Commodity Derivatives and Risk Management
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Lecture 36
Carbon Derivatives

Ok welcome to this session on Commodity Derivatives and Risk Management and we will be continuing with our discussion on Carbon derivatives. And if you recall in the last session we were discussing about Kyoto protocol we also discussed about United Nations Framework convention on climate change that is UNFCCC and how based on the UNFCCC guidelines or regulations companies can earn 3 different types of carbon credits, that is your AAU, that is assigned amount units as per the cap and trade program and CERs that is your Certified Emission Reduction units as per the clean development mechanism and ERUs Emission Reduction Units as per the joint implementation program.

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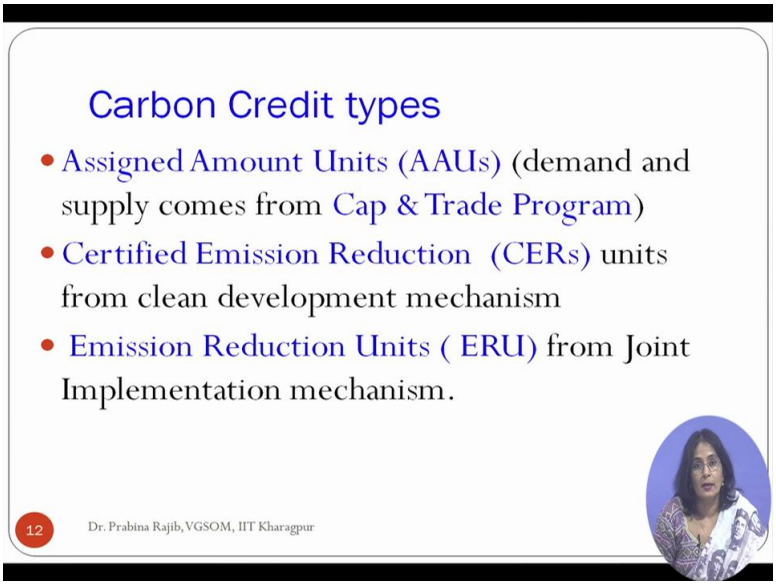

So if you can see, these are the 3 different types of carbon credits which a particular company can own or trade that is AAU Assigned Amount Units, which comes from the cap and trade program Certified Emission Reduction units which comes from the clean development mechanism and Emission Reduction Units which come from the join implementation mechanism.

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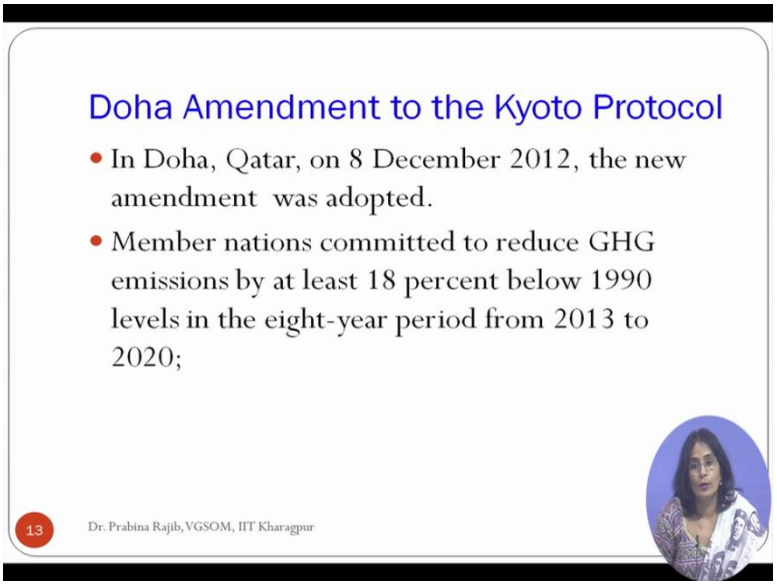

Now subsequent to Kyoto protocol subsequent to the Kyoto protocol this UNCCC met at Doha on Doha Qatar on 8th December 2012 and a new amendment was adopted and what was the new amendment? The new amendment intended to reduce the greenhouse gas emission by 18% below the 1990 level in the during 8 years period starting from 2013 to 2020. If you recall the phase 2 of the Kyoto protocol which you are intended to reduce the total greenhouse gas emission by 5% during 2008 to 2012. So this particular Doha round is an extension of that agreement in which all member countries went together jointly they will reduce the greenhouse gas emission by 18% below 1990 and this will be achieved over a 8 year period from 2013 to 2020.

Otherwise most of the other parts of the Doha agreement would be are same as far as this particular commodity derivative commodity derivative discussion is concerned though there are some other policy changes and all but that we are not going to focus on this discussion.

