Energy Resources, Economics, and Sustainability

Prof. Pratham Arora

Hydro and Renewable Energy Department

Indian Institute of Technology Roorkee, Roorkee, India

Week – 06

Lecture – 02

Lecture 28 - Global Climate Change Myths

Hello everyone, welcome back to the course, Energy Resources, Economics and Sustainability. In the past few classes, we have been discussing the issue of climate global change and specifically in the last class we have been discussing the different international agreements, treaties and protocols that were brought in specifically to counter this very important issue of global climate change. But we also see that this particular issue has been spinning around with many myths. We have been talking about this specific issue in the popular literature. We would have many social media talking about it, bringing it with the pros and the cons. Some still think that global climate change is not a reality, it's just propaganda.

And then there is another community as well who are trying to intensify the effects of global climate change as it is a doomsday that is approaching. So let us try to focus on this class to have a balanced opinion between the different myths that have been roaming around this important issue. Further, the myths have also gained a lot of importance because it is one of the issues that has implications in terms of the global treaties, the environment and threats, as well as the economic and social repercussions that are linked to it. We see that we have different scientists, politicians, economists and people in the media talking a lot about it.

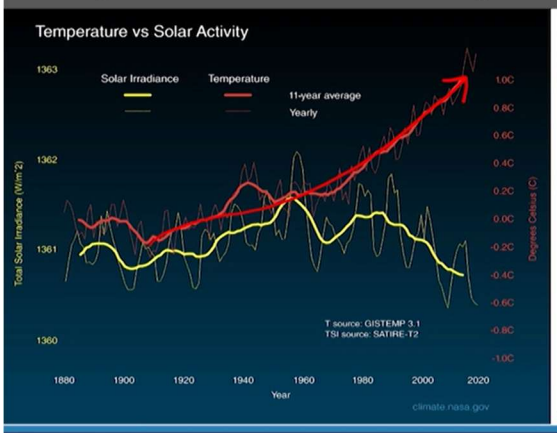
Myths and realities related to GCC

- The GCC is a unique, global, environmental threat with tremendous economic and social repercussions.
- It has attracted the attention of everyone, including scientists, politicians, economists, and the mass information media.
- The general public is frequently bombarded with "news" that encompass opinions of individuals who are often unfamiliar with basic science.
- The tendency of the mass media to "create a balance in every story" further complicates matters.

Source: Michaelides, E. E. (2018). Energy, the environment, and sustainability. CRC press.

And not everyone who talks about this important issue is having a scientific understanding of the underlying phenomena. And this is what we'll try to focus in the current class. We'll try to have a balanced opinion about the different myths, the different kinds of statements that we keep on reading about or that is related to the global climate change. And we'll try to analyse the statements from a scientific point of view. And let's go through these statements one by one.

Myth 1: There is no global warming; the global temperature variability is due to solar activity.



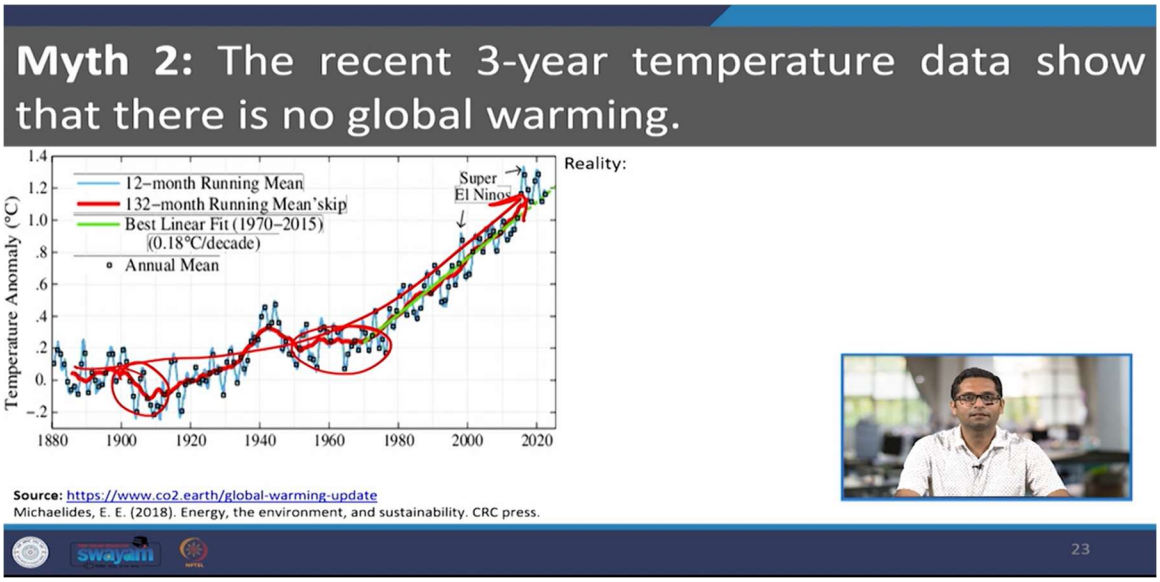
Reality: While solar activity affects the total radiation from the sun and the earth's temperature, solar activity is almost periodic with a timescale of 22 years.

Source: NASA

So one of these basic statements that we keep on hearing is that there is no global warming for say it's basically a small climate change. The global temperature has always

been changing in the history and it's basically a solar activity that keeps on changing. Well, there is truth to this. The solar activities does have a phenomena that increases the radiation of the sun and the earth's temperature. And this particular phenomena typically has a cycle of 22 years. So as you can see on the graph on the left and what you see in the yellow is basically the solar irradiance and how it has been oscillating in the past century or so. There has been ups and downs in terms of the solar irradiance that enters the surface of the earth and this is also very nicely coupled with the temperature it would bring in. So if this particular phenomena was to be there, there would be oscillations in the temperature ups and downs. But if you specifically see the temperature rise that has been happening for the past 70, 80 years or so, it has had an upward trend.

And this is no more an oscillation that would be triggered by a solar activity which is in the form of oscillations. So of course there is truth that the solar activity or the radiation that enter into the earth's surface have been oscillating and this affects the temperature of the earth. But if we see the temperature data for the past century, it has been more or less rising and it has been rising continuously. And this particular rise is very nicely correlated with the use of fossil fuels. It started with the onset of industrial evolutions and it has been nicely correlated with increasing economic development that has been happening in the major parts of the world.



Another statement that we might be reading or seeing is that in the recent 3 years or so the data shows that there is no global warming, temperature has been almost constant.

