

System Design for Sustainability
Prof. Sharmistha Banerjee
Department of Design
Indian Institute of Technology, Guwahati

Week -11

Lecture – 02

Other Design for Sustainability Tools and approaches – Carbon Footprint

Hello everyone, so, today is the last lecture on series of sustainability tools and approaches and today we will be discussing about the concept of carbon footprint. So, we will not only discuss only carbon footprint, but we will discuss about some of these concepts that is represent on the slide.

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So, carbon credits, carbon footprint, carbon trading, clean development mechanism, carbon trade exchange and carbon neutral. You might have come across all these terminologies and this lecture tries to explain what these terminologies means.

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The screenshot shows the IndiGo website's payment interface. At the top, there are navigation links for 'Contact us', 'Travel Information', 'Special Assistance', 'Career', and 'Weather Update'. Below these are icons for 'Search', 'Select', 'Passenger', 'Payment', and 'Itinerary'. The main content area is divided into several sections:


- Good Cause:** Includes 'Good Karma' (Yes, I wish to contribute Rs. 10 towards 'Di Se Diye Dus Rupay' campaign) and 'Clear The Air' (Contribute Rs. 100 to fund low-carbon initiatives). The 'Clear The Air' option is highlighted with a green box.
- Promo Code:** Fields for 'Promo Code' and 'Credit/Debit Card No.' with an 'Apply' button.
- Payment Method:** A list of options including 'Credit / Debit Card', 'IndiGo Cash', 'Voucher', 'Net Banking', 'Wallet', 'EMI', 'Hold and Pay Later', and 'Others'. The 'Credit / Debit Card' option is selected.
- PRICE SUMMARY:** A table showing flight details and costs. The total price is 5,782.00 INR.

At the bottom, there is a checkbox for 'I have read and understood all of the fare restrictions. I agree to the Terms and Conditions.'

So, if you have booked air ticket through IndiGo, you might have seen this green box. So, just before you are about to make a payment it as you clear the air contribute rupees 100 to fund low carbon initiatives. So, what does this imply? So, whenever you take a journey using an aircraft because of your journey, because of the air craft, you are releasing certain kind of gases and the atmosphere. You are causing certain kind of damaging effect efforts on the environment.

So, many airlines have come up with this concept that you can contribute certain amount which is a compensatory amount and that amount will be used for doing for funding certain low carbon initiatives.

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InterGlobe Aviation Limited
Level 5, Tower C, Global Business Park, DLF City Phase III, Gurgaon 122 002, Haryana, India
T: + 91 (0) 124 435 2500 F: + 91 (0)124 406 8036 www.goindigo.in

IndiGo goes Green; commits to low-carbon rural development programme

- Becomes the first airline in India to partner with Fair Climate Network for Low Carbon Rural Development
- Option for 6E flyers to voluntarily contribute Rs. 100 per booking towards reducing carbon footprint while improving quality of living and household earnings

India, February 8, 2014: IndiGo today announced its partnership with the Fair Climate Network (FCN), a consortium of NGOs committed to promoting simple measures that improve rural livelihoods and reduce carbon pollution. Through this partnership, IndiGo will enable its flyers to voluntarily contribute Rs 100 (per PNR) towards this cause. The revenue generated through this voluntary contribution will be

So, if we go into the press release by IndiGo in this context. So, indigo says that IndiGo goes green, commits to low carbon rural development programme. So, in India it is it claims to be the first airline to partner with fair climate network for low carbon rural development. So, this entire concepts that we are going to discuss today about carbon credits, carbon footprint, carbon trading, clean development mechanism, carbon trade exchange and carbon neutral. They are all about offsetting the damaging effects done by certain agencies or by certain individuals.

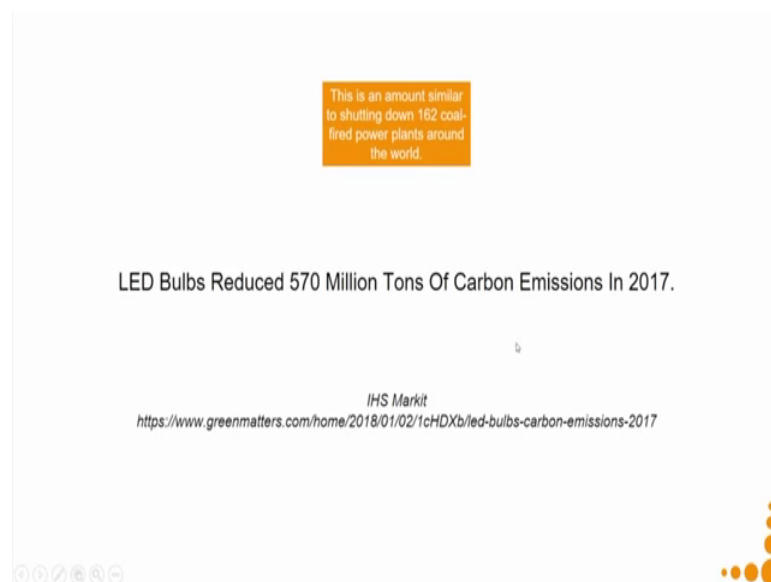
So, as per the Kyoto protocol one so, the Kyoto protocol decided that let us have a mechanism in which we can prevent the developing countries or rather say we can help the developing countries to come up with green solutions or say low carbon solutions. And these activities can be funded by developed countries whenever they want to offset the carbon which is being produced because of their activities.