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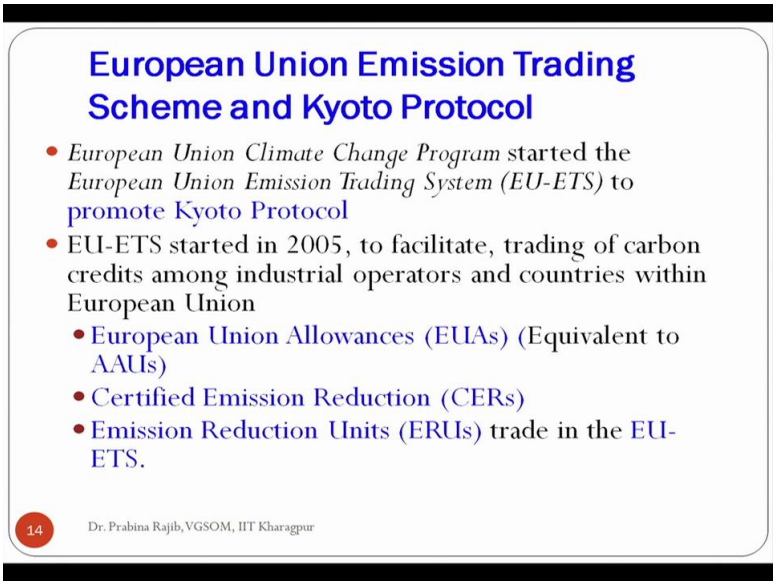

Now subsequent to the Kyoto protocol agreement United European Union Climate change program started European Union Emission Trading System. Let me repeat, to bolster the activity or to promote the activities of Kyoto protocol, European member nations created or started a trading system which was known as European Union Emission Trading System or EUETS and this EUETS started in the year 2005 and with the very clear cut objective of facilitate trading of carbon credits among the industrial operators and countries within the European union. So what which kind of a carbon credits could be traded at this EUETS?

It is these carbon credits are known as European Union allowances EUAs which are equivalent to AAUs, there is nothing there is no difference between AAUs or EUs they are same so this EUAs were traded at EUETS besides this European Union Allowances certified emission reduction and emission reduction unit were also traded at EUETS.

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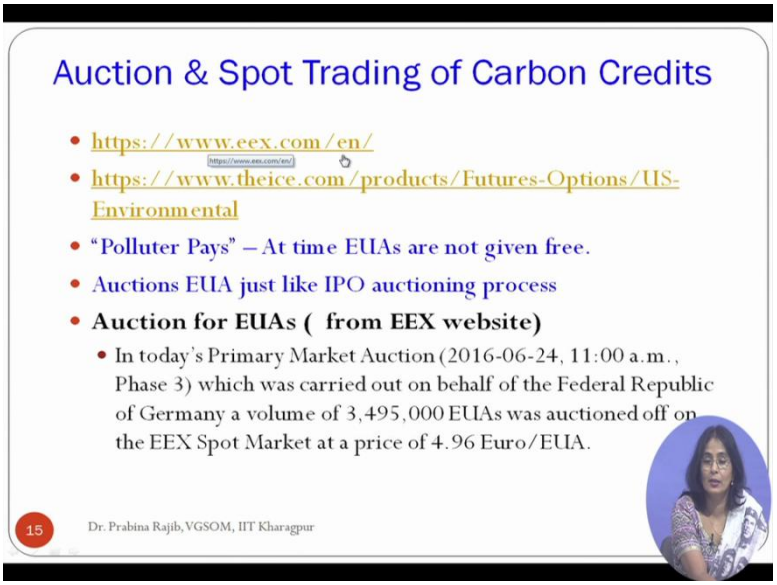

Now this particular this http www.eex.com this website will take you to the EUETS trading system so you can go into this particular website and see what are the different kinds of contracts and what trading happens. Also another exchange which is known as your the ice.com, this particular exchange lists a list the futures and options contract on different types of carbon derivatives. So these 2 exchanges are world famous for offering derivative contracts on carbon credits. Now let us go to little bit a more on understanding of EUETS program EUETS trading system.

Now European Union allowances are not freely given like AAUs. If you recall, AAUs were distributed to industrial operators by a member nation. Let us say a member nation is entitled to emit X units of AAUs and this AAUs this X unit is distributed to the industrial operators based on certain guideline and this industrial operators are free to emit whatever has been allocated to them. If they emit more than that they have to go to the exchange to buy carbon credits to the extent of extra emission they have generated.

Now this European Union Trading system as part of the EUETS what they decided is that this all EUA's are not to be given free or this assigned units will not be given free and a part of the assigned units will be given free and a part has to be auctioned as part of the EUETS system. So a the action will happen in the EUETS system, so now let us take example to understand what is this auction and how this auction happens.

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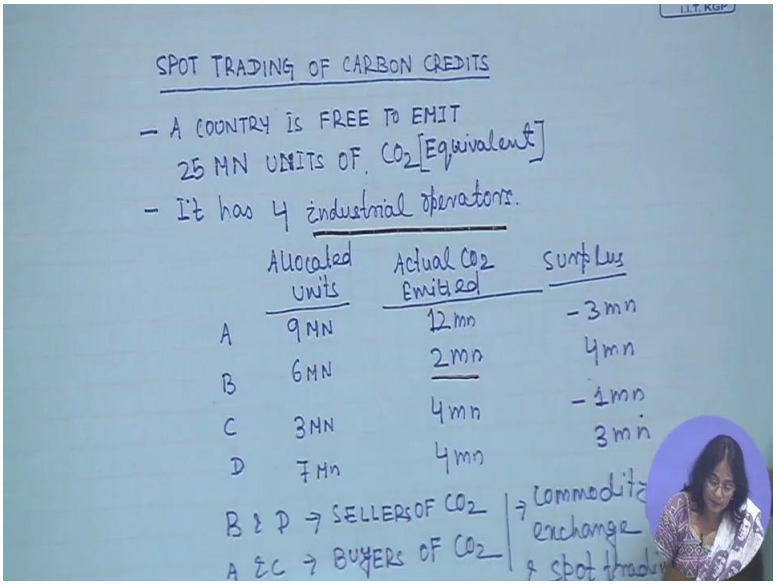

