Petroleum Economics and Management
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Module - 04
Price of Oil
Lecture - 18
Sector wise use of oil

Hi everyone, I am Dr. Anwesha Aditya your instructor for the course of Petroleum Economics and Management. So, if you remember we were in module 4 of our course where we are analyzing the movement of oil price over time. Now, we have already discussed the oil price movement from 1970s to 2010. Now, we will be going onwards, but before that we need to discuss the Sector wise use of oil. How oil use is being changed over time, how it is evolving over time.

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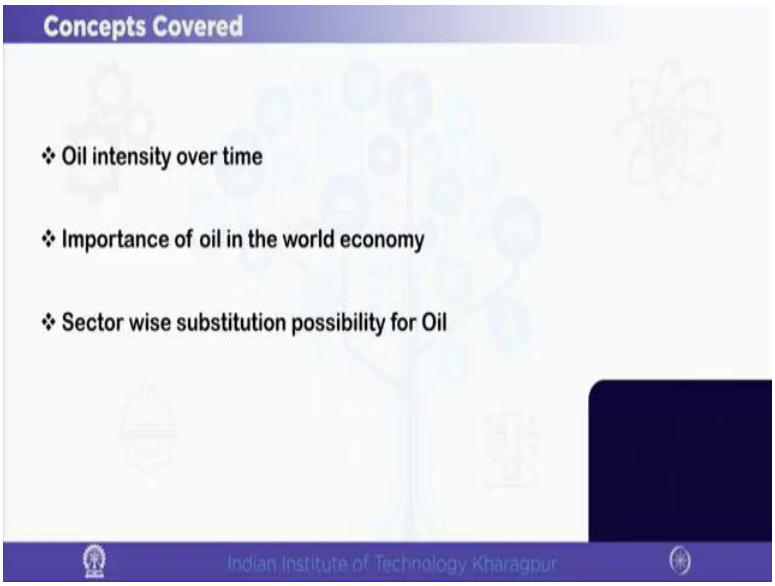

So, with this idea in mind I have designed today's lecture. So, we will be discussing how the oil intensity is changing overall and across the countries. Oil intensity means the use the importance of oil in GDP and then we will be also discussing the importance of oil in world economy and finally we will be studying the sector wise substitution that has been going on in oil, since the first oil price shock we experienced in the early 1970s.

So, since oil price started increasing, as we are already discussing in the previous modules. So, how this oil price shock is impacting the use of oil across sectors and how in the energy sector oil is gradually being replaced. We will be studying these things in more detail in today's lecture.

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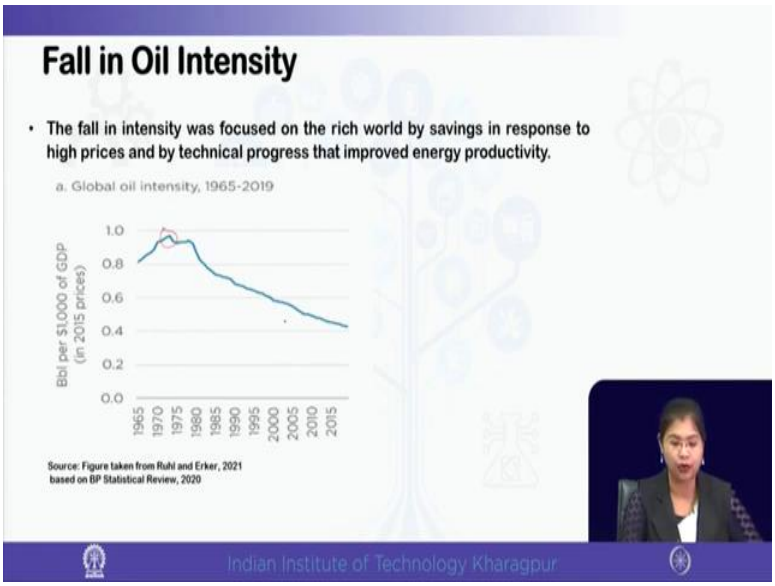

So, we start with the share of oil in GDP. So, we see that the global oil intensity over time from 1965 to 2019. So, if you look at we have used the data taken from Ruhl and Erker car 2021 which is based on the BP statistical review of 2020. So, the fall in oil intensity was mainly due to the high price of oil which led to substitution of oil in the consumption side, as well as in the production side or in the supply side what happened?

