Commodity Derivatives and Risk Management
Prof. Prabina Rajib
Vinod Gupta School of Management
Indian Institute of Technology, Kharagpur
Week-11
Lecture 54
Carbon credits and Carbon Credit Derivatives Market

Welcome to the 54th lecture on Commodity Derivatives and Risk Management. And today we are going to discuss various aspects of carbon credits and carbon credit derivatives market. Before we go and understand about the spot and derivative markets related to carbon or carbon credit, it is very important to understand what exactly carbon credit is? So, the definition of carbon credit is related to the emission of greenhouse gases. And all of us know that greenhouse gases are the prime contributor to global warming. And greenhouse gases basically trap the sun's heat in the earth's atmosphere, it is like putting a blanket on the earth and it leads to global warming and climate change. And all of us know that with global warming the earth is becoming hotter, leading to severe storms, drought, rising ocean, lot of loss of flora and fauna, lot of displacement is happening poverty, and the list is endless. And when we talk about greenhouse gases it is not only carbon dioxide, but we also have other harmful greenhouse gases such as methane nitrous oxide, hydrofluorocarbons etcetera. And when we are talking about one carbon unit, one carbon unit is measured as one kiloton of carbon dioxide equivalent. And what is the meaning of carbon credit? When one generates one carbon credit, one's effort leads to removal of one carbon unit from the earth's atmosphere. Let me repeat when one person or one company or any country would get one carbon credit, when that particular individuals or company's effort leads to removal of one carbon unit from the earth's atmosphere. And as all of us know, greenhouse gases lead to global warming and this particular image the right-side panel which I have taken from the World Bank website. As you can see the emission of greenhouse gases is increasing at an exponential rate as year on year, year on year it is going up. Only except for the year 2022 when the total amount of greenhouse gas declined about 2 million tons in the year 2022, this was because of the COVID related restriction in which lot of travel was restricted, lot of manufacturing activity could not be done. So, because of this COVID the amount of greenhouse gases which were generated from the earth to the earth's atmosphere reduced. Now, let us understand which sectors contribute to the maximum greenhouse gas emission. As you can see major sectors contributing to greenhouse gas emission comes from electricity and heat production. About 25 percent of the total greenhouse gas emission happens from electricity or power generation. So, burning of coal and natural gas and as well as other oil for electricity and heat contributes about 25 percent of the greenhouse gas emission. Similarly, agricultural activity forestry, and other land use, it

contributes to about 24 percent of greenhouse gas emission. So, cultivation of crops, livestock as well as deforestation leads to 24 percent of greenhouse gas emission. Other manufacturing industries contribute about 21 percent of the total greenhouse gas emission and of course, transportation 14 percent of the total greenhouse gas emission comes from the transportation sector. And please note that 95 percent of the world's transportation energy comes from petrol and diesel. So, these are the four major sectors which contribute towards the greenhouse gas emission. There are other activities related to greenhouse gas emission, but those are not very significant. In this context of the carbon market, it is very important to understand the historical development related to this carbon trading carbon market. Please note that in the year 1991 the United Nations Framework Convention of Climate Change which is popularly known as UNFCCC. So, this particular organization in the year 1991 started working towards reducing global warming. And in the 1995 the first conference of parties which is popularly known as COP, the COP 1 was held in the Berlin that happened in the 1995. And in the year 1997 at COP 3 which was held at Kyoto, the Kyoto Protocol came into existence. And this is a very important day in the sense on 11th December 1997 Kyoto Protocol came into existence. And what is the importance of the Kyoto Protocol? As part of this protocol or this protocol operationalize the UNFCCC's objective by committing industrial countries. Let me repeat this Kyoto Protocol operationalize the UNFCCC's objective by committing industrial countries to limit and reduce greenhouse gas emissions. So, many industrial countries agreed to limit and reduce the greenhouse gas emission as part of the Kyoto Protocol. And as part of this protocol all these member nations agreed to reduce, but the agreement was based on a principle of common but differentiated responsibility and respective capabilities. Basically, this principle of common, but differentiated responsibility and respective capabilities indicate that all these members nation agreed to reduce the greenhouse gas emission, but the extent or degree or the amount to which each of these countries are going to reduce will vary depending upon their capacity as well as different responsibilities. And please note that in the year 2022 we had the latest COP 27 meeting which was held at Sarm El Sheikh which is which is in Egypt. And as of now this UNFCCC has 192 member countries. And please note that even though the Kyoto Protocol came into existence in the year 1997, but it became a legally binding agreement on 16th February 2005 which is basically after 7 years as member countries had to take the approval at their country level. So, many countries showed interest in that they are going to abide by the requirement of the Kyoto Protocol, but they had to go back and get the same ratified in their country parliament. For example, USA signed the protocol Kyoto Protocol on 12th November 1998 during the presidency of Mr. Bill Clinton. However, the treaty could not be ratified by the Senate of USA for various reasons. So, even though the USA agreed to be part of the Kyoto Protocol, it could not be ratified and hence officially USA was not part of the Kyoto Protocol. Now, coming to the other countries which were part of the Kyoto Protocol, what initiative they did and how it led