Let us say so this particular let us say this, let us first understand the spot trading of the carbon credits, suppose a country is free to emit 25 units of carbon dioxide equivalent, so as per the as per the UNFCC convention a country is free to emit 25 million units of carbon dioxide. So when we are talking about country, it is nothing called a country, the industrial operators or companies operating in those countries are free to emit these 25 million units. Now let us say, this 25 million units has to be distributed freely among the 4 industrial operators. Now A will 9 million, B will get 6 million, C gets 3 million and D gets 7 million, now how this A, B, C, D how this different amounts will be distributed, this will be distributed based on the past operating history of a of these 4 industrial operator. Let us say A is A is a thermal power plant and traditionally thermal power plants have emitted more greenhouse gases so the nature of operation is that they are going to emit more greenhouse gases so more this the more this of more of AAUs are more of AAUs are assigned to or allocated to this industrial operator A.

So depending upon the nature of operation a country decides to allocate 9, 6 and 3, 7 million respectively among A, B, C, D. Now what is actual carbon dioxide emitted like by the end of the year let us say A emitted 12 million, B emitted 2 million and C emitted 4 million and D emitted 4 million units. Now what is going to be the surplus, the surplus is going to be, so the surplus is negative million that means the this company or this operator was supposed to emit only up to 9 million but it has gone up to more than that so 12 million so it has a deficit of 3 million. Similarly party B or industrial operator B has 4 million surplus C has 1 million

deficit and D has 3 million 3 million surplus. Now what will happen, B and D are going to be the sellers of the carbon dioxide or carbon credits.

They are going to be the seller of carbon credits and A and C are going to be buyers of the carbon credits, they are the they are the deficit they are the deficit industrial operators, so they have to go to a commodity exchange and they can buy this units 3 million and 1 million 4 million 4 million units and this parties this 2 B and C will be the sellers and B and D are going to be the seller and A and C are going to be the buyers and they will go to the exchange platform and buy and sell the commodity carbon credits. This is a example of when the carbon credits is given absolutely freely and depending upon the actual emission this industrial operators will go to the exchange platform and buy the deficit buy this carbon credit if they have generated more greenhouse gas emission or and those who are emitted less greenhouse gas they will be selling these assigned units.

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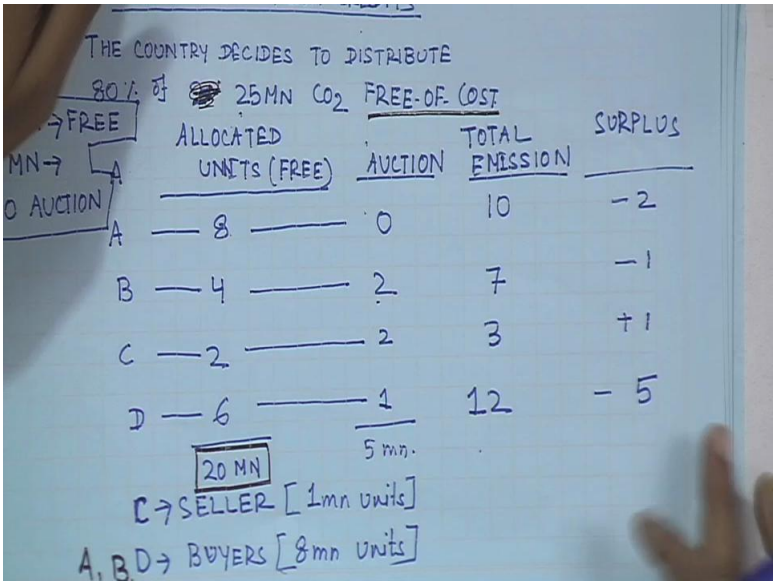

Now let us go to the to understand how EUETS undertakes a auction, so what exactly is auction of carbon credit, let us say this country decides not to distribute the complete 25 million carbon credits free of cots, it only distributes it is willing to distribute only 80 units as 80% of 25 million free of cost. And rest 20% that is 5 million will be auctioned off. So how exactly this will happen let us understand.

So as part of the free distribution A will get let us say 8, B will get 4, C will get 2 and D will get 6 million, sum total of it is 20 million. Now the remaining 5 million will be auctioned off in the exchange platform. So I am sure all of you must know how companies auction their

shares. When a company comes out with their IPO Initial Public Offer, they solicit bid from different buyers and depending upon whoever is the whichever buyer or who the buyer who has given a highest bid those buyers are allocated shares, exactly the same procedure is undertaken at EUETS. So this 5 million AAU's or E U's will be available for buying and these 4 industrial operators will be bidding for this 5 million carbon credits. So depending upon whichever party has bided highest amount accordingly allocation will be done.

Now let us go to, let us say as part of the auction process B got allocation of 2 units, C got allocation of 2 units 2 million units, 2 million unit 2 million unit and D got allocation of 1 million unit and A did not get any allocation because A probably had quoted a very low price, so it did not get a allocation. So going by that what is the total allocated unit, allocated unit is 8 unit for A and for B 4 unit freely given 4 million units freely given, 2 million was procured or bought by the company so and so forth. And what is actual emission, total emission is going to be 10 and 7, 3 and 12, so going by that what is going to be the surplus and deficit, it is going to be - 2 that is deficit, the company owns or permitted to emit 8 million but actually it has emitted 10 million, so it has a deficit of 2 million.