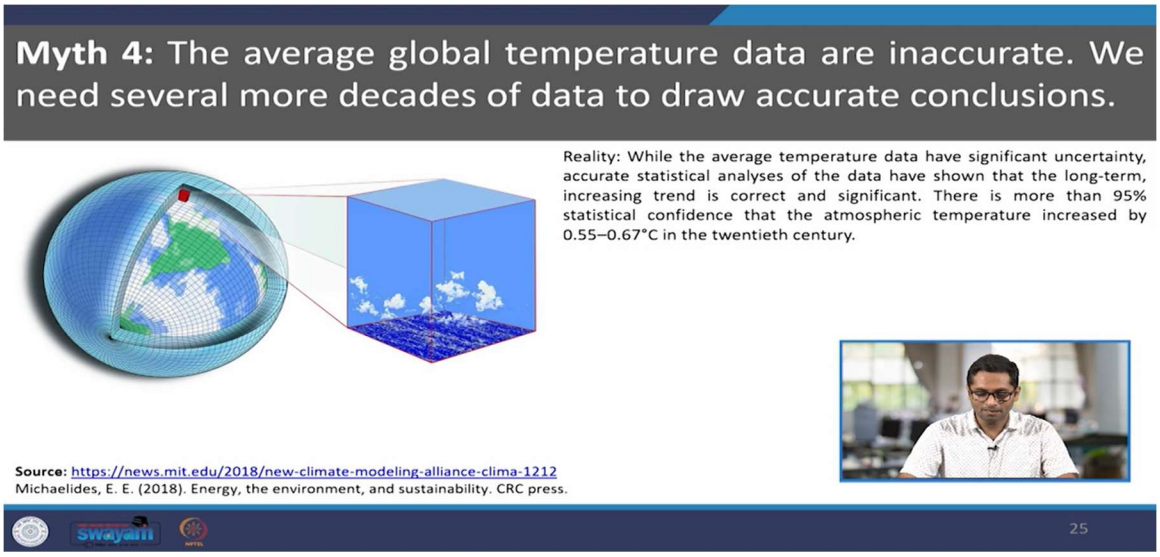
And again there is some truth to this. There have been span of a few years when there was stagnation in the temperature of the world. So if you see the graph in front of you, we see that there have been years specifically the years around 1910 or around 1914 when there was a stagnation or even reduction in the global temperature. Further we see that the temperatures around 1960s to 1970s again were stagnant and in some years there was a reduction as well. But again climate change or the temperature rise is a very long term phenomena and it should be looked with that lens. And if we see over the whole of the century, say if we consider the data how it has been changing from the 1880s or 1900s since till the very past till around 2020s, we see there has been an increase. And a better estimate of this increase could be an average of maybe 5 years, 6 years, 7 years and in that data we see there has been a continuous increase. So if we see the temperatures it has had a continuous increase. And of course there have been periods of stagnation or even reduction that might be therefore 2 to 3 years or 5 years but even after that span of 5 years is over there is again a rise.

And many of these reductions or stagnation could be attributed to the global phenomena such as El Niños and La Niñas which are basically the movement of the ocean currents that affect the global temperatures. But over the long term there has always been or in the past century there has been a consecutive rise in the temperature of the planet Earth.

Further, there can be statements like how can we have global warming? Like just in the month of maybe December or January I went to a nearby hill station, take for example

Mussoorie, it was covered with snow, I played with the snow, we made snowmen and did all sorts of enjoyment, had there been a global warming how could I be seeing snow there. Now here we should bring in the difference between weather and climate. So we should refer to the earlier discussion that we have that weather is a short term phenomena whereas climate is a long term phenomena that is which we are more interested in.

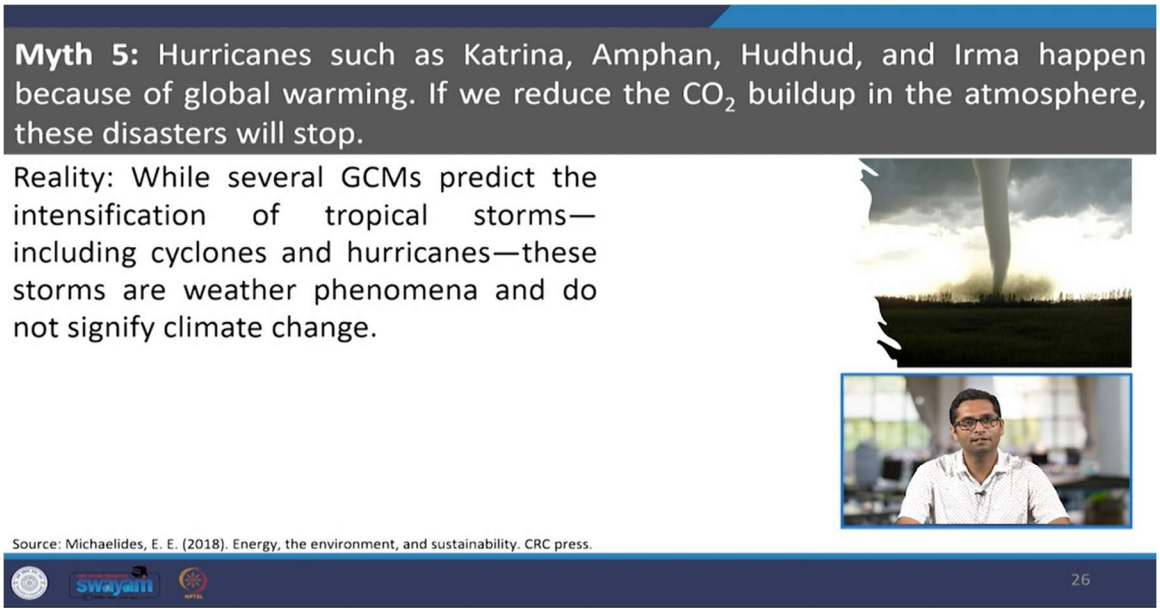
Even if there was a global temperature rise of say a few degrees Celsius it would not mean that there would be no snowfall happening in Mussoorie or any of the North Indian states say Kashmir, Uttarakhand, Himachal. There are going to be snow days, there are going to be snow blizzards, no one is stopping that, but the overall the average temperature is going to rise that is what we mean. It is not that there is going to be no snowfall as such. So the phenomena might reduce, might become lesser as we proceed in the future but still there are going to be few days when the place is going to experience snowfall or a cold climate.



Then there could be some kind of accusations or statements like the global temperature data are incorrect. We need several decades of data to do accurate results. There might be conclusions that the observation that have been made on the temperature rise span to only a few decades and if you look at the accuracy, the accuracy has been good only for the recent few years. And so we do not yet have good amount of data to make conclusions that the global temperature is indeed rising. It is reaching a few levels which might have serious consequences and this is what these are the type of statements people will be

making. But if we consider the different types of global climatic models that are available by the different leading labs of the world, they are all in agreement and they have more than 95% confidence that there is an indeed an atmospheric temperature rise and the temperature for the 20th century has indeed increased for somewhere between 0.55 to 0.67 degrees Celsius. So there is a complete agreement on the increase in the temperature that is happening and this has been in agreement by the different leading labs of the different countries. So most of them agree that the data that we have been collecting is quite apt. The models that they have been relying on are quite robust. Of course there are inefficiency in any models.