to the emergence of carbon credit and carbon credit trading let us understand this aspect. Please note that the Kyoto Protocol set binding emission reduction targets for 37 industrial countries. So, as part of the Kyoto Protocol, 37 industrial countries agreed to reduce emission targets and these 37 countries are known as annex I countries. And what is the agreement these members did? Overall, all these members agreed to reduce 5 percent of their total emission which they were emitting in the 1990 level over the 5-year period which is the first commencement period of 2008 to 2012. Basically, what this particular detail indicates that if a particular country is emitting let us say x unit of greenhouse gas in the year 1990 it is going to commit to reduce the greenhouse gas emission by 5 percent of that 1990 level over a period of 2008 to 2012 which is known as the first commitment period. And article 3 of the Kyoto Protocol clearly spells out the details of the emission reduction. I will just read out what is given in the quote unquote as you can see the Kyoto Protocol article 3 stated that the parties included in annex I shall individually or jointly ensure that the aggregate anthropogenic GHG emission listed in annex A do not exceed their assigned amount calculated which is about at least 5 percent below 1990 levels in the commitment period of 2008 to 2012. And here please note that annex A so this annex A detail I have provided also in the right panel the annex A lists the which gases will be part of the greenhouse gases. So, for the first time Kyoto Protocol identified emission of this carbon dioxide, methane etcetera will be part of the greenhouse gas emission list and which sectors of a particular country will be asked to reduce the greenhouse gas that detail is also clearly is mentioned or articulated in the annex A of Kyoto Protocol. As you can see the sector or sources or categories of companies which will work towards reducing the greenhouse gas commission greenhouse gas emission that is your energy and under the energy fuel combustion energy industries manufacturing industry and construction industry. So, various kinds of industry will be required to reduce their greenhouse gas emission. As mentioned just now, annex A clearly lists the greenhouse gas emission and also the targeted industry and the sectors which would work towards reducing the greenhouse gas emissions. Please note that annex I is the list of countries annex I of the Kyoto Protocol indicated the list of countries 37 industrially industrialized countries which are going to be part of the protocol and annex A listed out the list of greenhouse gases and which industries belonging to which companies belonging to these 37 industrialized nations will be working towards reducing greenhouse gas emissions. Now, let us understand how a country who is part of the annex I would arrive at the amount of greenhouse gas emission to be to be reduced or to be controlled. As you can see from the right panel which is also known as annex B of the Kyoto Protocol that particular annex B lists the country against the percentage of emission limitation or reduction commitment percentage of the base year. For example, Australia agreed to reduce 108 percent of the total emission which was done in the year 1990. We will take a numerical example to understand this aspect. So, this annex B lists all 37 countries' percentage of commitment. Now, I have just for the sake of simplicity I

have given only the list of few countries the if you go to the UNFCCC Kyoto Protocol website you will be able to get the complete list of all countries and how much of emission reduction target, they had set for themselves. Please note that these numbers are varying, this percentage is varying to indicate this is that everybody has agreed to a common principle, but the approach or the extent of reduction is different from country to country. So, that is what the common yet differentiated approach as articulated by the Kyoto Protocol. Now, let us come to the next part that is annex I countries accepted different targets for limiting or reducing the emission annex B indicates the list of annexes 1 countries and their commitment percentage. And this emission reduction percentage also sets the allowable level of emission for a given country. So, based on this percentage a specific amount of greenhouse gas will be allowed to emit or industries belonging to a particular country will be allowed to emit that amount of greenhouse gases. So, let us understand how exactly that calculation will be done, but before that each of these units will be known as assigned amount units or AAUs. So, AAUs are defined as allowance to emit 1 ton of carbon dioxide equivalent. So, now let us understand how the assigned amount unit for Australia will be calculated. Please note that the level of emission in the base year 1990 into the emission limit percentage that is 108 percent for Australia into the number of years in the commitment period that was 5 years. So, as you can see the Australia's level of emission greenhouse gas emission was 4,18,372 units in the year 1990 multiplied by 10 percent into 5. So, that gave 2.259 million units of carbon dioxide equivalent. So, that means, the companies or industries which are part of the annex A belonging to the Australia will be allowed to emit this many units of carbon dioxide over the 5 years. And this unit, that is this number 2.259 million carbon dioxide equivalent became a cap or the emission cap or the maximum amount of greenhouse gas a country can emit. When we are talking about a country can emit, we are meaning that the industries which are part of the annex A list belonging to a country can emit. Now, let us take a simple example of how exactly this cap is set and how cap and trade program of Kyoto Protocol is done. Let us say we have country A and the total permitted units is 100 units. The way we calculated 2.259 million AAUs for Australia, let us say country A has 100 unit of AAU's. Now, let us say this country has only 2 companies which are part of annex A let us say company A and company B and based on company A's activity the country allocates 60 units of AAU to company A and 40 units of AAU are allotted to company B. And this difference in unit comes from the industrial activity of the or volume of activity done by both company A and B. Let us say inherently historically company A is a big company, company A's business is much higher than the company B. Hence the country government decides to allocate 60 units of AAU to company A as compared to company B. Now, let us say during the 5-year period the actual emission by company A is 45 units while for company B it is 50 units. So, as you can see there is going to be a surplus of 15 units for company A while there is going to be a deficit of 10 units for company B. And as part of the Kyoto Protocol the

