Carbon Accounting and Sustainable Designs in Product Lifecycle Management

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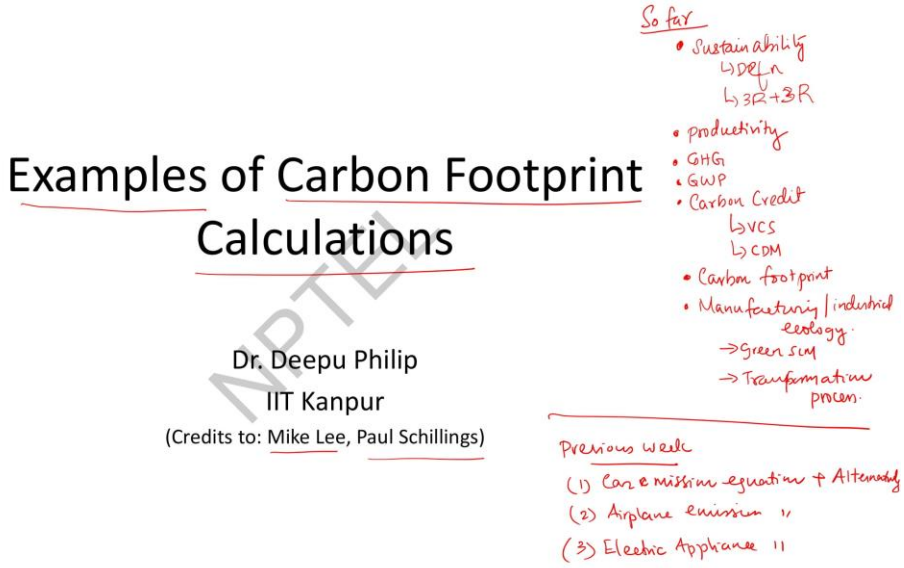
Week 03

Lecture11

Examples of Carbon Footprint Calculations

Good afternoon, everyone. Welcome to the NPTEL MOOC course titled Carbon Accounting and Sustainable Designs in Product Lifecycle Management. I am Prof. Deepu Philip. I am from IIT Kanpur. Along with me, Dr. Amandeep Singh Oberoi and Dr. Prabal Pratap Singh are co-teaching this course. And we are now into the third week of the course, and we have been going through many topics as part of this.



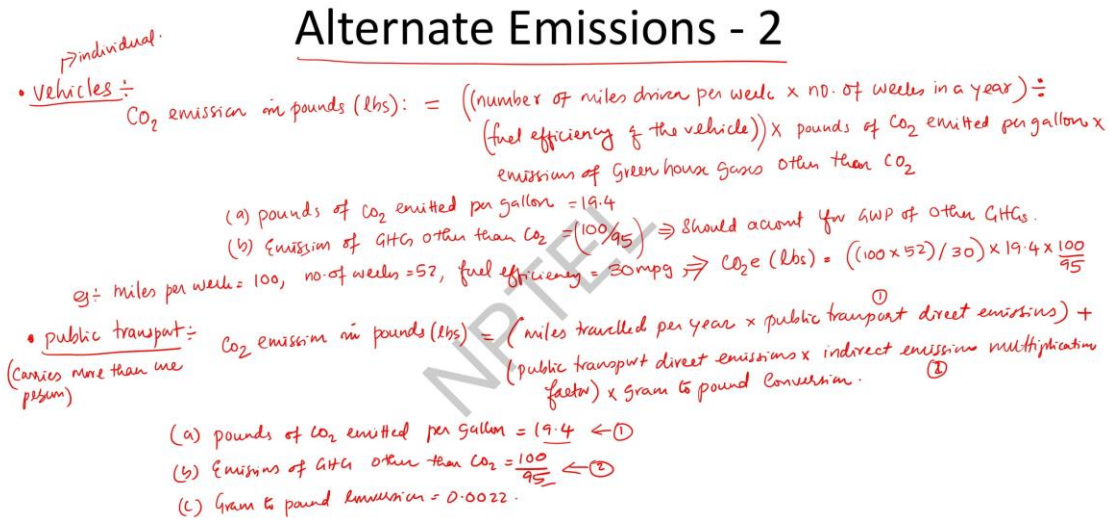
If you look at the screen, we were previously looking at examples of carbon footprint calculations. So far, we have studied what sustainability is. We have studied the definition. We studied the 3R + 3R and various other aspects of sustainability and a few examples. We also saw what is productivity.