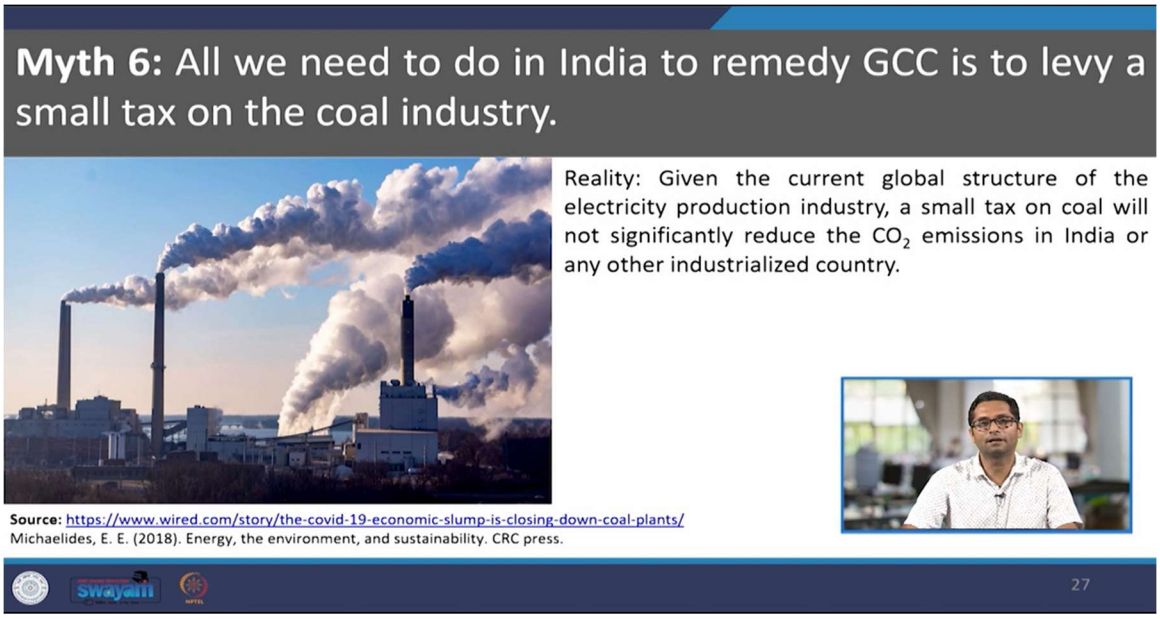
So there is a popular statement that goes in that says that essentially all models are wrong but some models are useful. So given that if we point out the inaccuracy of any model we can find that but the models have been useful in coming up with useful output in the creation of scenarios to understand how the problem of global climate change is progressing and how the different types of intervention can help deal with these kinds of analysis.



Further there could be another statement which says that it has been an understanding with the rise in the global warming there would be an increase in intensive weather events like hurricanes and we see a lot of hurricanes that have been happening in the past two decades. Some examples could be Katrina, Amphan, Hudhud, Irma and it is and a lot

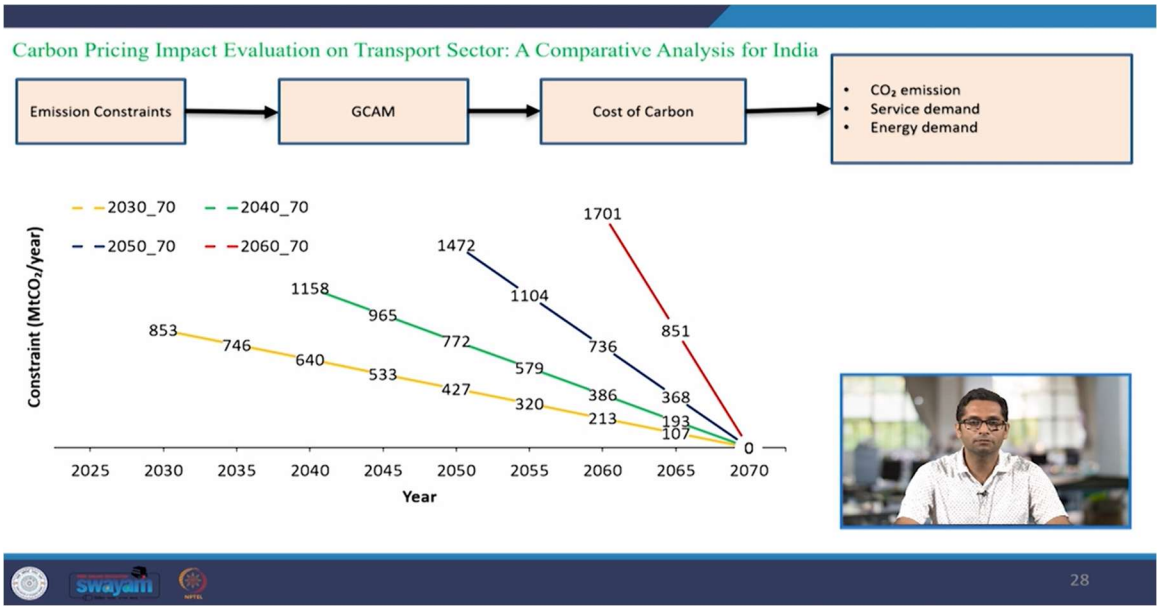
of time these hurricanes or the destruction that the hurricanes have been causing has been attributed to the global warming. And so if we reduce the CO2 build up in the atmosphere that these disasters will stop.

Well we need to correct ourselves we need to understand that hurricanes have been there for many centuries. We have been hearing about extreme weather events for many centuries at that point there was no global warming coming into being there was no fossil fuels being used but still the extreme weather events were occurring. It is only that the intensity or the frequency of these events have increased with the introduction or with the increase of the climate change or the global warming problem. So even if we go back to the pristine environment maybe 200 years back or so it is not that there would be no more hurricanes. These hurricanes are weather phenomena that will keep on happening. It is only the intensity which has been aggravated because of the extreme weather conditions might subside and we might see less of these events happening but it is not that these events will stop happening all of a sudden if we have zero CO2 emissions or something similar.