The supply side there was technological improvement and that increased the energy productivity. So, both issues in the demand side and supply side factors culminated and relate to a decline in oil intensity. So, if we plot the oil intensity over time in 2015 price we can see a steady decline over time.

Especially you can relate, if you look at the figure over here, you can relate it very easily, we can see if you remember in the one of the modules, we discussed the oil price shock. So, first oil price shock was in 1973. So, in 1975 you see; you can see very clearly, after the oil price shock that the oil intensity started falling and there is a steady decline ok.

So, how you see that the global events, the geopolitics how that affect not only the price, but the price also affects the use of oil.

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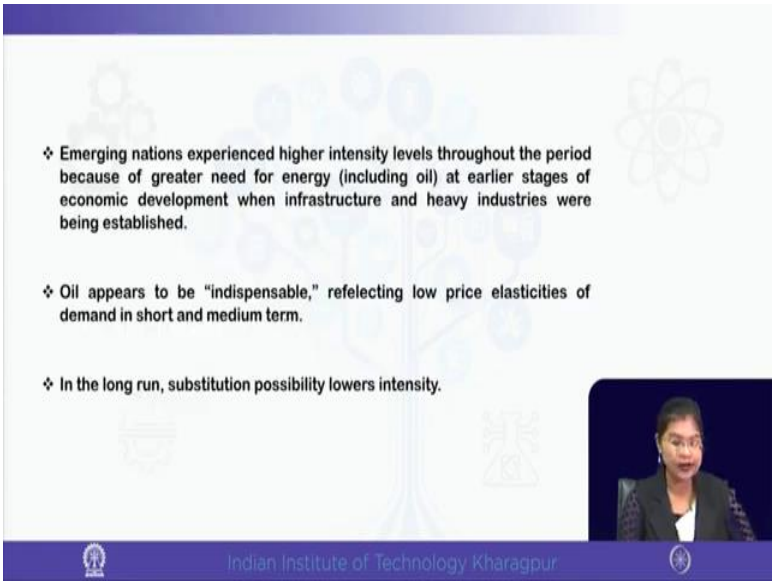

Now if we look at the; for reason for oil intensity decline, so mainly it was due to the fall in oil intensity or oil demand by the developed countries. Now, if you remember the very initial lectures, what we discussed is that the industrial revolution led to a change in the use of energy what happened. Before industrial revolution we are mainly dependent on the primitive sources of energy like, wood and cow dung.

But industrial revolution led to a huge change in the pattern of energy use, because after that we started getting dependent on fossil fuel. So, the industrial revolution actually started in the United Kingdom and then it spread to other parts of Europe and even to US. So, in like in US also we discussed the major driving force behind its economic growth has been oil.

So, the major part of energy use or oil demand was met by the developed countries the advanced countries or what we also call the OECD countries. Now, these countries already attain the higher level of economic development they became developed countries, they were already rich and then we also discussed that after second World War the countries had to reconstruct them self that time also oil demand increased.

So, the developed countries they entered into the third stage of economic development, where the tertiary sector actually dominated, they have completed more or less, the process of industrial development or developing their manufacturing sector. Now, from 1980s or especially 1990 onward it is the developing countries or the emerging countries that entered into the phase of industrialization.

Because many of these developing countries were colonies, so they became independent and after that they started they entered into the phase of industrialization. Now, in the initial phase of industrialization, the countries need to set up the physical infrastructure. Because manufacturing sector depends very much on a good physical infrastructure like transportation, road, electricity so these four of creating the physical infrastructure for transportation, a huge amount of energy is required.

And due to lack of other alternative cheap sources of energy in the developing countries, the developing countries oil demand increased very much. Because other better the renewable sources of energy like, solar energy or other sources of energy let us say nuclear power was not accessible to the developing countries.

So, the developing countries they started consuming more oil. Therefore, what we can show from this figure we can conclude that this fall in oil intensity that we can experience, that was mainly due to the fall in oil demand for the developing countries. But the emerging countries still experienced a higher intensity level, because they were in the phase of industrialization where their oil demand was very high.