This is again a concept which is based on life cycle assessment. So, what is IndiGo trying to do in a with this 100 rupees that it ask you to contribute in case you want to do away with the carbon footprint? Of course, that is a 100 rupees for everybody, it does not differentiate whether you are travelling 500 kilo meters or whether you are going to travel 2000 kilo meters.

So, in order to be able to offset the environmental damages caused because of me flying, I can contribute this 100 rupees, which IndiGo will use to bring wind powered electricity to certain rural areas.

So, because of this wind power electric generation which will happen in these rural areas there will be some kind of carbon offsetting happening which will be. So, may be as an airline company they might have calculated that overall when they do it for all their willing customers, they might be able to achieve so, much of offset of their pollution per year.

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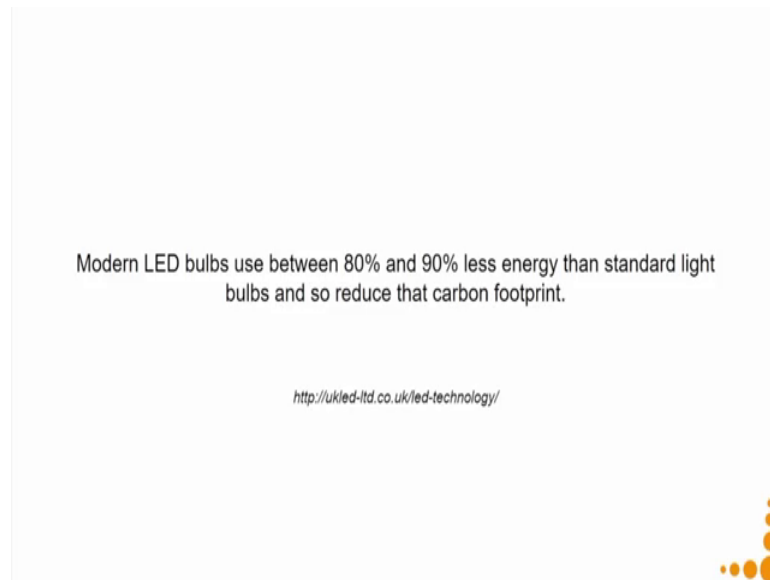
LED bulbs reduced 570 million tons of carbon emission in 2017. So, this is from one of this kind of information keeps on coming a newspaper.

So, like LED bulbs reduce 570 million tons of carbon emission how did we calculate them? So, we are going to compare it with say CFL bulbs or incandescent bulbs. So, we compare all the 3 bulbs say for example, and then see that if I have bring in LED because they are more energy efficient how much energy I could save with respect to that of using incandescent bulb?

So, it is not that LED bulb, in itself is very environmental friendly solution what it implies is with respect to your incandescent bulb it is a more environmentally friendly solution.

How? Because, if I had used an incandescent bulb whereas, if I use a LED bulb, I will be or on a global scale on an average in 2017 we could save around 570 million tons of carbon emission. So, this is an amount similar to shutting down 162 coal fired power plants around the world.

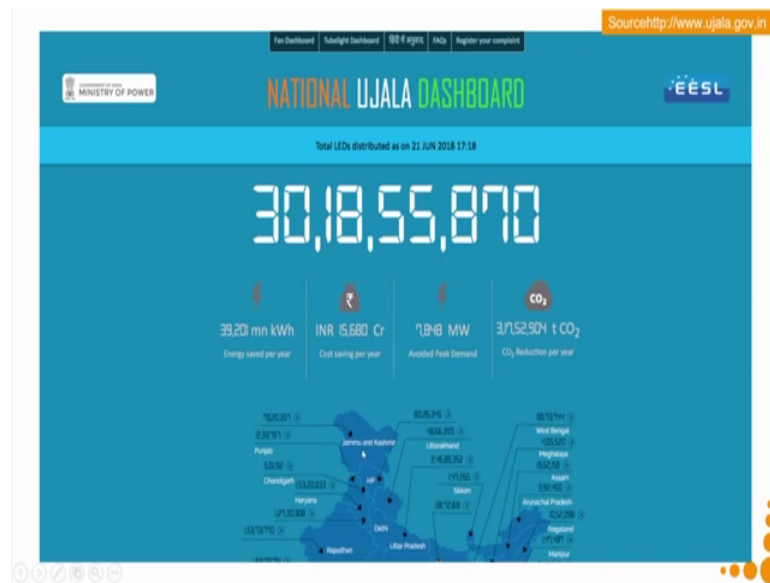
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Why this is possible because, modern LED bulbs used between 80 to 90 percent less energy than standard light bulbs and. So, reduce that carbon foot print because I will have to spend less on generating that electricity. So, electricity generation the carbon which would have got emission emitted in the electricity generation is now been prevented.

So, that is how this whole reduction in carbon footprint business works.