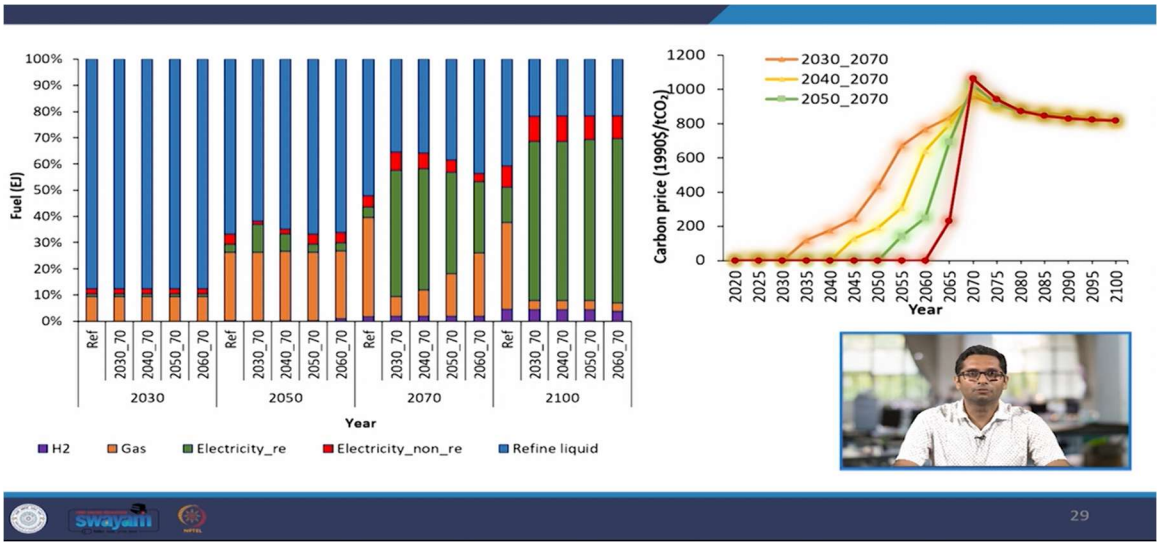
Then there could be another statement that in India we can simply solve the problem of global climate change and what we have to do is put a small tax on the coal industry. We already have something called as a coal cess and so we just tax it the coal industry to some level and this would mean that the renewables become at par with the coal based

power and people will adopt the renewable power and it is very easy in that sort. Well it is very easier said than done like the amount of CO2 that is coming out from this typical coal based power plant is very huge. Even today in India more than 50% of the electricity that we are generating is coming from coal based power plant and the shift from coal based power plant to a renewable based power is not going to happen in a very quick fashion. It is going to take its own time and a small tax would be appreciable might help in accelerating to a bit accelerating the transition to a bit but it is not going to change things much because as such not many policies have a coal tax. In India recently there have been talks about the carbon trading systems and it is expected to come up quite nicely in the future but the inter cases of this carbon trading systems are still to be looked into.

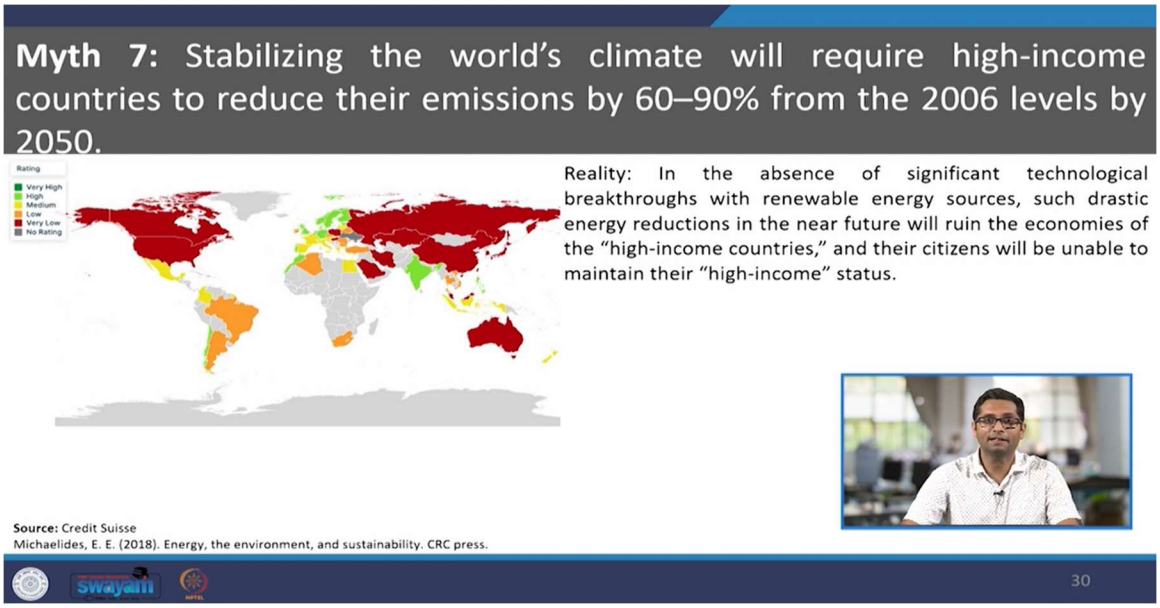


I would also like to point you people to a similar study that we did for the transportation sector in India wherein we tried to see what would be the carbon tax that would be needed to make the transportation sector to be net zero. Now transportation sector itself has its own integrities like there are options like EVs or hydrogen vehicles that might be easier to implement as compared to others. When I say easier it is in terms of like it is very hard to decarbonize the marine sector or the air sector the aeroplanes and the big cargo ships that we are running are very difficult to be run on green power and if we

would have to shift to cleaner fuels for these two particular sectors it would also entail a good amount of carbon tax.