So, and we already have started that in the short run and medium run the elasticity values are very less. But in the long run, the elasticity values are greater because there are possibilities of substitution both in the demand side, as well as in the supply side. In the demand side people can gradually start changing their consumption pattern.

So, the developing countries also move to other sources of energy and in the supply side also over time there are technological improvements, there are new sources of energy which can increase the productivity of energy. Therefore, in the long run the elasticity values were higher.

Therefore, we see that over time the there has been a gradual substitution being going on in the energy sector for oil in and we are getting more reliant on the renewable sources of energy which are more sustainable also.

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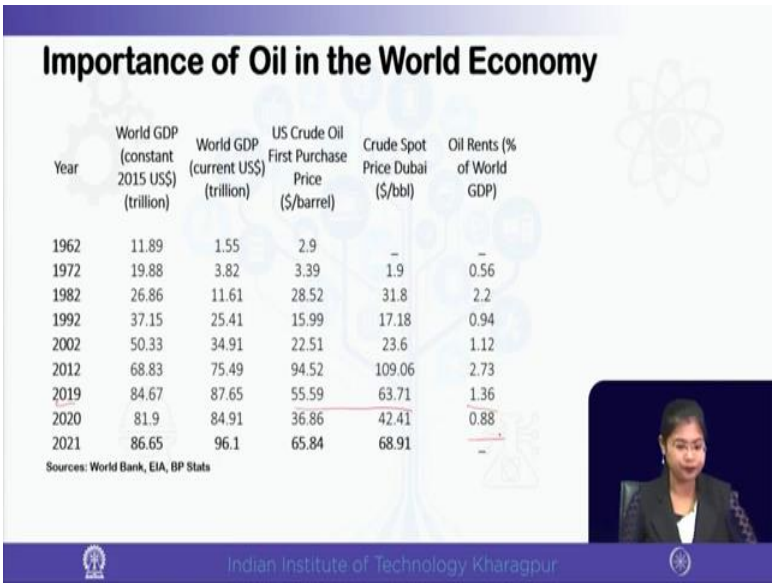

Now, if we look at the importance of oil in world economy, if we look at some data provided by the World Bank and EIA and BP statistics, we can show the oil rents how that is being falling over time it was increasing, but then it started falling. So, if you remember earlier also, we discussed in depth about oil rent. So, oil rent is what? Rent is the difference between the total value and total cost.

So, we can see from this figure from this table rather that as the crudes price is rising, the crude oil price is rising the rents also started increasing. So, we are representing in the last column the oil rent as a percentage of world GDP. And you can see that as the oil price increased and it was very high around 2012 at that point of time the oil rent is also very high.

So, if you look at the table very clearly, we plot the world GDP in both constant and current values in the first two columns from 1962 to very recent time of 2021 and then we have plotted in third and fourth column we have shown the US crude oil price, the first purchase price data and the crude spot price Dubai data and the last column correspond to the oil rent.

So, you see as price is increasing, oil rent is increasing; but then when price also starts falling, oil rent has fallen ok.

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So, we can see that the importance of oil rent as a percentage of GDP. It increases with increase in price of oil, but then it also can fall when price of oil falls. So, if you remember we have already discussed, the relationship between revenue and price elasticity of demand. So, what happens, when we know that oil comes under the category of inelastic good?

So, for inelastic good, if price increases so what will happen? Then if we are going down along the demand curve, linear downward sloping demand curve in the lower part of demand curve elasticity is less than 1. So, when oil price increases, we are going up along the demand curve rather, so the total revenue will increase. But at the same time the cost of production also increases over time.

Therefore, oil rent may fall, if the oil price increases very high. So, we can see that in 2002 and 2012, oil rent as a percentage of GDP was 1.12 and 2.73 percent respectively because in 2012 oil price was skyrocketed. We remember that in 2008 we had the global financial crisis, right.

So, there was a demand side decline in the oil market, so that led to a fall in price of oil, but around 2012 onward the US economy as well as the world economy also started

reviving. So, when the global economy starts reviving, the total demand for oil increases. And oil price also started increasing from 2012 onward. So, when oil price increased, oil rent also increased.

But after that will be; as we will be proceeding in the lecture in the other topics also in the oil price module, we will see that how from 2014 onward unexpectedly oil price trend reversed. We will be discussing the reason; we will be discussing about the shale oil revolution in depth ok.