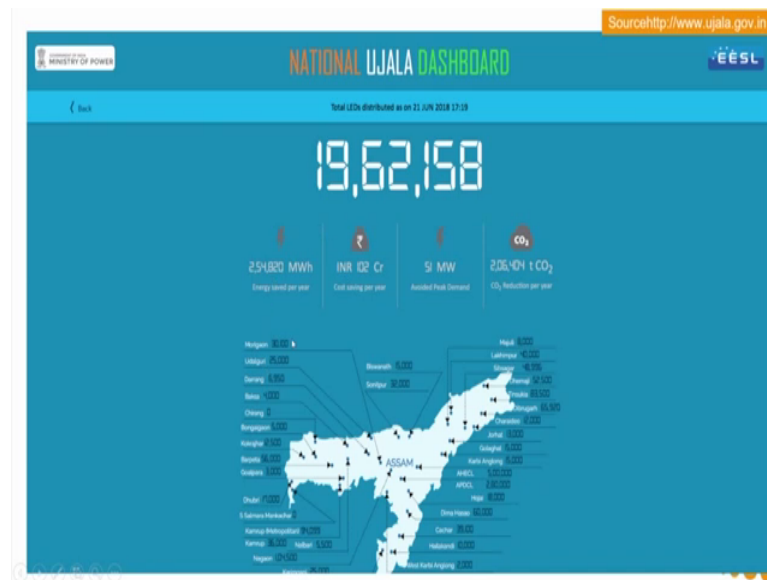
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There is a website it is called the National Ujala Dashboard. So, Ujala is a program by the government of India under which the discoms and uncertain other companies they are distributing LED bulbs. So, when you go on to this website it will show you in real time total LED distributed save this data was picked up on 21st June 2018 as 17-18.

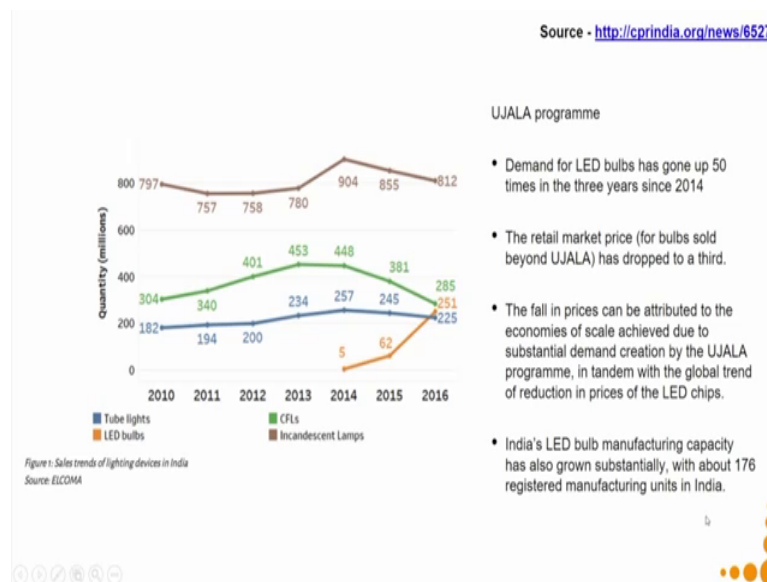
So, you can see that there are so, many LED bulb. So, which have been distributed by this program which has done energy saved per year is 39,201 million kilowatt or how much money it has saved, how avoided peak demand how much, then how much of carbon dioxide reduction per year has happened. If you go to one of these particular states, and click their. So, this is the data for Assam.

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So, again another real time data, and it is a district wise data which shows how much bulbs have been distributed in this particular area.

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So, this is a particular graph which shows tube lights number of tube lights in million so, quantity in millions versus the year. So, starting from 2010 to 2016 tube lights, LED bulb, CFL's and incandescent labs. So, you can see that the LED bulbs from 2014 because of the Ujala scheme there is a spike in the number of led bulbs in the country.

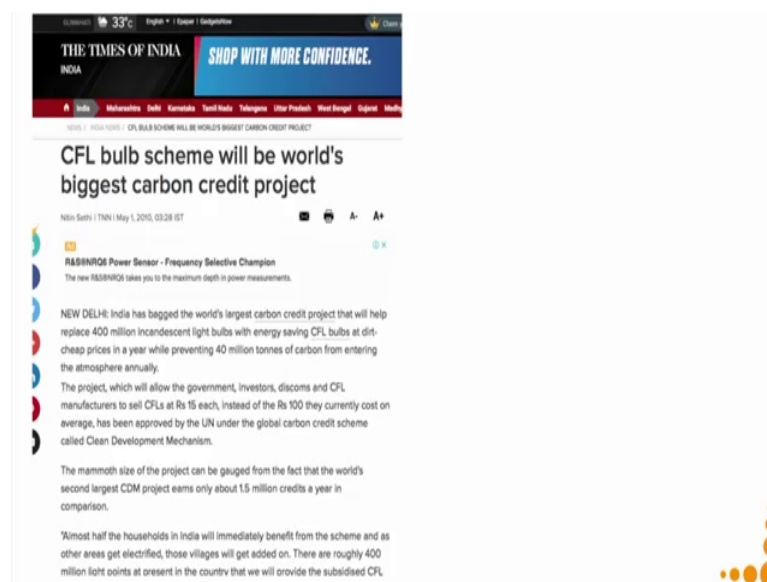
Whereas, in other bulb other lighting fixture. So, say for example, this blue and is for the tube light, there is a minor decline in case of the CFL's there is a sharper decline.