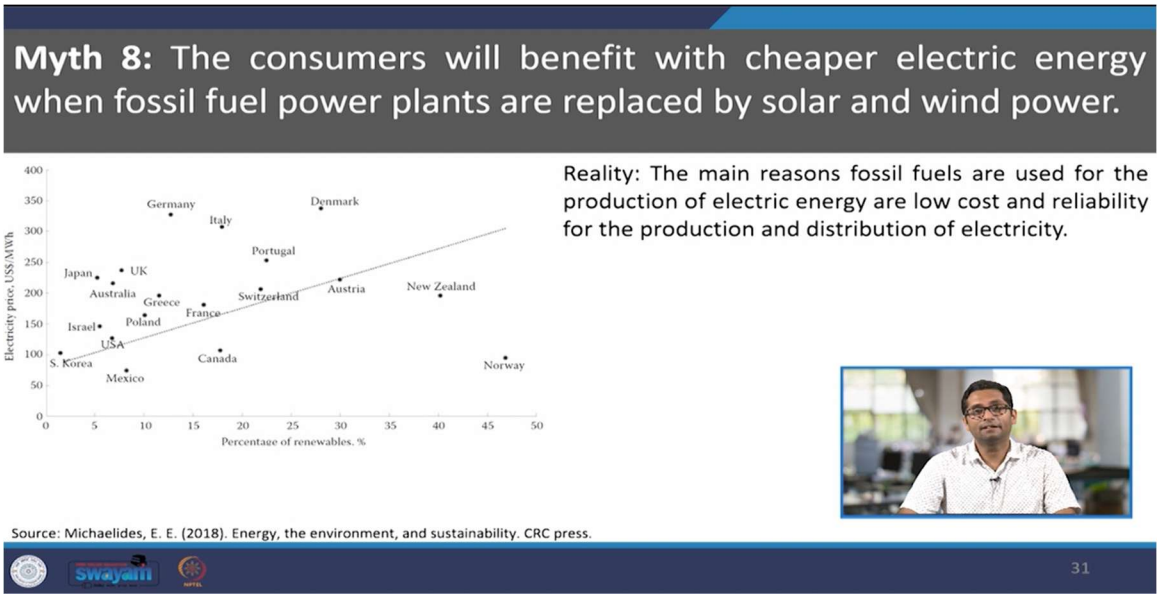


So we did an analysis and tried to understand what would be the range of carbon tax that would be needed for achieving these kind of transition and it happened like for a complete net zero transportation sector we would have a very high carbon tax of more than like 1000 dollars per ton of CO2 and just for comparison the normal carbon credits that you get for trading a ton of carbon somewhere is somewhere around 20 dollars or so in the developed world might be 50 dollars or so. So the carbon tax that might would have to be put in to bring in the complete decarbonization of any particular sector might have very high values.



Further there are other statements like stabilizing the world's climate will require high income countries to reduce their emissions by 60 to 90% from the 2006 levels by 2050. Of course that is a welcome step and this is what they are expected to do as well but it cannot happen that it is only the high income countries making all the transition. I would just want to point you towards the example that we did in the last class where we saw that if the countries like US or Canada were almost reducing their emissions by half and we were increasing the emissions of countries like India and Indonesia to almost close to world average still there would be a drastic increase in the CO2 emissions.

Further we need to also understand that in the absence of the technological breakthroughs that might happen in the renewable energy resources such energy reductions if that happens in the near future would cause the economies of high income countries to have a very heavy penalty and the citizens of these so called high income countries might not be able to maintain their high income status which they are currently doing and there are going to be difficulties for the world to agree to a common strategy and this is a cause of concern and that is what calls for all the countries of the world to come together to tackle this important issue of climate change.



Then there are also some kind of statements being made that the consumer will benefit from the cheap electrical energy from fossil fuel sorry cheap electrical energy when the fossil fuels are replaced by solar wind power. So yes we have seen great amount of

economic progress that have been happening in the solar and the wind energy in many parts of the world and also in India we can see that direct solar and wind energy production happens to be sometimes cheaper than the electricity that is produced from fossil fuels in terms of coal that is again a truth but overall if we see we can see the graph on the left hand side with the increase in the percentage of renewables we also see an increase in the electricity price that has been noticed by the different countries of the world and this is specifically because these sources of energy like solar or wind are not available round the clock which means they have to be stored there are going to be seasons when they are going to perform much better and there are going to be some time periods where the production is not going to be up to the mark and what would you do when the production is not up to the mark specifically you would have to go for some kind of storage mechanisms and when the storage is brought into being the prices of the electricity that you would use is expected to increase in a very high manner and so it's the cost and that we would have to pay for reliability. So coal natural gas based and natural gas based power has been used as a major form of energy because it was one of the reliable source of energy it didn't had a change that is happening on day or night or the seasonal change whereas that's not the reality with solar and wind and if we go towards the different types of storage mechanisms they are going to be additional cost.

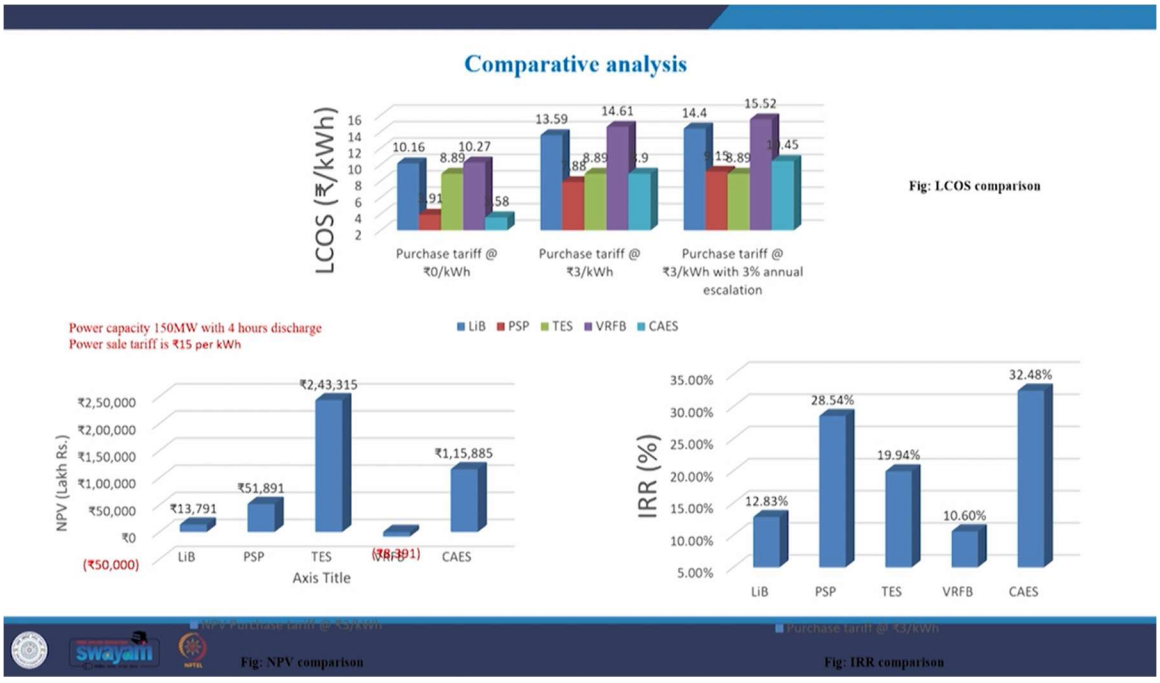
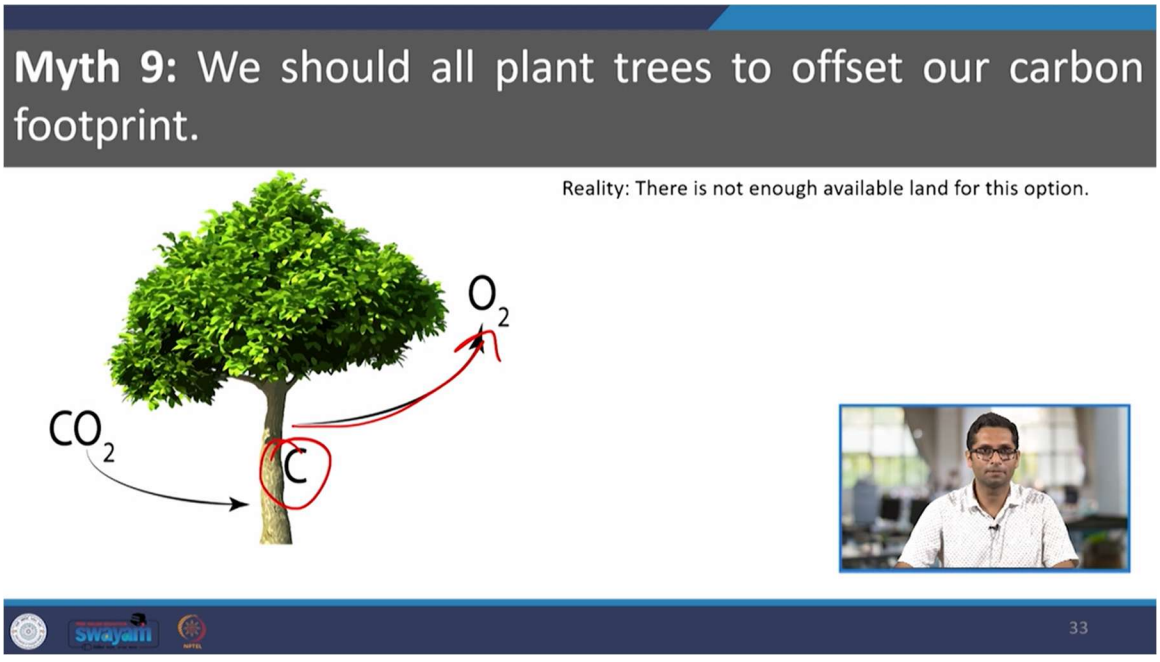