So, then I am not elaborating on that because we have devoted a separate lecture for it. So, with the shale oil revolution certainly there was increased supply in the oil market that led to a fall in oil price. So, you can clearly see in 2019 also oil price was much less than 2012. So, oil rent also subsequently started falling.

And in 2020 we have discussed earlier and we will be discussing in more detail how the COVID-19 pandemic and the travel restrictions imposed along with the lockdown measures how that led to a demand side decline and oil price also fail at that time. So, oil rents also declined.

So, due to the pandemic, we can easily conclude that the oil rents declined because of the low demand for oil and hence prices. So, more or less what we can conclude from this table, that when price of oil increases, oil rent as a percentage of world GDP increased and when oil price starts falling, then due to maybe due to supply side or due to demand side factors. So, oil rents importance in GDP has also declined.

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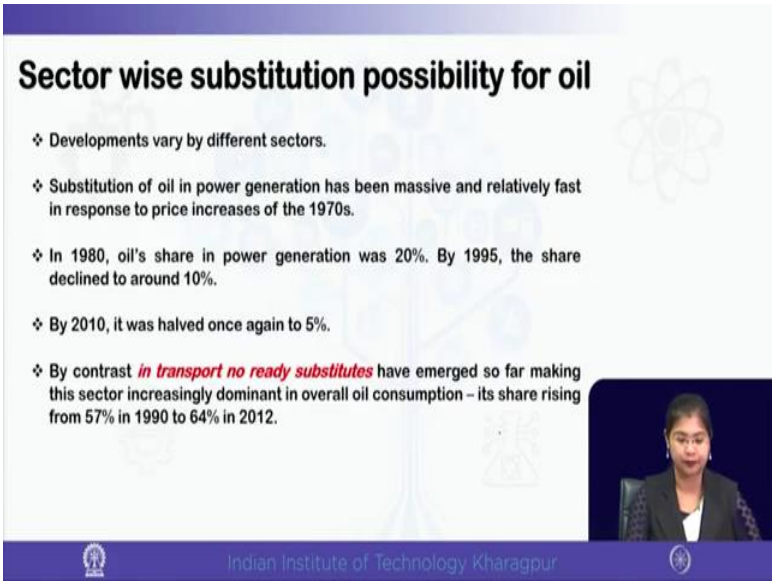

Now, let us see how the use of oil has varied sector wise. So, till now we are discussing the use of oil over time. So, now, you see what happens to the use of oil sector wise. This is very important to understand the impact of the COVID-19 pandemic on oil market ok. How the sector wise substitution possibility has been going on in oil.

So, earlier also a few browse through the lectures, you can see what we have discussed is that from mid-19 or 1980 onward, we gradually started replacing oil by other sources of energy. What is the reason for that? Because the oil price has been skyrocketing very much from 1970 onwards, we already have seen the two oil price shocks in 1973-74 and then again in 1979 and 80.

So, due to this oil price shock and we also discussed that, Saudi Arabia and OPEC overall was a follower or supporter of high price of oil. So, they deliberately also restricted the quantity supplied in the total oil market. And given Saudi Arabia and OPECs leadership position in the global oil markets, oil price was high.

But we discussed already in the previous lecture also, that Saudi Arabia had to abandon the high price policy of oil because over longer run, there was increased substitution possibility of oil. So, what happened was that? We experienced a great price collapse in 1985 and 86 because Saudi Arabia and the OPEC countries saw that the high price difference was not proving to be very profitable in the long run.

So, they had to abandon the price policy by increasing the supply. But seeing this high price of oil the countries around the globe, especially the developed countries started replacing oil gradually by other alternative sources of energy. Like from mid-1980 onward many of the power stations were converted to cheaper substitutes like coal and natural gas, because prices of those products were increasing, but much at a lower rate than the price of oil.

So, in the developed countries mainly from 1985 onwards, they started replacing oil with other sources of energy. The new power stations were built using the hydroelectric power plants, tidal power plants. Even the developing countries also started gradually replacing oil especially in the energy sector for electricity consumption.

