we saw that biomass energy can be available to us in solid form, in liquid form, and in gas form and therefore, it very nicely substitutes for already existing fuel lines which are in solid form, liquid form or gas form and a significant amount of population can benefit from it economically because it opens up a supply chain, where they are directly involved it is not just a oil company which has drilled a hole into the ground that is involved.

So, that for it is very nice; however, there are issues in the in the sense that when you talk of carbon neutrality of biomass that is carbon neutrality from the perspective that whatever carbon was captured is the only carbon that has been released and therefore, it is carbon neutral, but we it is complicated because you have to keep in mind things like timescales and so on.

I also spoke about the fact that environmental impact from the perspective of how other say wildlife is affected by this process also needs to be kept in mind. And therefore, when you say it is renewable that is true it is renewable when you say it is clean you have to look at it a little greater care to understand what we mean by clean and then you have to define that and accept that within that context is what you are talking.

And then finally, if you look at it you find that plant products can either be directly used as fuel to power plants or can be converted to petrol or diesel and then be used. So, it is you know a significant activity that is on which impacts the way our energy is supplied to us and used by us, and has a lot of ramifications from the perspective of the environment as well as economy and the lives of people. So, that's the you know sum when a substance of the biomass as you know as a discussion and the sort of gives you an overview of this area.

Thank you.

KEYWORDS:

Biomass; Biowaste; Anaerobic Fermentation of Sugar and Corn; Ethanol; Biogas; Organic Wastes; Bagasse; Carbon Dioxide; Calorific Value; Carbon Neutrality

LECTURE:

Definition of Biomass energy, and its stand on whether it’s a clean energy or not is discussed. The pros and cons of extracting energy from Biomass is discussed.