Fig: LCOS comparison

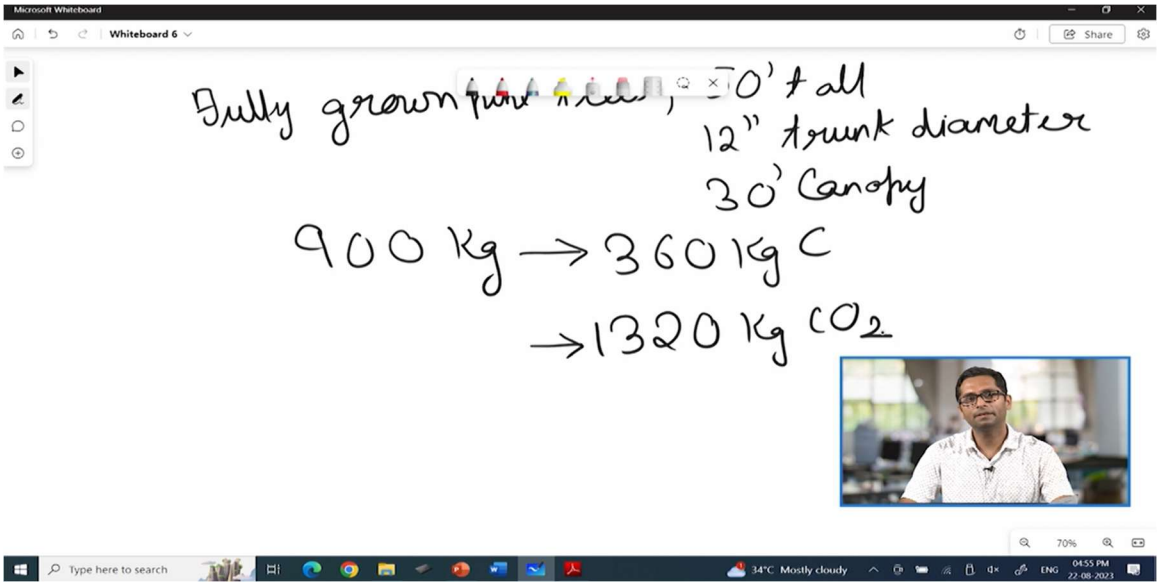
Fig: NPV comparison

Fig: IRR comparison

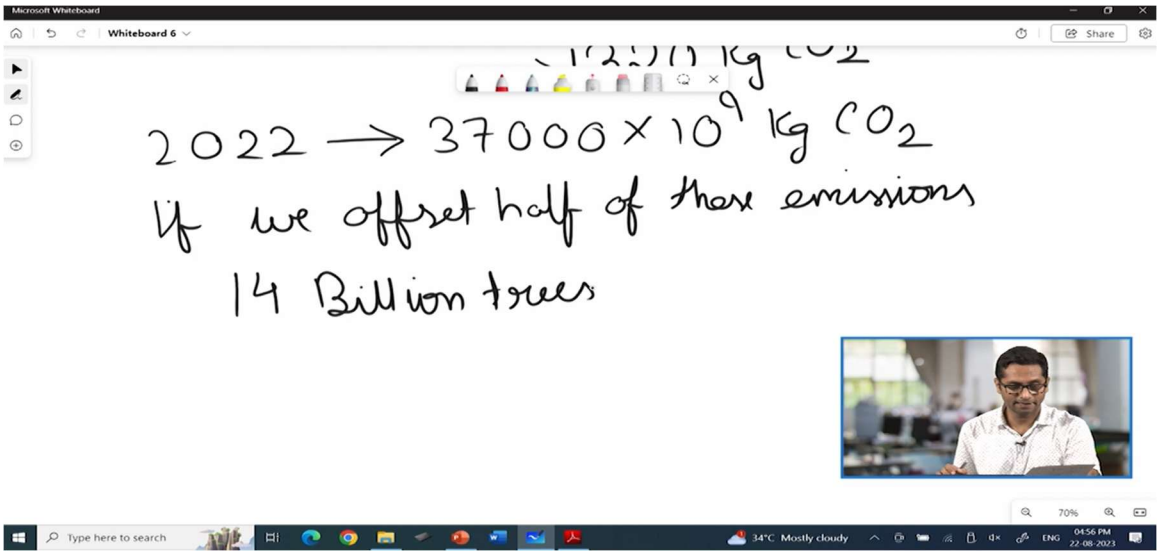
So we did this analysis for specifically for India and we tried to analyse the different types of grid based storage systems for India which included the lithium ion batteries and the pump storage and the thermal energy storage the vanadium flow batteries and compressed air systems and our estimates that we derived was like this cost of storage in terms of per unit of electricity in kilowatt hour could range somewhere between 3.5 rupees to 10 rupees of extra. So if you are the solar is producing electricity at say 3 rupees a unit and if you would have to store some units the stored energy would cost you around 13 rupees or so if you are going for batteries and it could be a bit lesser if you go for other types of energy storage but these are some of the estimates that we have tried to derive and of course some of these are hypothetical cases as well but there is a significant energy penalty that you would have to pay if you would have to go for reliable renewable energy.