So, we can see that in 1980 oil share in electricity or power generation was 20 percent and after 15 years it halved, it was around 10 percent, whereas in 2020 it was further halved to 5 percent. However, now its very interesting to note that in transportation sector there is no easy and close substitute, cheap substitute of oil.

So, far therefore, transportation sector heavily depends on oil. Therefore, if there is a demand side shock in the transportation sector as it happened during the pandemic that has huge impact on oil price, we can see from data reveals that the share of oil in the transportation sector has increased from 57 percent in 1990 to 64 percent in 2012.

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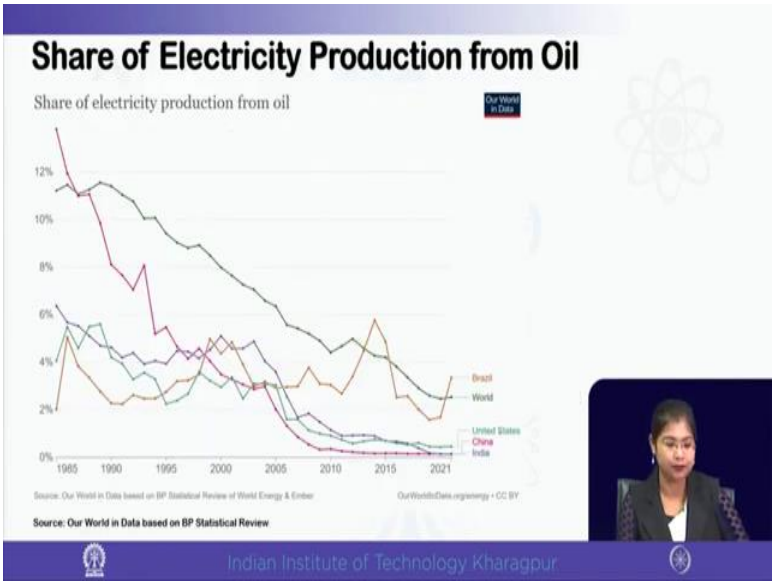

So, we plot the data from the BP statistical review, which is the source is the our world in data. So, here we plot the share of electricity production of oil and you see there is a steady decline. So, we have plotted for the world market as a whole and for individual countries like, US and then some developing countries like Brazil, China and India.

So, we can see that there has been steady decline in the share of electricity production from oil. So, this is from 1985 to 2021. So, you can refer to the world market has experienced steady decline and other countries has also experienced like India and China, for Brazil there are some in between increases, but overall, the trend is for many most of the countries and world market as a whole the trend is declining.

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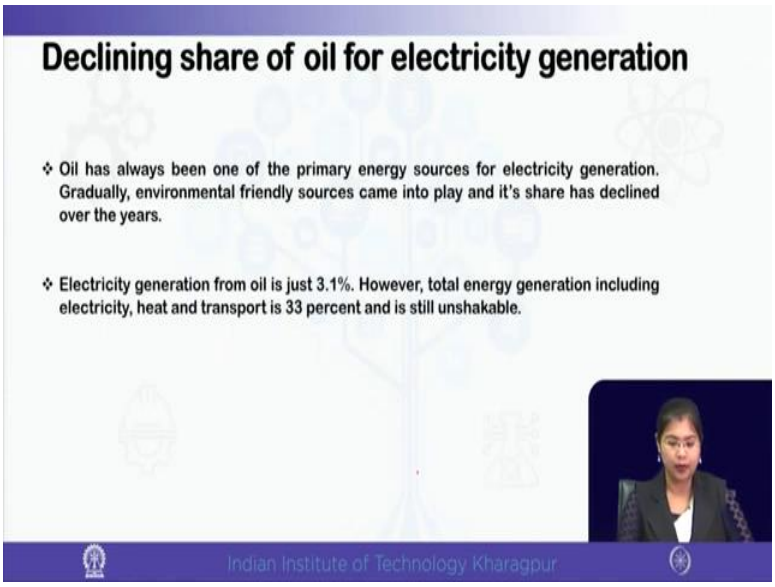

So, for electricity generation though oil was one of the primary sources of energy, but gradually more and more environmentally friendly sources have come into play and the share of oil in electricity has declined.