So, incandescent bulbs consume a very much more larger amount of energy, CFL bulbs where much more environment friendly because, they consume lesser energy as compared to incandescent lamps. And now LED bulbs have come into the market, which consume even lesser amount of energy.

Also because of this particular program demand for LED bulbs has gone up by 50 times in the 3 years since 2014. The retail market price for bulb sold under Ujala has dropped to a third, why so? So the fallen prices can be attributed to the economies of scale achieve due to substantial demand creation by the Ujala program in tandem with the global trend of reduction in prices of the LED chips.

So, when demand goes up usually the price of those products fall down because of the scales economies of scales. Also India's LED bulb manufacturing capacity has also grown substantially with about 176 registered manufacturing units in India which are now producing LED bulbs.

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So, let us go back to first May 2010. So, this is an article from times of India from first May 2010 which talks about CFL bulbs scheme, scheme will be the world's biggest carbon credit project. So, at that point of time before this carbon credit project came into

CFL bulbs are quite expensive, as a result most people would not like to buy those bulbs. But, this project came up in which.

So, the project which will allow government investors discoms and CFL manufacturers to sell CFL's at rupees 15 each instead of rupees 100 so, what this carbon credit project did? It paid for the rest of the 85 rupees. So, because if lots of homes in India, which is a developing country buys these CFL bulbs, they will be savings on the energy. As a result there will be carbon credit available because, they are saving on that carbon dioxide emission.

So, there can be other companies or other organizations in developed countries who have to because for their operational purposes who are going to release damaging environmental effects they can buy this credits from India. As a result the CFL bulb prices can go down. So, this offsetting will pay this 85 rupees. The result of which will be because now the CFL bulb cause only 15 rupees. So, more and more people will buy it and use it bringing in greater savings in the energy consumption.

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The screenshot shows a news article from The Times of India. The headline is "CFL bulb scheme will be world's biggest carbon credit project". The article is dated May 1, 2010. The main text describes a project where India will replace 400 million incandescent light bulbs with energy-efficient CFLs. This project is approved by the UN under the Clean Development Mechanism. The article mentions that the project will allow the government, investors, and manufacturers to sell CFLs at Rs 15 each, instead of the average price of Rs 100. The article also states that the investor sells the carbon credit in the international market where buyers – such as manufacturers and power producers in Europe – buy the certificates to meet the greenhouse gas emission reduction targets the countries have set for them. At present, each certificate sells at around 10-12 Euros in the international spot market. BEE estimates that investors will be able to recover the rest of the Rs 85 per bulb by 5-6 years and by the 7th year, earn some on the top. BEE has in its scheme ensured that the CFL bulbs are of a standard that they last that long.

So, at that point of time this was 2010 report from 2010 each certificate would sell each carbon credit certificate would sell at around 10 to 12 Euros in the international spot market. So, that is where the concept of carbon trade exchange also comes. It is kind of a trading situation which has been developed where in people can trade their carbon credits, people can buy carbon credits and people can sell their carbon credits.

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Clean Development Mechanism

- The CDM allows emission-reduction projects in developing countries to earn certified emission reduction (CER) credits, each equivalent to one tonne of CO₂.
- These CERs can be traded and sold, and used by industrialised countries to meet a part of their emission reduction targets under the Kyoto Protocol.
- The mechanism stimulates sustainable development and emission reductions, while giving industrialised countries some flexibility in how they meet their emission reduction limitation targets.
- The CDM is the main source of income for the UNFCCC Adaptation Fund, which was established to finance adaptation projects and programmes in developing country, parties to the Kyoto Protocol that are particularly vulnerable to the adverse effects of climate change.
- The Adaptation Fund is financed by a 2% levy on CERs issued by the CDM.

Source: <https://cdm.unfccc.int/about/index.html>

So, let us understand what this clean development mechanism implies. So, the clean development mechanism or the CDM as it is called, it allows emission reduction projects in developing countries to earn certified emission reduction credits CER each equivalent to one ton of carbon dioxide. We will in this particular definition it is very important to see this aspect which says each equivalent to 1 ton of carbon dioxide. We will shortly come into discussing what it means.

So, these CERs can be traded and sold and used by industrialized countries to meet a part of their emission reduction target under the Kyoto protocol. So, say for example, a country a developed country x has set for themselves that they are equivalent their carbon dioxide emission reduction has to be reduced by 12 level of 200.

So, but their production processes cannot stop. So, what they can do is the you can fund certain activities and developing countries say setting up solar power stations or setting up wind power stations. Because, the solar power station will generate electricity which will have some offsetting effect on the otherwise the CO₂, which might have got emission because of a thermal power plant will help them in buying carbon credits.

So, it is again like a concept in which we considered the whole globe as one entity. So, entity x cannot reduce their carbon footprint. What they will do is they will fund entity why to set up offsetting activity. So, the mechanism stimulate sustainable development and emission reduction.

While giving industrialized countries some flexibility in how they meet their emission reduction limitation targets. The CDM is the main scope of income for the UNFCCC adaptation fund which was established to finance adaptation projects and programmes in developing countries parties to the Kyoto protocol that are particularly vulnerable to the adverse effect of climate change. So, the adoption fund so, for each CER credit they take 2 percent levy on CER's issued by the CDM.