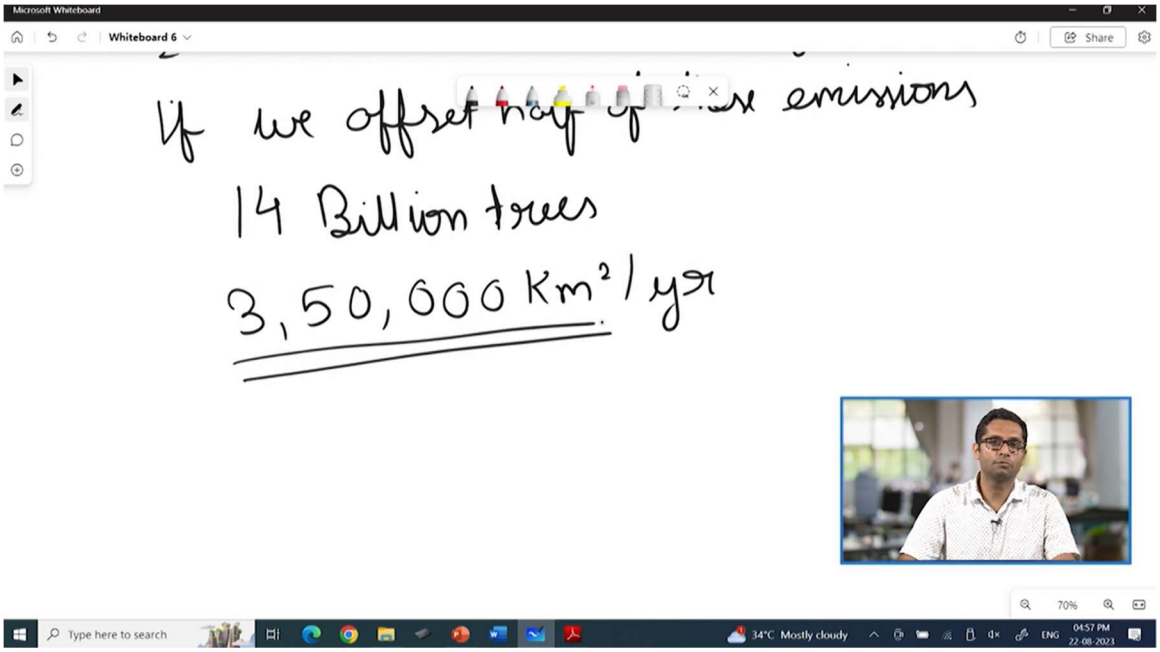
Then there is another statement that has been put that says that we should all plant trees to offset the carbon footprint. So as the normal understanding goes and there are trees would be taking in CO2 the carbon is captured by the tree for the production of biomass and the oxygen is released back into the atmosphere. Well if we go let us do a try to do a simple calculation to understand this particular pathway and let us go to the whiteboard to make a simple calculation.



So suppose I take into account a fully grown pine tree. So pine trees are the tall trees that you find in the mountainous regions and the typical dimensions of the tree that I take in is around 50 feet tall a considerable height around 12 inch of trunk diameter and around 30 feet of canopy. If I take a typical tree like this which has a 30 feet of canopy and 50 feet tall and the typical weight of this particular tree is going to be around 900 kgs a fully grown tree and this is expected to have or store around 360 kgs of carbon considering it will have almost 40% of the carbon the rest being oxygen and hydrogen so this is the normal formula and this particular kgs of carbon if I multiply that with 44 and divide by 12 in its potential to produce CO2 this has the potential to basically sequester around 1320 kgs of CO2.

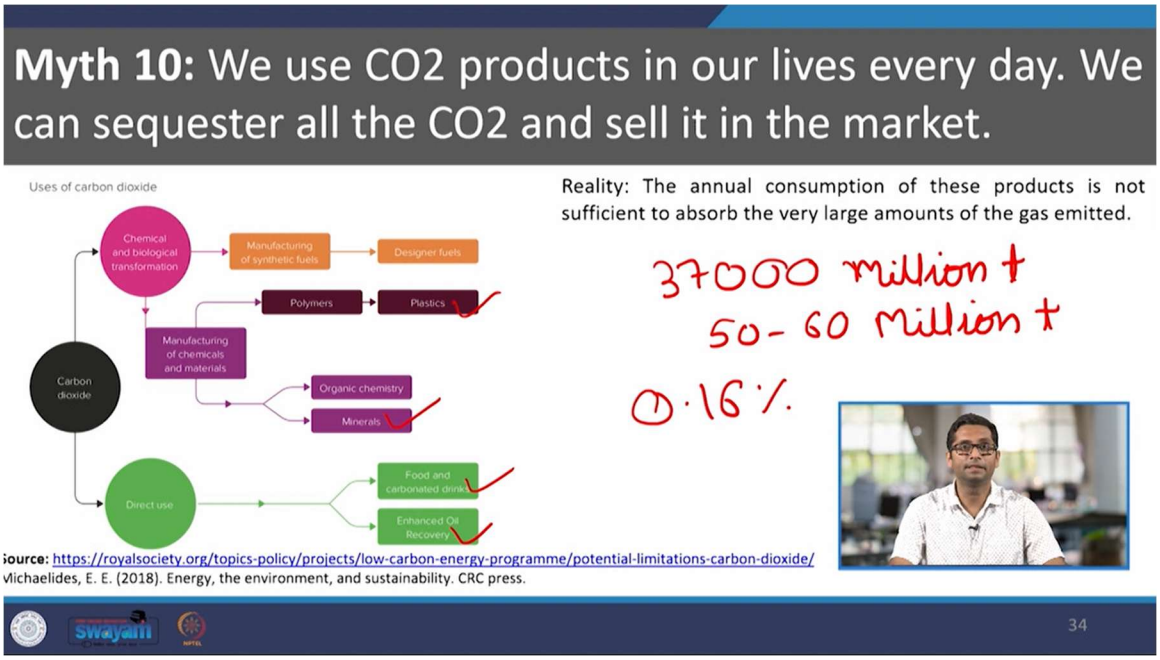


So I am taking another typical pine tree weight is around 900 kgs and it is going to sequester around 1320 kgs of CO2 during its growth to the present weight and if I consider the year 2022 the total emissions globally were 37000 billion kgs so these were the global emissions and if I would have to offset just half of these emissions by planting more trees. So that would we just divide the total emissions by the capacity of single tree and this would approximately require around 14 billion trees.