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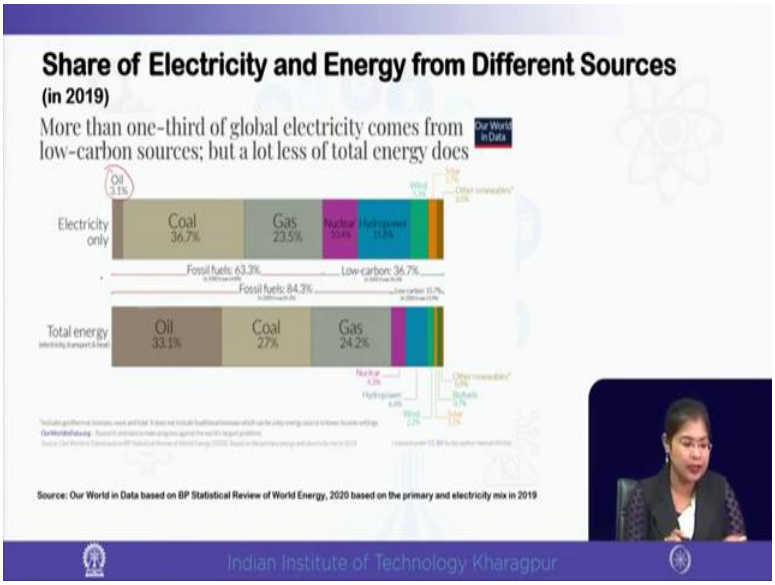

So, here we can see the share of electricity and energy from different sources. So, this is very interesting data you can see. So, again this is from our world in data based on the BP statistical review. So, what we have plotted over here is that the share of oil in electricity and what are the other sources of electricity production.

So, you can see that as share of oil in electricity production is only now 3.1 percent and you see are the what are the other sources of energy. So, coal is the significant source it is having almost 37 percent share, whereas natural gas is around 24 percent and then hydroelectric power plant is around 16 percent and nuclear is 10 percent. And you have other sustainable or renewable sources of energy like wind, solar which are more or less relatively low.

So, we see that in electricity the oil share has decreased very much. So, you see, electricity generation from oil is only just 3.1 percent. But now you compare this upper panel with the lower panel, where we see? The importance of oil, coal, gas and other sources of energy for total energy ok.

So, this includes not only electricity, but also transport and heat. So, what is the difference between the two panel? In the upper panel we are comparing the sources of energy for electricity production, in the lower panel we are comparing the similar sources of energy for overall energy production which includes electricity transport and heat.

But there you can see the heavy importance or heavy dominance of oil which is 33 percent. Whereas, coal has the second position of 27 percent followed by gas, 24 percent and other sustainable and renewable sources of energy are really less. So, you can see the importance of oil for transportation because for electricity oils importance has fallen.

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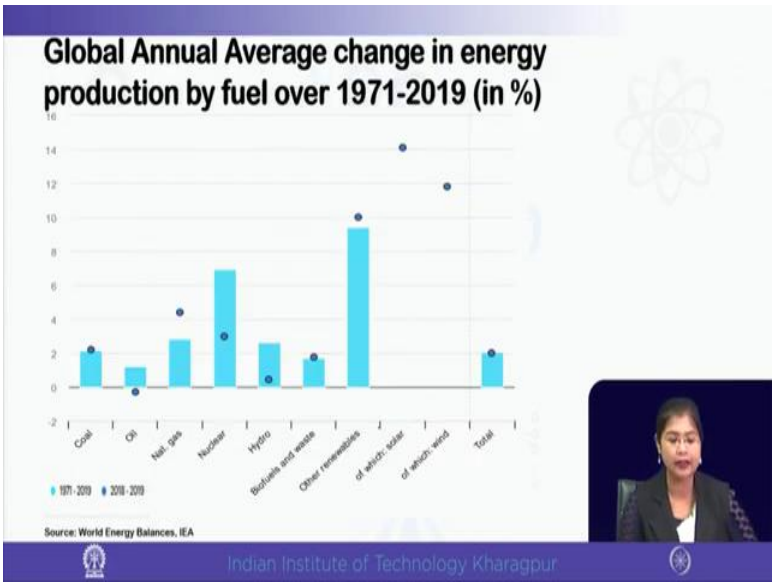

But for transportation oil is very important, we do not have any cheaper and easily accessible substitute of oil for transportation. Now, next we also plot the global annual average change in energy production by fuel type over 1971 to 2019. Now, this is the percentage change data.