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https://cdm.unfccc.int/Issuance/SOPBy/ProjectsTable.html

The share of proceeds from the clean development mechanism project activities for the Adaptation Fund

Total: 38,830,888

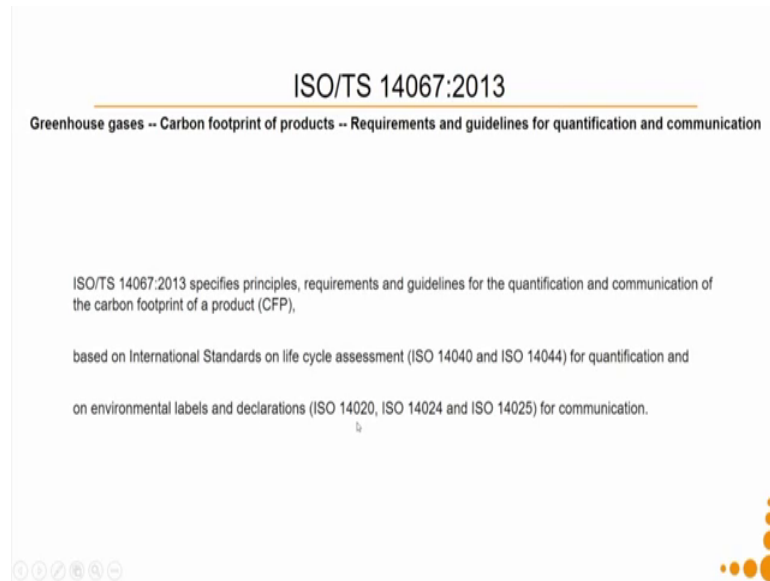
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Displaying 1-20 of 9577 notifications.

Ref	Project Title	2% CERs for Adaptation Fund	Host Party	Other parties involved
2636	A/UNG-S-01, Methane Recovery and Biogas Utilization Project, Nghe An Province, Vietnam	957	Viet Nam	Switzerland Sweden Netherlands Norway
6637	Reduction of N2O emissions from the new nitric acid plant #5 of Hu-Chem Fine Chemical Corp.*	1,763	Republic of Korea	Algeria
4928	Huangqi Changji Phase 3 Wind Farm Project	8,432	China	United Kingdom of Great Britain and Northern Ireland
2637	A/UNG-S-02, Methane Recovery and Biogas Utilization Project, Nghe An Province, Vietnam	349	Viet Nam	Switzerland Sweden Netherlands Norway
5746	CCN Inner Mongolia Sunleyouq Phase 3 Windfarm Project	4,791	China	United Kingdom of Great Britain and Northern Ireland
0765	Catalytic N2O destruction project in the tail gas of three Nitric Acid Plants at Hu-Chem Fine Chemical Corp.	6,917	Republic of Korea	Austria Germany
0851	Daegu Bangechon-RI Landfill Gas CDM Project	4,981	Republic of Korea	Switzerland United Kingdom of Great Britain and Northern Ireland
7215	Bundel 9.00 MW wind power Generation project in Rajasthan, India by M/s. Gangathar Narsingh Agrawal Group	427	India	United Kingdom of Great Britain and Northern Ireland
0009	La Esperanza Hydroelectric Project	587	Honduras	Canada Netherlands Italy Denmark

So, if you go onto this particular website UNFCCC is a website you can see list of projects. So, you can see here it is showing 9,577 notifications. So, you can see list of projects; if you can see that 2 percent of CER so, adaptation fund this is the amount. So, you can know how much amount this whole project is worth off. Then the host party it is the place where the CER project the developing country where the CER credit is being 1 and these are the other parties, who are going to fund those activities and they are all developed countries.

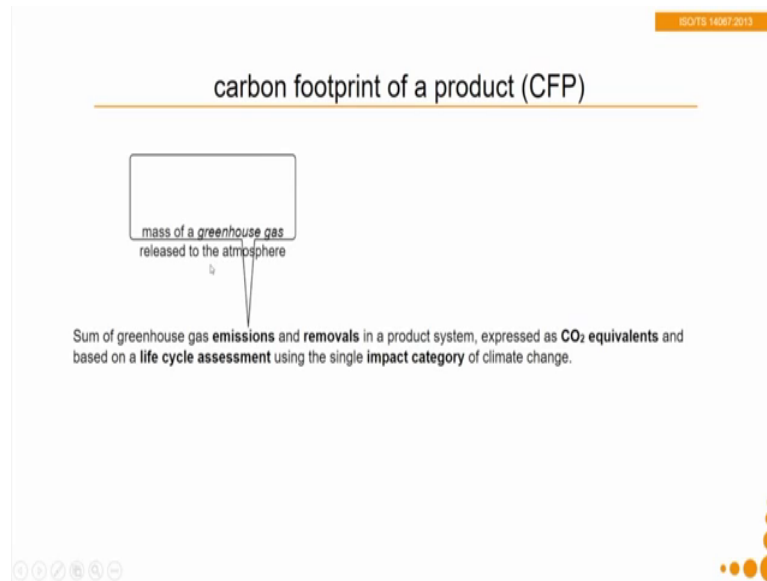
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There is also an ISO standard for this particular activity like how do we do this carbon footprint calculation for products. So, this is called as ISO TS 14067 and this latest version is from 2013. So, that is why the year 2013. So, it is called as greenhouse gases carbon footprint of products requirements and guidelines for quantification and communication.