Similarly party B or industrial operator B is - 1 industrial operator C is + 1 and D is - 5, so obviously C is going to be the seller of the carbon credits 1 million units and A, B, D are going to be buyer of the carbon credit. And if this kind of a situation happens when you have more amounts to be bought than the amount to be sold it will give rise to the spot price of this carbon credits are going to increase.

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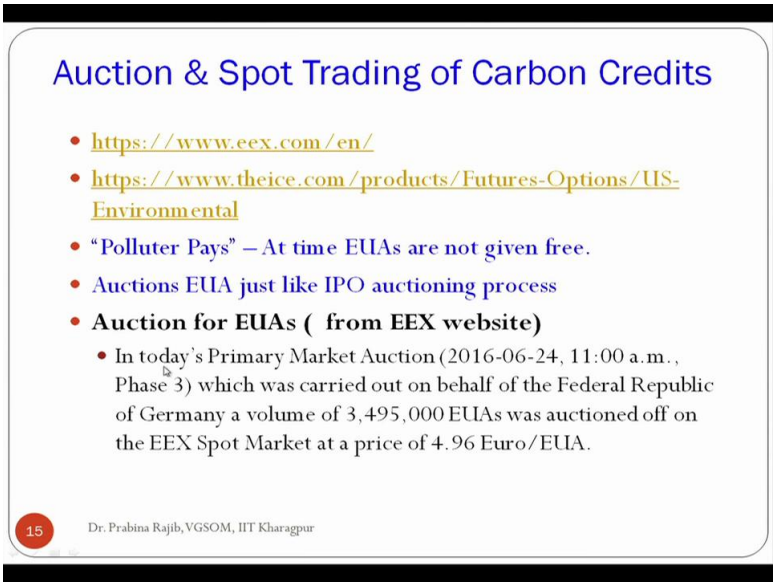

Now let us focus on this is the I have taken eex website how auction is done announcement by the eex website says that in today's primary market auction which has held on 24th June 2016 11 am on behalf of the Germany government, 3.495 million of European allowances was auctioned off on the EEX spot market at a price of 4.96 Euro per unit of EUA. So this 3.495 million 3.495 million UA EUAs were auctioned off and people who bided for it on an average they may have bided at different price but they have paid to buy they have paid 4.96 Euro to buy one unit of European union allowance.

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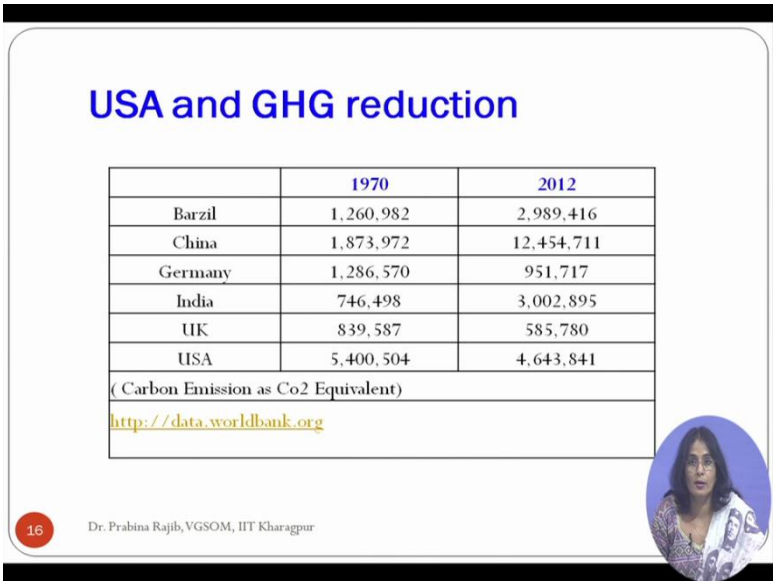

Now let us quickly discuss about discuss little bit about US USA and Kyoto protocol and greenhouse gas emission reduction initiative. this particular table shows what has been the greenhouse gas emission in terms of units during 1970 and 2012, this data I have validated from worldbank.org, in fact this detail yesterday, this detail I have discussed in the previous class, so you have if you see this one if you see Brazil emitted 1.26 million in 1970 and it has gone up to 2.989 million in 2012 and China is a remarkable you know remarkable growth in terms of greenhouse gas emission almost 11 times it has gone up, India also has gone up significantly and if you see USA from 5.4 million to it has come down to 4.64 million during 1970 to 2012.

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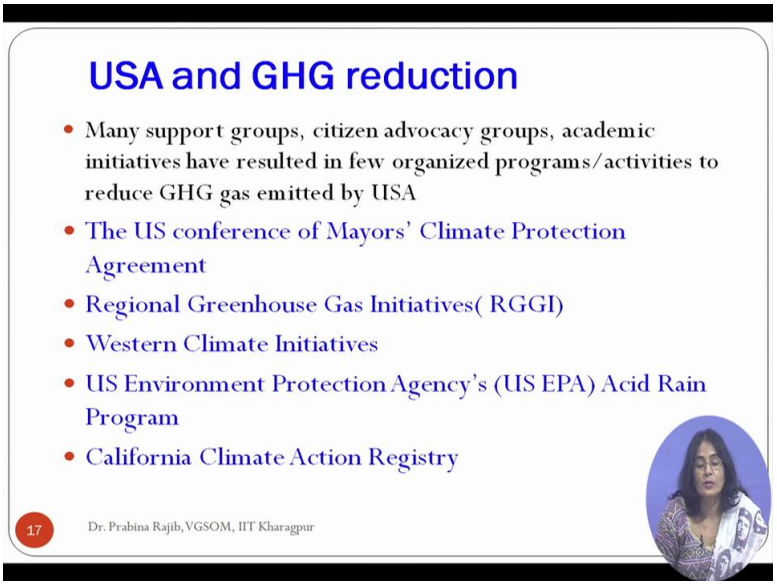