UNFCCC required countries to create a platform where the buyers and seller's deficit companies and surplus companies will be able to come to a common platform and trade the surplus and deficit. So, basically as you can see company A has been able to underachieve the target. So, it is getting 15 units as surplus, and this is happening maybe the company has undertaken lot of investment major to reduce the greenhouse gas emission. So, obviously, to encourage the company A to continue with this kind of activity obviously, company B will be penalized, and company A has to be encouraged and a market-based initiative has to be done where B will be paying money to A and A will be able to benefit from the efficiency major or benefit from the reduction in greenhouse gas emission it is doing. So, this concept is known as cap and trade. Please note that the 100 unit is the cap and these 100 units for a country level will be distributed among the industries based on countries own understanding and those units becomes the cap for the individual companies. And if a particular company does not go beyond the cap that particular company has surplus and if a particular company greenhouse gas emission is much more than the cap set that particular company has to buy the excess amount of greenhouse gas emission it has done. So, this is the first kind of initiative which was brought in by the Kyoto Protocol which is known as your cap-and-trade program. In this context, please note that countries also need to create a national registry to maintain records related to greenhouse gas emission by different companies or industrial units. And this national registry is going to be part of the international transaction block which will be operated by the United Nations climate change secretariat. So, every country will be maintaining a registry, or a record and that record will also be reflected in the international transaction log maintained at the UN climate change secretariat. And please note that this is the first or more major initiative of the Kyoto Protocol. In addition to this cap-and-trade system United Nations framework or UNFCCC also allowed countries to meet the greenhouse gas reduction targets through three other initiative that is called as your Clean Development Mechanism or CDM Mechanism, Joint Implementation Mechanism JI and RMUs that is Removal Units. We will understand what these three other mechanisms are and how Kyoto Protocol goes about implementing all these three different mechanisms. However, before we proceed to discuss more aspects related to CDM, JI or RMU let us understand what initiatives which have been done by European Union. The European Union as a group of countries has done a considerable amount of effort in making the carbon market successful. So, the European Union progress related to limiting greenhouse gas emission by the member countries has been very commendable. So, in this context let us understand how the European Union has gone about undertaking that initiative. As part of this European Union initiative related to carbon reduction of carbon credits, the whole central theme of European Union revolves around European Union ETS that is Energy Trading System Carbon Credit Auction. So, let us understand what exactly this carbon credit auction is done and why it is done. Please note that in the previous slide we discussed that AAUs