So, it specifies principles requirements and guidelines for the quantification and communication of the carbon footprint of a product. It is based on international standards on life cycle assessment. So, when we were discussing about the life cycle assessment we shortly touched upon the fact that it is based on 2 ISO standards 14,040 and 14,044. So, it is this standard is based on that particular standard on environmental labels and declarations for communication.

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So, according to this particular standard the carbon footprint of a product CFP is defined as some of greenhouse gas emissions. So, when I say greenhouse gas emissions there comes the concept of equivalents of carbon dioxide. So, there might be sulphur based, sulphur oxides, they might be nitrogen oxide, they might be methane all those greenhouse gases they are converted into equivalents of carbon dioxide for the ease of making the standard.

We had also discuss this while we were discussing the life cycle assessment of a product. So, carbon foot print of a product is somehow green house gas emissions and removals in a product system expressed as carbon dioxide equivalents and based on a life cycle assessment using the simple is using the single impact category of climate change. So, when I am talking about greenhouse gas emissions is the mass of greenhouse gas released to the atmosphere.

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ISO 14067:2013

carbon footprint of a product (CFP)

of a greenhouse gas removed from the atmosphere

Sum of greenhouse gas **emissions** and **removals** in a product system, expressed as **CO₂ equivalents** and based on a **life cycle assessment** using the single **impact category** of climate change.

The slide features a title bar with 'ISO 14067:2013' in the top right corner. The main title 'carbon footprint of a product (CFP)' is underlined. A callout box points to the word 'removals' in the definition. The bottom left contains navigation icons, and the bottom right has a decorative graphic of four orange circles of increasing size.

So, emissions is about what is released to the atmosphere, removal is of a greenhouse gas, remove from the atmosphere. So, there can be certain activities in due to which greenhouse gases will be removed from the atmosphere.

So, say for example, if my product system involves planting a tree which is also going to absorb some amount of greenhouse gases. So, in my product system I have certain ways in which I am also removing it. So, is similar to also like just try to recall your life cycle assessment lectures, where we also spoke about how certain activities can get you credits for removing damaging effects from the environment say for example, certain recycling activities if you use certain amount of recycle products and so, on

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ISO/TS 14067:2013

carbon footprint of a product (CFP)

Sum of greenhouse gas **emissions** and **removals** in a product system, expressed as **CO₂ equivalents** and based on a **life cycle assessment** using the single **impact category** of climate change.

mass of a greenhouse gas is converted into CO₂ equivalents using global warming potentials

Navigation icons: back, forward, search, refresh, close.

So, both emissions and removals carbon dioxide equivalent. So, mass of a greenhouse gas is converted into carbon dioxide equivalents using global warming potential.

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ISO/TS 14067:2013

carbon footprint of a product (CFP)

Sum of greenhouse gas **emissions** and **removals** in a product system, expressed as **CO₂ equivalents** and based on a **life cycle assessment** using the single **impact category** of climate change.

1 x – carbon dioxide (CO₂)
25 x – methane (CH₄) – Releasing 1 kg of CH₄ into the atmosphere is about equivalent to releasing 25 kg of CO₂.
298 x – nitrous oxide (N₂O) – Releasing 1 kg of N₂O into the atmosphere is about equivalent to releasing 298 kg of CO₂

Navigation icons: back, forward, search, refresh, close.

So, say for example, 1 unit of carbon dioxide is the base unit for example; methane is if you are talking about methane then releasing 1 kg of methane into the atmosphere is about equivalent to releasing 25 kg of carbon dioxide. So, we multiply it by 25. In case of a nitrous oxide, 1 kg of nitrous oxide into the atmosphere is about equivalent to

releasing 298 kg's of carbon dioxide. So, I multiply by 298 x. So, that is how my concept of carbon dioxide equivalent comes up.

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ISO 14067:2018

carbon footprint of a product (CFP)

Sum of greenhouse gas **emissions** and **removals** in a product system, expressed as **CO₂ equivalents** and based on a **life cycle assessment** using the single **impact category** of climate change.

compilation and evaluation of the inputs, outputs and the potential environmental impacts of a *product system* throughout its *life cycle*

The slide features a title 'carbon footprint of a product (CFP)' underlined. Below it is a definition: 'Sum of greenhouse gas emissions and removals in a product system, expressed as CO₂ equivalents and based on a life cycle assessment using the single impact category of climate change.' A callout box points to the definition, containing the text: 'compilation and evaluation of the inputs, outputs and the potential environmental impacts of a product system throughout its life cycle'. The slide also includes the ISO 14067:2018 logo in the top right and a decorative graphic of orange circles in the bottom right.

Life cycle assessment so, it is compilation and evaluation of the inputs, outputs and potential environmental impacts of a product system throughout its life cycle likely head already covered.