So, you see the blue light blue colors are the percentage change from 1971 to 2019 and the deep blue ones this dots are the two 2018-19 value. So, we can see that for oil you see the 2018-19 annual average change is less than the to the overall this 1971 to 2019 value.

Whereas for coal, the annual percentage change of 2018-19 is just above more or less they are same, but for oil it has fallen. Whereas, you can see for other sources of energy like, natural gas also recent time it has increased ok. Biofuel and waste other renewables have increased overall solar, wind they have increased. But for oil it has fallen, so this is very important.

So, we can conclude that a major reason for this fall in the oil use, in the as far as the annual average change is concerned in the recent time is due to the replacement of oil gradually in the electricity production. But till for transportation we are heavily dependent on oil.

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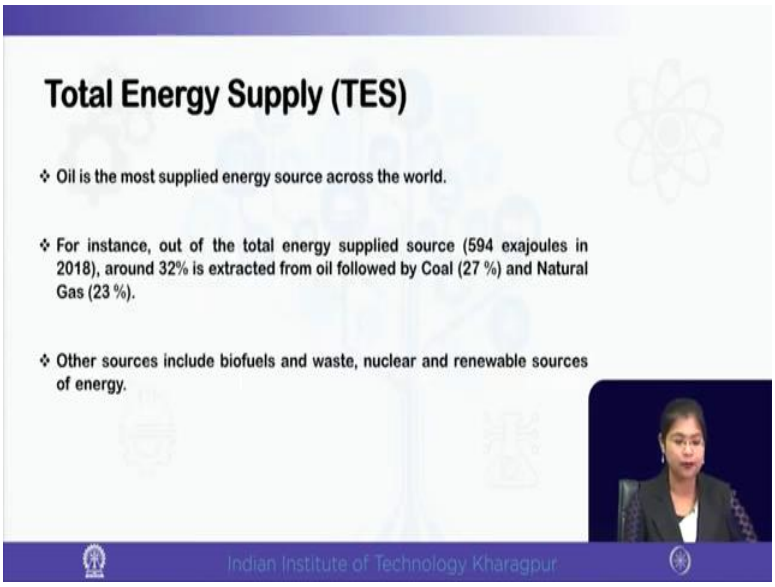

Next, we also discuss the total energy supply. So, oil is the most supplied energy source across the world. For example, out of the total energy supply source that is 594 four exajoules that is an unit of energy. So, in 2018 around 32 percent is extracted from oil and the second position is obtained by coal that is 27 percent and natural gas is 23 percent. And we have the other sources of energy like biofuel, waste, nuclear and renewable sources of energy.

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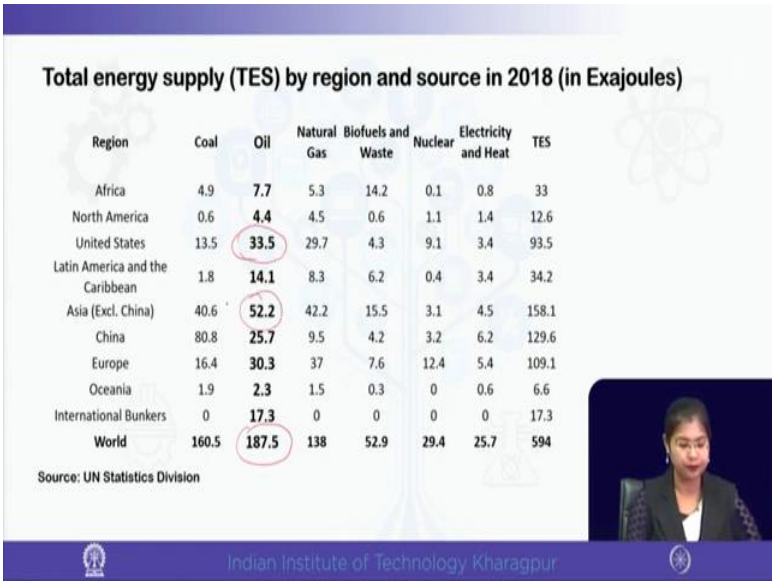

So, we can look at this data total energy supply across region and source wise. So, you see here, across the columns we have plotted the source wise data, whereas the rows correspond to the different regions ok. And the last row correspond to the total world and the data source is even statistics division.