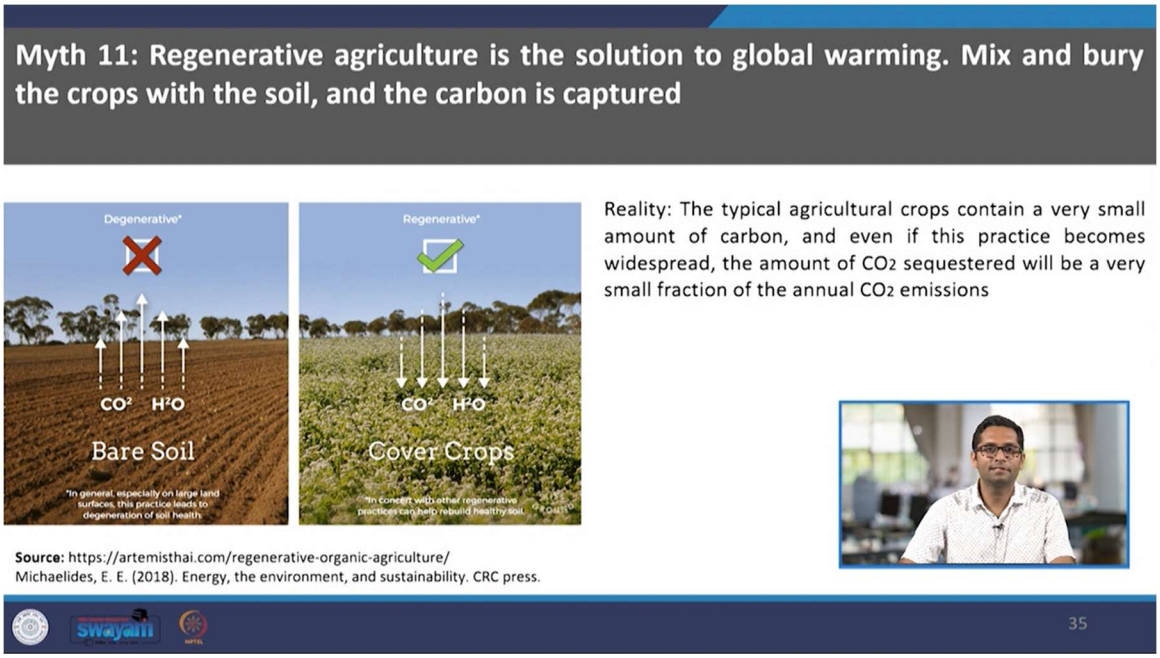
And area that would be required for planting all these trees would be roughly 3 lakh 50,000 km2 and this is the emissions for one year. So this amount of area is roughly equal to the area that is basically acquired or that is for a country like Germany or Finland and if you want to see for India like the largest state of India that is Rajasthan has an area of almost this range around 3,47,000 km2.

So you would need area of the size of Rajasthan every year if you would want to sequester half of the total CO2 emissions that are happening globally. So of course planting trees does have its own benefits it is an activity that should be encouraged but we also need to be realistic that the potential that the growing of future trees have in curbing or sequestering the CO2 emissions that we have on a global level. If you go back to the slides so we just need to understand that there is not enough space available for this particular option.



There are also things that we use a lot of CO2 products in our lives a typical example could be the carbonated beverages that we drink or another example could be in the urea that we use as a fertilizer they all need CO2 for their manufacturing and if we use these if we capture CO2 and use them in this products possibly we can curb the CO2 emissions. But again here again we need to understand what the reality is the global emissions as we have discussed are of the tune of around 37,000 million tons.

So this is the global CO2 emissions whereas all the consumption of CO2 that be it for the direct use in terms of the carbonated drinks or the enhanced oil recovery or for the manufacture of different plastics or minerals are somewhere around 50 to 60 million tons. So again there is an order of magnitude difference here so what we can utilize the amount of CO2 that we can utilize for our activities somewhere around 0.16%. So even not 1% of the CO2 that is being generated we can use for our day to day activities. So we need to be realistic in this case.



Another argument that has been put in like there are many options and one particular option is regenerative agriculture where the aim is to keep the field covered so the top soil losses are not much. There could be some carbon sequestration that is happening and further because the carbon because the roots of these crops are within the soil and after the crops are harvested the roots tend to be in the soil and there is some kind of sequestration that is happening. Of course this is a good practice should be encouraged different kinds of green agriculture or organic agriculture, permaculture, regenerative agriculture should be encouraged. But we should be realistic about the ability of these particular pathways in curbing the global CO2 emissions. Of course they do sequester a small part of CO2 but as compared to the total CO2 emissions that are happening because of the anthropogenic activities their potential is quite small.

Myth 12: We should not rush to take any measures about CO_2 emissions because scientists still disagree on global warming

Source: Michaelides, E. E. (2018). Energy, the environment, and sustainability. CRC press.
https://www.europarl.europa.eu/committees/de/product/product-details/20221219CHE11181

Then there is another myth which says like we should not rush to take any measures about CO2 because scientists still disagree on the global warming. Well there have been saying that there are a lot of scientists who say that global warming is a myth. Well if we see a majority of the scientific committee they are in agreement that it is no longer a myth and there are scientific observations and there have been more than 95% acceptance that global warming in itself is a reality. So we should go with the majority of the scientific community and that which accepts that global warming is not a fake news but is something real that all of us are facing.

Myth 13: POLAR BEAR NUMBERS ARE INCREASING

Reality: Climate change is the biggest threat faced by polar bears.

Source: https://www.wwf.org.uk/updates/here-are-10-myths-about-climate-change

Another statement that you might come across would be the number of polar bears in the Arctic region are increasing and so how can the global warming be real? Well to some extent the number of these animals are increasing but we also need to be realistic that because of the global warming the area of the land of the Arctic is also continuously reducing in terms of ice which also means there is going to be loss of habitat for these particular animals specifically the polar bears and there have been studies which suggest that there could be a loss of around 30% of the populations of polar bears just because of the effects of global warming. So of course the numbers of animals might be increasing because of certain aspects which are being brought in by the different types of rules or different types of agreements but if you see the long term effects that might have detrimental effects in some of the species of life.

Further an exaggeration to this particular aspect could be animal will adopt to climate change. Well this is not our truth this is a reality this is something we all understand that the different forms of life have been very good in adapting to the features but the problem is that not each and every organism will be able to adapt it is only going to be the survival of the fittest. There is there are going to be many significant population among a particular species who are not who will not be able to adapt and might not be able to have a good future. So something similar to the polar bears it is not that the polar bears are

going to get extinct but the survival is going to reduce the number and something similar can be expected for the other species of life as well.

But as the saying goes on like the life is going to go on it is going to adapt to the different new climate but again it is going to have serious consequences and people would have to face different hardships and there is going to be economic penalties or the social penalties that people would have to pay but over the whole it is not something it is like a doomsday that everything is going to finish it is not going to happen that day but it is going to lead to different problems which might impact us in economically, environmentally, socially. So with this we have tried to discuss some of the major myths and realities that we keep on reading in the popular literature or the news and we have tried to gain an understanding of these of some of these statements. With this we take a break for the current class. Thank you.