Then, what is GHG (Greenhouse Gas) emissions? We saw what GWP (Global Warming Potential). Then, we saw what is carbon credit. And in this, we actually saw the VCS and the CDM schemes as part of it. And then we started getting into what we call the carbon footprint. What is it? Okay.

And we have seen some aspects of it already. And we also saw the manufacturing or slash industrial footprint ecology also. Then we saw what's green supply chain under this. Then we saw how the transformation process was part of this also. So, we've gone through so many of these topics.

And in the last class, the previous week, As part of this lecture, we saw what you call the emissions equation, which is the car emissions equation. Then we also saw what you call the airplane emission equations. Plus, we also saw how we can calculate it alternatively. And we also saw the electric power appliance emission equations, okay.

We also saw that, and we also looked at the other ways of considering alternative approaches for that. This was the car and airplane emissions equations and the alternate methodology for calculating car emissions. Then we mentioned the electric appliance emission equations. And then we also talked about the alternate emission approaches for electricity, natural gas, and propane. We talked about that.



Now, in today's class, we will look at alternate emissions approaches. And the first one we will do is for vehicles. And then we will do it for public transport. And here, instead of doing a car or something like that, we are just taking vehicles as a broad thing. So what we are going to calculate is CO_2 emissions in pounds or lbs, that is the 1.

So, how do we calculate that? It is given by, we will say, the number of miles driven per week times the number of weeks in a year, okay. So that is the first part, the number of miles driven per week and the number of weeks in a year. Then, after that, we take that value and divide it by, within the brackets, the fuel efficiency of the vehicle, okay.

So this is initially the product of the number of miles per week multiplied by the number of weeks in a year. You divide that by the fuel efficiency of the vehicle. This whole thing you multiply by pounds of CO_2 emitted per gallon, multiplied by emissions of greenhouse gases other than CO_2. Emissions of greenhouse gases other than CO_2, okay.

So, we want to look into this. The first one is A. Pounds of CO_2 emitted per gallon, that is taken as 19.4. And the B emissions of GHG, greenhouse gases other than CO_2, is taken as 100 over 95. Okay, so this is the factor, so slightly more than 100 in this regard, right. One, so more than one, which gives you what is the additional aspect is the GHGs that are emitting other than CO_2. This additional increase should account for GWP of other gases, other GHGs. So nitrous oxide, whatever it is emitted, then that is counted as part of it.

So, let's do a small example of this. Miles per week, let's say it is 100. Number of weeks in an year is 52, okay. And fuel efficiency is, let us say, 30 mpg, 30 miles per gallon. And then, if that much data is given to you, then you can calculate that CO_2e in lbs = $100 \times 52/30$.

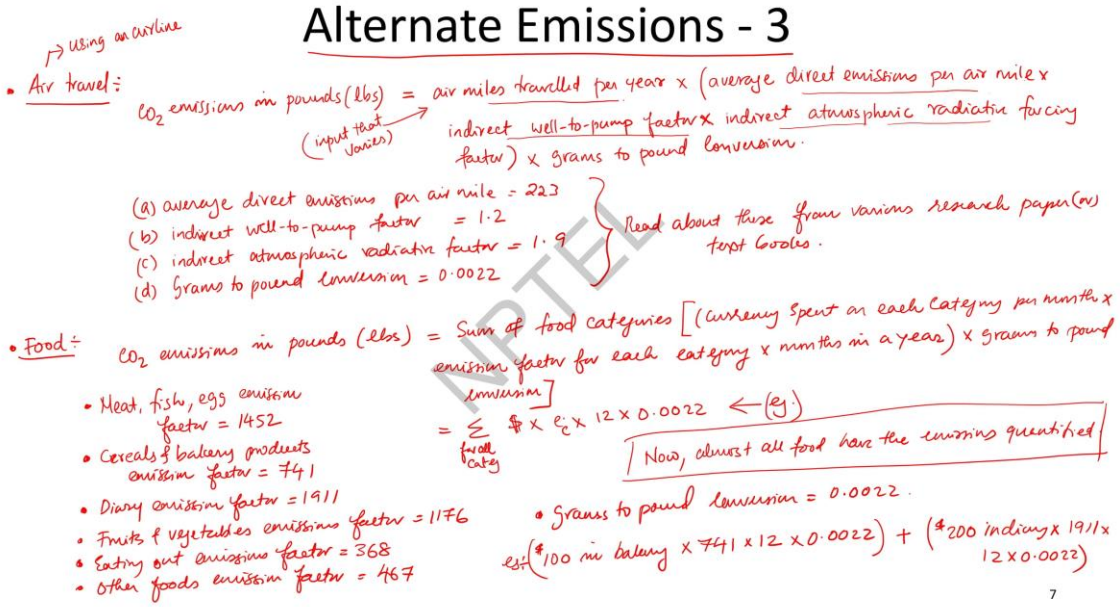
This multiplied by 19.4 multiplied by 100/95. So, this will give you the total CO_2 emissions for that particular type of vehicle. And here, if you change the fuel from gasoline to diesel, some slight variations can happen. Now, these are assuming, these are individual vehicles. Now, let us talk about public transport. Okay.