So, for limitation of time we are not able to present there are many interesting data whoever is interested can browse through the data sources. It is very much interesting also, if you look at the data sources you have a faster experience. So, if you see we have written the values of oil in, we have highlighted in bold and you compare with other sources of energy you can see the importance of oil.

So, oil dominates as the total energy supply source as compared to the other sources of energy like, coal and other renewable sources of energy. So, you can easily; see the importance of oil over other sources of energy and across regions also you can see. As we also discussed that oil has been the important reason or important driving factor behind the economic growth of US, you can see the use of oil in total energy supply. So, how it important it is, even Asia also you see.

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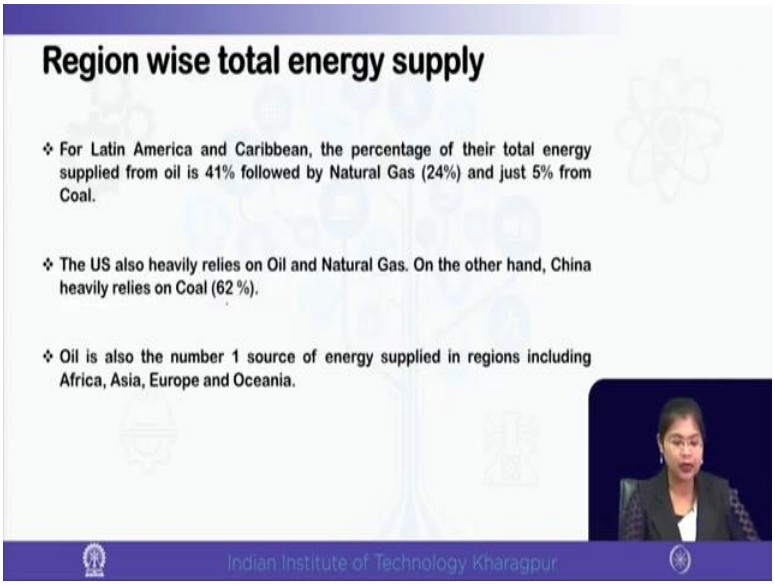

So, what we can conclude is that? For Latin America and Caribbean, the percentage of total energy supply from oil is 41 percent and the second position is by natural gas and 5 percent from coal. So, you can see Latin America and Caribbean region ok. So, again for this region also oil is dominating.

Then US also, US also heavily relies on oil and natural gas. Whereas, one exception here is China, China domain is more dependent on coal than other regions. So, that is why when we are in expressing the value of other Asian countries, we have excluded China and we have represented the Chinese data separately.

So, China is relied more on coal than on oil which is an exception. For other countries even the developed countries also, they are more dependent on oil for their total energy supply. And oil is the number one energy supply source for regions like Asia, Africa, Europe and Oceania. So, we can easily see from this figure.

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So, what we have done in today's class, we have discussed the declining oil intensity over time for the world economy and we have also compared it across countries and across region. So, what we found is that, oil intensity from 1980 onward especially is declining and major reason is the gradual replacement of oil for energy production or electricity production. For transportation we are till now very much dependent on oil.

Then we have studied in depth the region wise and sector wise use of oil, we have also seen empirical evidences regarding the importance of oil in world economy and we saw that whenever oil prices increase, the oil rents have increased. But when oil prices fall, oil rents as a percentage of GDP has also fallen.

So, what we need is that? We need to have more easily accessible substitutes because the developed countries are till now very much dependent on oil and we have earlier also discussed that we have to be concerned about the issues of sustainability, about the issues of climate change and greenhouse gas emission. So, we need more alternatives cheaper substitutes of oil even in the developing countries.

So, those use of renewable sources of energy should not be limited to the developed countries. So, with these understanding of the sectoral use of oil, next we will be discussing about the oil price movement, post 2010 onwards. So, this was very much required because we had to understand, how the oil use varies across sectors and across regions.

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So, the references are the two petroleum economics book that I have already referred and there is also a paper by Ruhl and Erker that one can refer to.

So, thank you very much in the next class we will be discussing the oil price movement from 2010 onwards.