are distributed by a country government among the different industries. Please recall just one slide before we were discussing let us say particular country had 100 units of AAU and it allocates 60 unit and 40 unit of AAUs to company A and company B. In this context, please note that the European Union does not allow or does not give these 60 units or 40 units freely. It creates an auction platform that company A and company B have to bid for the units whatever number of units they want to have that they have to buy, and this is known as your EU ETS primary auction of carbon credits. So, let us go ahead and understand how exactly the auction is done. So, as you can see, the European Union auctions the units which are known as EUA. Please note that the same carbon credits are known in a different manner at different places. So, basically the European Union auctions the units carbon credit units which are known as European units. So, this is the same thing as European Union and European units are not given free, and EU basically follows a principle that the polluter pays, and these units are auctioned. So, please see the right panel data the latest auction was held on 29 June 2023 and as part of the auction 24 million of carbon credits were auctioned off and total amount of bid units as you can see it was about 51 million and the cover rate or over subscription rate is 2.12, that is for every one unit of carbon credit which has auctioned off total buyers that is the companies who are interested or who are mandated to buy mandated to have these carbon units 2.12 times bidding happened and number of bids submitted is 87 number of successful bidders is 20. So, we will go ahead and understand what the context of successful bidder is here, and maximum price bid is 120 euro per ton carbon dioxide equivalent and discovered price please note that the price at which the European Union sold the carbon credits to the bidders is at 86.6 euro per ton of carbon dioxide equivalent and total amount collected is basically 86.6 into 24 million of auction volume. And in this context please note that the auction process which is followed by the EU-ETS is nothing, but the same process which is done in case of a book building process done for initial public offer for share selling. I am sure all of you have heard about the IPO offer conducted by companies in which the companies sell shares to general public and the companies undertake a process called book building. So, the same process of book building is undertaken by the EU-ETS carbon auction. We will take a numerical example to understand what the concept of book building is and how the discovered price 86.6 is arrived through the auction process. In this context, please note that the auction proceed goes to the respective countries depending upon the successful bidders from this 29 June 2023 auction as you can see Australia sorry Austria received this amount Belgium received about 5.519 or 5.19 million Bulgaria received about 8.57 million euro. So, different countries will be receiving different amounts of money depending upon the number of successful bidders coming from a specific country. Now, quickly let us understand what exactly the book building process is and how the auction price is arrived at EU-ETS. We will draw an analogy and take a simple example to understand the EU-ETS uniform auction price of the book building. This auction concept please note that let

us say a particular company which is wants to sell 5000 shares and this particular company is soliciting bid from different bidders. So, different bidders will be giving different bid quantities at different prices. As you can see the price depending on anybody's interest, how many shares the particular person will be buying at what price that price comes. So, once the bid closes the company starts doing a book building process. Please note that the total bid quantity is 7840 when the company has basically wanted to sell 5000 shares. So, once this particular detail comes to the company, the detail which is given in this block having different bidders different bid quantity and bid price. The company starts the process of book building. The process of book building is in the process in which the highest bidder is giving the priority. In this case as you can see the person E has bided 650 quantities, but the bid price is the highest price among all so, 86 is the bid price. So, this particular person is given the highest priority. Similarly, in ascending order the bid price the bid volume is in a bid volume is identified and also the cumulative bid volume is calculated. As you can see at a price of 72 total cumulative bid volume is 5245. Please note that the company wanted to sell 5000 units of share and at a price point of 72 you have 5245 shares are demanded. So, the company which is selling the shares would not be interested in what other members like CFJL have bided. So, what the company would go ahead and find company would inform everybody that the discovered price is 72, but please note that in the price of 72, 5245 shares are demanded, but the company wants to sell 5000 units. So, what the company would do the cutoff ratio will be 0.953 which is basically 5000 divided by 5245. So, this 0.953 is going to be the cutoff ratio in that sense a successful bidder E, E has a successful bidder it had bided about 650 units, but the company is going to allocate 620 units to the bidder E. Similarly, for other bidders the company will go ahead and allocate different units. So, that the total amount of allocation will be done for 5000 number of shares and the discovered price is 72. So, this is a simple example of a book building process. Please note that CFJL, even though they have bided different amounts, but they will not be allocated any shares, or they will not be able to buy the shares. So, basically it is the seller who is conducting the bid, and it is a uniform price auction means every allocated bidder will be paying 72 euro or 72 rupees or 72 dollars for buying 1 unit of share. In that sense Mr. E is going to pay 620 into 72, B is going to pay 238 into 72 and so on so forth this amount will be calculated. Please note that the same book building process is done by the European Union Energy Trading System to allocate the carbon greenhouses to the house gas GHG carbon credits to different companies. And this process and whatever the money which is being collected through the auction process will be divided among the member nations of European nation European Union depending upon the number of successful bidders who is coming from which country. So, with this we will end today's discussion or introductory session on carbon credit. In fact, the discussion related to carbon credit can run into 6 to 7 hours basically 10 to 12 sessions, but we do not have the luxury of going into so much detail. Please note that lots and lots and lots and lots of initiative is being

done by UNFCCC at a country level, at company level, at universities level, at different mutual funds level, even at an individual level to reduce the greenhouse gas emission. So, lots of market-related activities buying, selling and many new concepts are there. I will try my level best to highlight or bring out the essence of different initiatives being done in the coming 2 to 3 lectures. However, for today we are ending the session on the introduction part of carbon credit and how cap and trade system works with respect to carbon trading. We will continue with the remaining part of the discussion related to carbon trading carbon derivatives in the next session. Once again, I eagerly look forward to interacting with all of you in the next session.