However, one interesting aspect is that USA is not part of a Kyoto protocol signatory. USA did not sign the Kyoto protocol, however many support groups and citizen advocacy groups and academic institutes have undertaken many initiative, which has resulted in many programs being undertaken in USA for reducing greenhouse gas emission. So some of the interesting or some of the important initiatives I have listed, so which are these US conference mayors, climate protection agreement, regional greenhouse gas initiative and this is western climate initiatives, US environment protection agency, acid rain program and California climate action registry.

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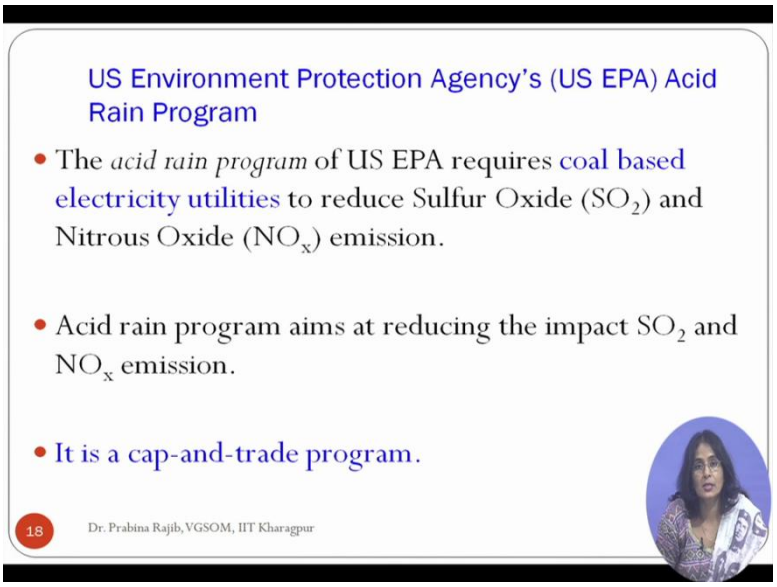

There are many more initiatives; this is just a sample example of what are the different initiatives taken by different organisation, different bodies in USA to reduce the greenhouse gas emission. And at this juncture I am just going to discuss little bit on this acid rain program. US environment protection agency USEPA started a acid rain program, so what exactly this acid rain program? It requires coal based electricity utilities to reduce their sulphur dioxide and nitrous oxide emission.

So it is basically cap and trade program so all this coal based electricity utilities will be are permitted to emit some level of sulphur oxide and nitrous oxide and beyond that if they if they emit this sulphur oxide and nitrous oxide beyond that amount they have to go to the exchange platform and buy this the excess emission, it is exactly like a cap and trade program. And why this only coal based utility electric utility has been has been identified in fact if you know that one third of the greenhouse gas emission comes from coal fired electricity generation, so this is a major contributor towards the greenhouse gas emission all over the world.

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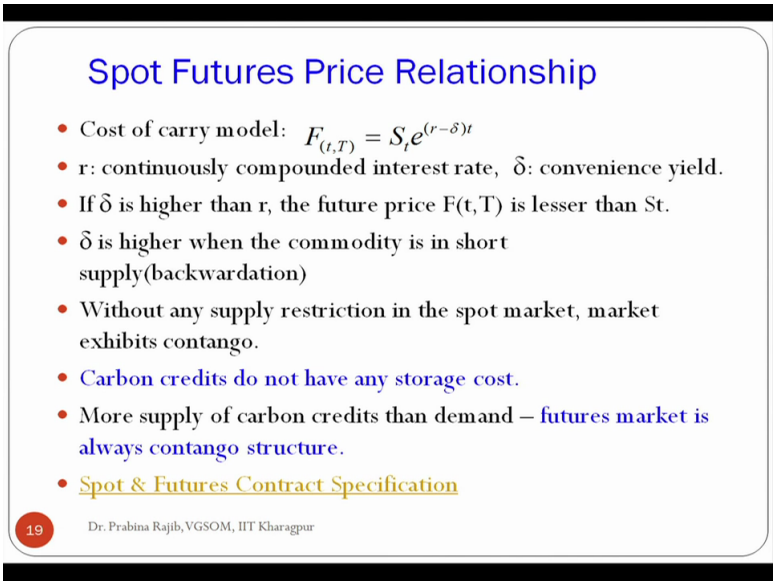

Now with this we will discuss little bit on spot future price relationship between carbon credits and if you recall any derivative can be any derivative can be model using your cost of carry model and in this as you can see in this formula mentioned ST is your spot price of the the underlying, so in this case it is going to be the carbon credit, R is your cost of capital, delta or Y in the previous sometime in the previous session we have discussed, it is nothing but a convenience yield and T is your time to maturity. And if delta is more than R then the commodity is in short supply and the market exhibits backwardation. So without any supply

restriction or if the underlying commodity is available in abundant manner than the market will exhibit a Contango, that means futures price is going to be more than the spot price and far month future price is going to be more than the near month futures price.