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Offsetting

Mechanism for compensating for all or for a part of the **CFP** through the prevention of the **release of, reduction in, or removal of** an amount of **greenhouse gas emissions** in a **process** outside the boundary of the **product system**.

Example of **investment outside the relevant product system**: in renewable energy technologies/ energy efficiency measures/ afforestation/ reforestation and so on.

The slide features a title 'Offsetting' underlined. Below it is a definition: 'Mechanism for compensating for all or for a part of the CFP through the prevention of the release of, reduction in, or removal of an amount of greenhouse gas emissions in a process outside the boundary of the product system.' Below the definition is an example: 'Example of investment outside the relevant product system: in renewable energy technologies/ energy efficiency measures/ afforestation/ reforestation and so on.' The slide also includes a set of navigation icons in the bottom left and a decorative graphic of orange circles in the bottom right.

Then coming to offsetting so, how are we defining offsetting as per the standard. So, mechanism for compensating for all or part of the CFP through the prevention of the release of reduction in or removal of an amount of greenhouse gas emissions in a process outside the boundary of the product system. So, it has to be outside the boundary of your own product system then I am calling it as a offsetting process.

So, say example prevention of the release off. So, if I know that my production process or my product releases so much amount of carbon dioxide equivalent or so, much amount of green house gas then I might do certain activity say some adsorption technique. So, that the release is prevented or say I can do certain amount of reduction into it or say some amount of removal say for example, investment outside the relevant product system.

Say in renewable energy technologies so, when I say that I am preventing the release of my emission of greenhouse gases at the factory gate itself what I am considering is I am still inside my product system. But, the offsetting activity over here to be able to get carbon credits and so, on, it has to happen outside the boundary of the product system.

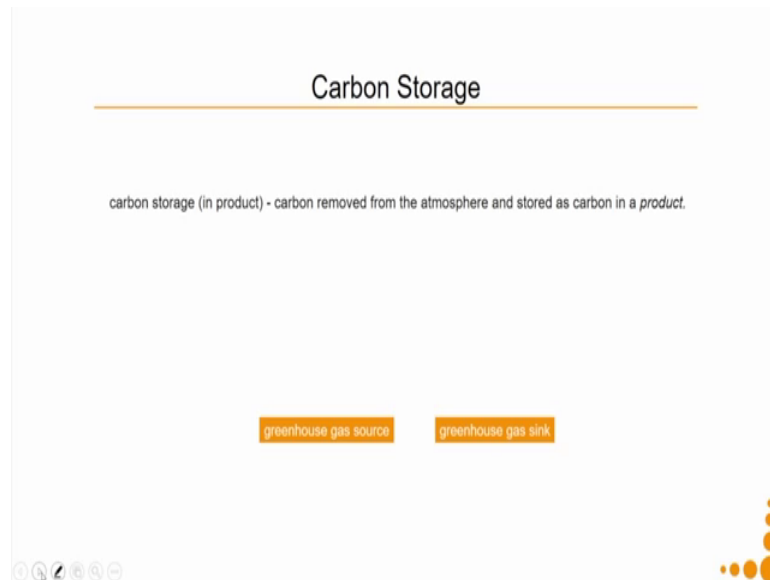
So, investment outside the relevant product system in renewable energy technologies. So, what this renewable energy technology we will do is reduction in CO₂ emission which might be caused due to thermal power plants.

Or say energy efficiency measures outside my product system not inside my product system. So, if I do certain energy efficiency measures then I will be able to reduce or remove certain amount of emissions say for example, if I fund a project in which LED bulbs can be distributed. So, I pay for the LED bulb, LED bulbs can be distributed in many homes that is like energy efficiency in measure for lighting.

And I am helping to prevent emission of equivalent amount of greenhouse gas emissions or say some kind of a forestation activity where your planting trees or some kind of a reforestation activities and so, on. So, one has to be careful of the fact that this particular for the offsetting it has to happen outside the boundary of the product system. Of course, within the product system you will always try to reduce your carbon footprint.

But, for the concept of offsetting we are talking about outside the product boundary. Carbon storage, so, carbon storage in terms of carbon storage in a product it is like when carbon is removed from the atmosphere and stored as carbon in a product.

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In the same light we can also have terminologies like greenhouse gas source which produces greenhouse gases and greenhouse gas sink place or a activity or a product which absorbs greenhouse gases. Say for example, forest is a greenhouse gas sink; factory is a greenhouse gas source. Next coming to the concept of carbon trade exchange CTX.

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Carbon Trade Exchange (CTX)

- enables buyers and sellers to transact carbon credits electronically.
- is the first commercial partner to the United Nation CDM Registry, which makes it possible to access **UNFCCC Certified Emission Reductions (CERs)** for voluntary cancellation via the CTX global voluntary carbon market exchange.
- lists Carbon Credits certified by the **Gold Standard** and **United Nations CDM**.
- trades in CERs, VERs, VCUs, EUAs, REDD, REDD+ and other units.