And when we price the carbon futures contract, we do not have to adjust or accommodate the storage cost because there is no cost associated with storing carbon credits, so the formula for calculation of the carbon derivative is this there is no storage cost and there is also delta is also 0 because carbon credits there are abundant number amount of carbon credit available for trading, in fact supply is more than the demand. So futures market is always Contango in nature when the carbon credits are the underlying.

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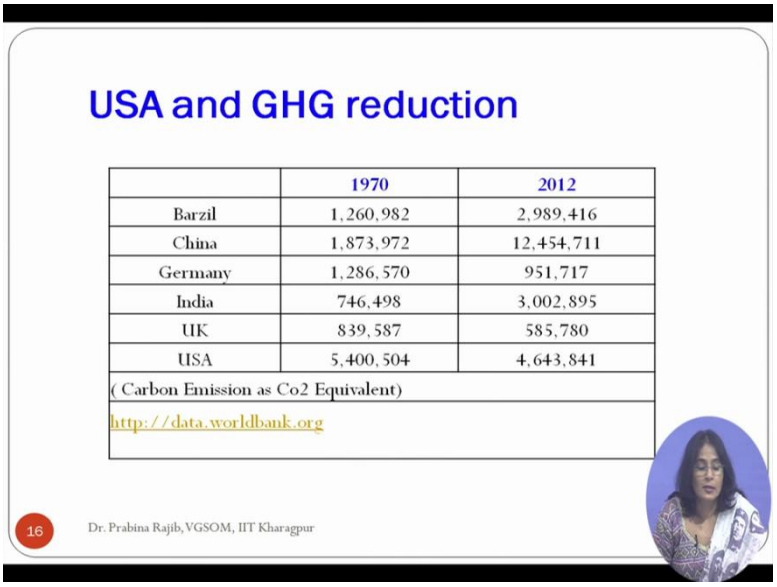

Now let us quickly uh, let us quickly take you through the spot and futures contract specification for this carbon credits. Ok, please focus on this particular if you see this is the contract specification for European Union Allowances futures product and what is the underlying that is EU allowances and which is permitted I mean which is equivalent to emit 1 ton of carbon dioxide equivalent and what is the delivery method, please see this one, a delivery period you can have monthly futures, you can have quarterly futures and you can have yearly futures and as of today somebody can enter into futures contract for a contract going up to 2020 December 2020. What is the minimum lot size? That is 1000 units of European Union allowance.

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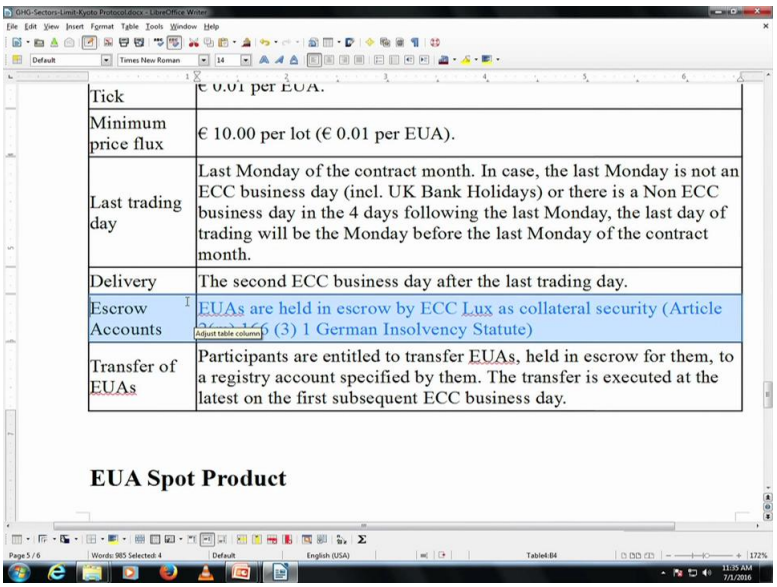

Tick	€ 0.01 per EUA.
Minimum price flux	€ 10.00 per lot (€ 0.01 per EUA).
Last trading day	Last Monday of the contract month. In case, the last Monday is not an ECC business day (incl. UK Bank Holidays) or there is a Non ECC business day in the 4 days following the last Monday, the last day of trading will be the Monday before the last Monday of the contract month.
Delivery	The second ECC business day after the last trading day.
Escrow Accounts	EUAs are held in escrow by ECC Lux as collateral security (Article 6 (3) 1 German Insolvency Statute)
Transfer of EUAs	Participants are entitled to transfer EUAs, held in escrow for them, to a registry account specified by them. The transfer is executed at the latest on the first subsequent ECC business day.

EUA Spot Product

And how the how the transfer can happen, the transfer will happen through a escrow account so I am not going into this detail, it is mostly like the way the transaction happens currently for your share buying and selling so from your demat account share gets transferred, if you are selling shares gets transferred to the buyers demat account exactly similar procedure will be followed.

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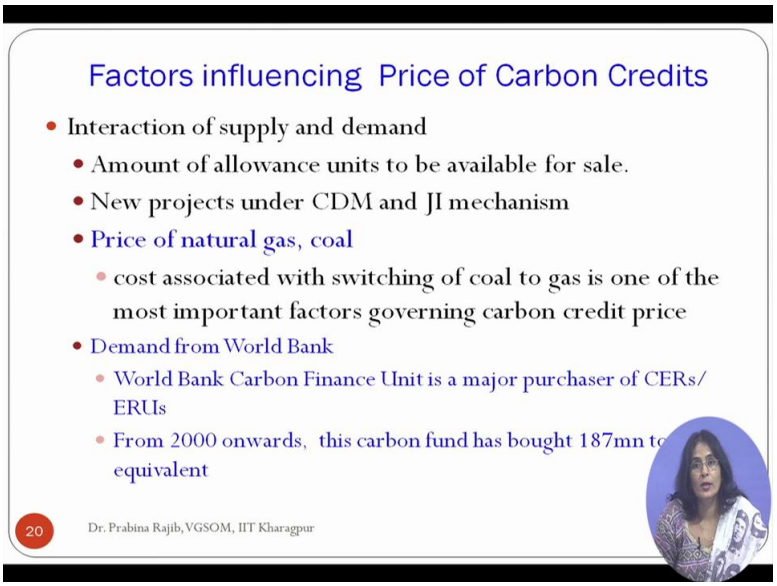

Now when we are talking about the spot and futures price let us quickly discuss what is going to be the, or what are the factors which influence the spot and futures price. And let us first discuss what the factors which influence your spot price are. In fact one of the very important determinants of the spot price is the amount of allowance unit available for sale. If a higher

limit is given to us given to a industrial operator and that means that industrial operator will have a more amount of allowance unit available for sale, so the supply will be higher.

And now let us go to the second factor which will be influencing the supply that is new projects under CDM and JI mechanism, joint implementation mechanism. So if more number of new projects are coming, so you will have more amount more number of CERs and ERUs available for trading. And very interestingly the price of natural gas and coal also is a significant contributor of carbon credit price; we will come to that discussion little later. Also another thing, demand from world bank is a is also another major contributor of the carbon price, so World Bank has a unit called carbon finance unit which is a major purchaser of CERs and ERUs so this carbon finance unit buys CERs and ERUs and by buying this CERs and ERUs the demand increases and thus it influences the spot price.

And if you can if you can see this as mentioned in this particular PPT, from 2000 onwards World Bank has bought around 187 million tons of carbon dioxide equivalents. So the demand from World Bank is this is influences the spot price considerably. Now let us focus on how the price of natural gas and pole influences the carbon spot price. We know that companies can either use coal or it can use natural gas to generate electricity, so when electricity or higher gas based electricity generation leads to lower GHG emission and more availabilities of allowance unit and less price for carbon.

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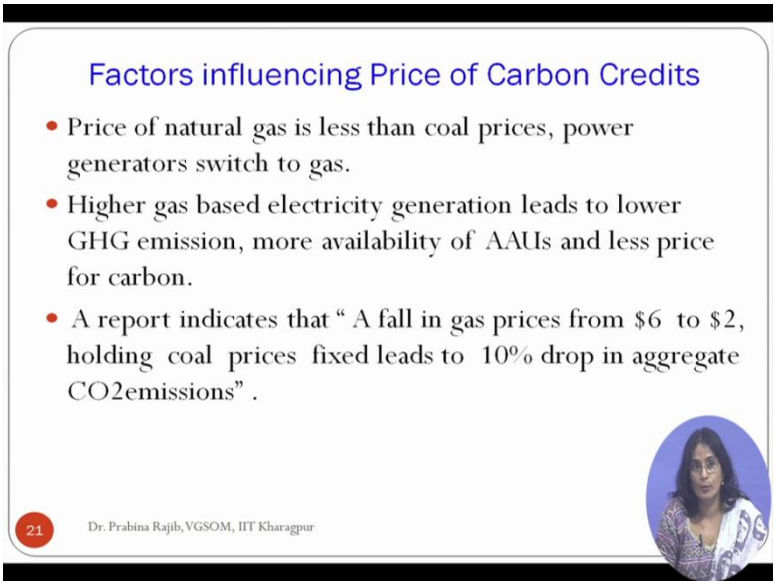

So whenever companies start using gas for generating electricity natural gas for generating electricity, they emit less greenhouse gas emission, so when they emit less greenhouse gas

emission, their available of assigned unit becomes more and this influences supply of carbon credit increases and this influences the spot price. In fact some researchers have undertaken a study when the gas price goes down and an electricity generator start using gas, then the carbon credit price drops and as you can see this report indicates that a fall in gas price from 6 dollar to 2 dollar reduces the carbon dioxide emission prices by 10%.

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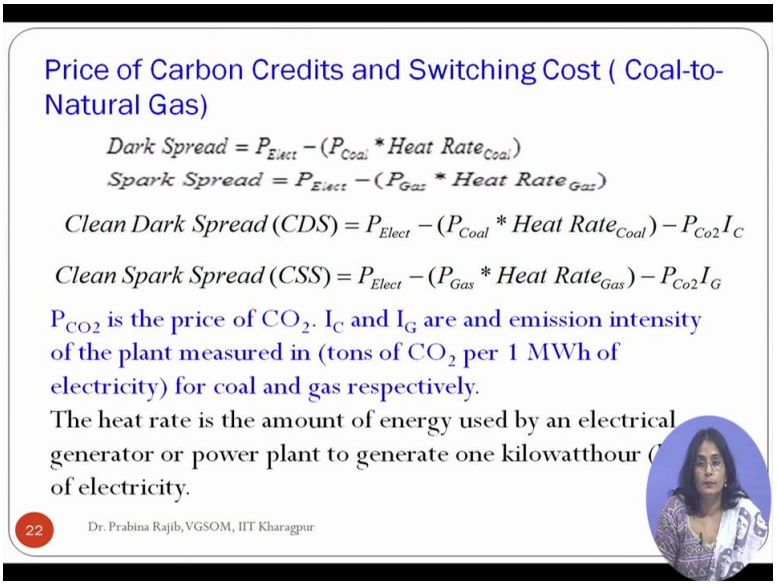