Source - <http://ctxglobal.com>

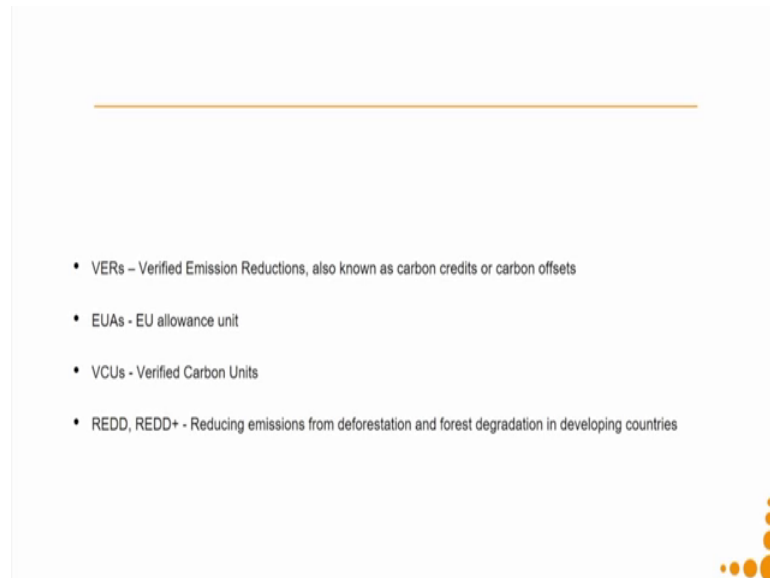
So, CTX enables buyers and sellers to transact carbon credits electronically. So, first the carbon credits needs to be calculated then it needs to be traded. Because, we are using the terminology trade so, you can look upon carbon trade exchange like stock exchange where trading constantly keeps on happening and prices of the traded units. So, we will shortly see what are the traded units, the trade the prices of the traded units will keep on wearing.

So, it is the this carbon trade exchange is the first commercial partner to the united nation CDM registry, which makes it possible to access UNFCCC certified emission reductions for voluntary cancellation via the CTX global voluntary carbon market exchange.

It list lists carbon credits certified by the gold standard and United Nations CDM. So, 2 types of carbon credits are credit over here, one that is certified by the gold standard that is one of the standards we will not go into the details of it, if you are more interested into it you can read about them or this United Nations CDM project.

So, the units in which trading happens are called as CER's. So, you already know what CER is it is a certified emission reduction, VER's, VCU's, EUA's REDD and REDD plus and some other units.

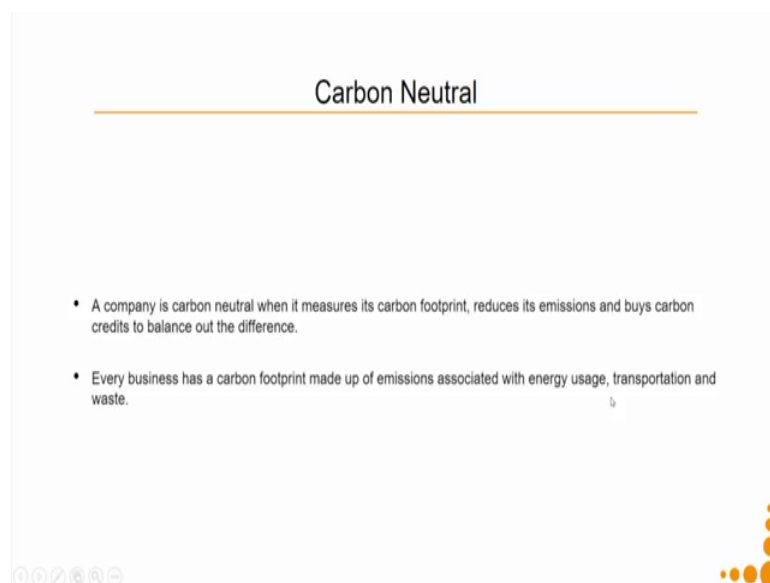
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So, VER stand for verified emission reduction they are also known as carbon credits or carbon offsets. EUA stands for European Union alliance unit, VCU's they stand for verified carbon units, REDD and REDD plus they stand for reducing emissions from deforestation and forest degradation in developing countries.

So, from these few examples of units you can see the width and the spectrum of different units which are being traded at CTX. Then comes carbon neutral.

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So, what do we mean by carbon neutral? So, you might have heard that certain companies claim that they are carbon neutral. What are say there are certain regions who will claim that we are carbon neutral. So, what does it mean? So, company is carbon neutral when it measures it is carbon footprint reduces it is omissions and buys carbon credits to balance out the difference. Every business has a carbon footprint made up of emissions associated with energy usage transportation and waste.

So, you do not naturally become carbon neutral if you do not consciously try to make your foot print 0. So, what you have to first do is measure it, then you reduce your own emissions and you do certain offsetting activities.

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In the next lecture we will be discussing about design for sustainability, engineering design criteria and guidelines. So, these criteria and guidelines are helpful in case you do not have the time say for example, to go ahead with an entire product service system design. Because a products service system design, sustainable product service system design, it is very good design approach. But, that amount of time required the number of exports required or number of stakeholders involved is very large.

So, there might be times where you are not able to go to that approach, but you still you can make a more environmental friendly product by taking into consideration these engineering design criterion guidelines.

So, these criterion guidelines they help you to also assess a certain product on the criterion guidelines and also helps you in ideating on to features, which will bring in better environmental friendliness in the different features. But, this particular method it is only target it towards the environmental dimension of sustainability.

Thank you.