Now in with respect to this price comparison between coal and natural gas, we have 2 concepts called dark spread and spark spread, so what exactly is dark spread, price of electricity - the price of coal into the heat rate of the coal. And what is a spark spread; spark spread is price of electricity - price of gas into heat rate of gas. From these 2 spread when we are subtracting the price of carbon dioxide and emission intensity of a particular plant what we get is a clean dark spread and clean spark spread. So when clean spark spread is greater than the clean dark spread than companies will be using gas to generate electricity. Let me repeat, when the clean spark spread is more than the clean dark spread, companies will be using natural gas to generate electricity.

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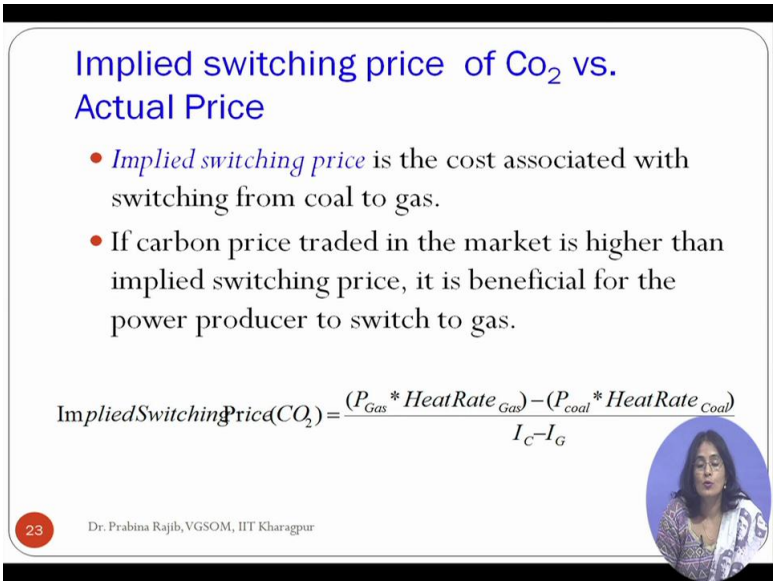

In fact when we equate these 2 equations clean dark spread equation and clean dark spread clean dark spread and spark spread equation what we get is something called a implied switching cost of carbon implied switching cost. So what exactly is implied switching cost or price is the cost associated with switching from coal to gas. See coal is a cheaper source of generating electricity, so naturally companies will be interested to use coal to generate electricity and when they generate and when they use coal they emit more GHG and they have to buy carbon credit. So if carbon credit price is more than they will be discouraged to use coal because if they use coal they have to end up they maybe saving on maybe saving on cheaper coal but they may end up paying a higher cost for buying carbon credits.

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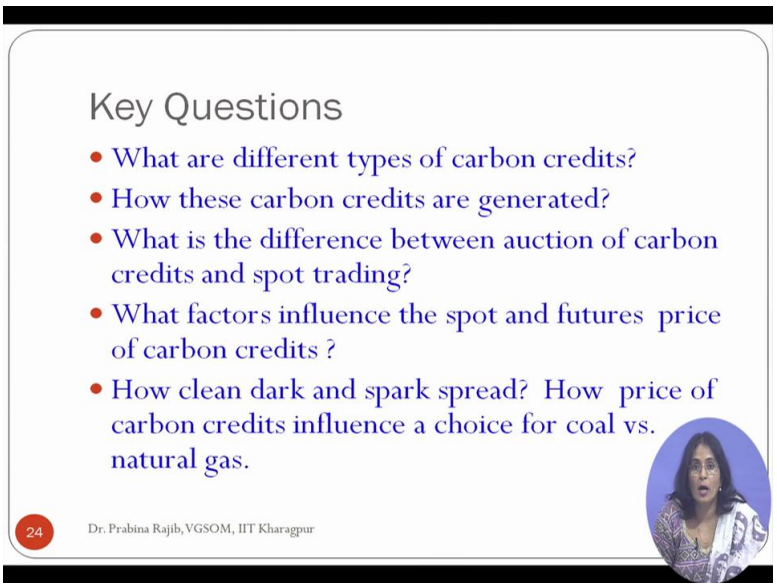

So if carbon price traded in the market is higher than the implied switching price than it will be beneficial for the power producer to switch to gas, so many power producer calculate this implied switching price and accordingly take a decision. Now with this we will end up our discussion. So just a key questions that is what is the different, what are the different types of carbon credits and how these carbon credits are generated, and what is the difference between auction of carbon credit and spot trading, and what factors influence the spot and futures price of carbon credits, and how clean dark and spark spread is calculated and how price of carbon credit influences the choice for coal versus natural gas. With this you we will be winding up our discussion on carbon credit. And as usual I am ending this session and looking forward to interacting with you in the next session, thanking all of you