How do we do this for public transport? So, public transport assumes that it carries more than one person. So, it is not just 1%, it carries more than 1%. So, here the CO_2 emissions in pounds (LBS) is equal to, you can calculate it by miles traveled per year multiplied by public transport direct emissions, plus the next factor is public transport direct emissions. Direct emissions multiplied by indirect emissions multiplication factor.

Indirect emissions multiplication factor. This one multiplied by gram to pound conversion. So, how does we do that? There are a few things. A pounds of CO2 emitted per gallon = 19.4 B is emissions of GHG other than CO_2, which is 100/95.

C is gram to pound conversion. Conversion, that's equal to 0.0022. So, the miles travelled per year and then multiplied by the public transport direct emissions. So, the direct emissions can be taken by this, and then the indirect emission multiplication factor is this, and then grams to pounds conversion is from this. So, this will be becoming, so if we say 1, 1, and this is 2, this is 2.

Now we know the reason why this is being done is when you have more than one person traveling, so this actually gets averaged out to multiple people.



So now let us get into the other aspects of it, some more alternate emissions calculations as part of it. So let us take, we talked about public transport, now let's talk about air travel. Air travel we are assuming. airline using an airline, okay. So we are now traveling by private jets. So CO2 emissions emissions in pounds, okay. LBS.

It is calculated by air miles traveled per year multiplied by within brackets average direct emissions per air mile multiplied by indirect well-to-pump multiplied by indirect atmospheric radiative forcing factor, okay. So, it's a product of three things. Average

direct emissions per air mile multiplied by indirect well-to-pump factor multiplied by indirect atmospheric radiative forcing factor multiplied by gram to pound conversion. So, it's a product of many factors. So, what are those factors?

So, A, average direct emissions per air mile = 223. That is the first value. B, indirect well-to-pump factor. So, that is because the aviation fuel, which is taken from an oil well all the way to the pump that delivers it to the aircraft, is 1.2. C is indirect atmospheric radiative forcing factor.

That is 1.9, okay, radiative forcing factor. So, then the last one is the grams to pounds conversion = 0.0022. So, the assignment is to read about these from various research papers or textbooks. These factors are very well documented and available to you from various textbooks and other stuff. So, if you look into this, air miles traveled per year, first you calculate that. Then it is multiplied by average direct emissions per air mile, which is 223.

Multiplied by indirect well-to-pump factor, which is 1.2, and then indirect atmospheric radiative forcing factor, which is 1.9, and multiplied by gram to pound conversion is 0.0022. So, it is a product of all. So, the input is typically this one. This is the input. That way it is.

Others are mostly constant. Now, there is also something else we can do as part of this, or we should understand as part of this, which is food. How do you calculate the carbon footprint of food? And we will see other aspects of this later. But how do we do that? So, CO2 emissions in pounds (lbs), okay.

Which is equal to, so what we call it as, the sum of food categories that is calculated by currency spent on each category per month. This first thing multiplied by the emission factor for each category multiplied by months in a year, okay. So, multiplied by grams to pound conversion, okay. So, if you look into this, you have to sum this. It's almost a summation.

So, if you look at it, it is sigma for all categories, okay. So, the currency dollar multiplied by the emissions for the category multiplied by the months in a year, which is 12, multiplied by 0.0022, something like this, okay. This is an example. So, some of the values here, important aspects are meat, fish, and egg emission factor. That is equal to 1452. If you take meat, fish or egg, then the emission factor is 1452.

Cereals and bakery products emission factor. That is equal to 741. Then dairy emission factor. That is equal to 1911. Fruits and vegetables emission factor. That is 1176. Then comes something called Eating Out Emission Factor. Eating out means you are going to a restaurant and eating there.

That includes taking a car or a taxi and traveling there, then sitting at a place. Whether you are there or not, the restaurants are heated, lighted, and all those kinds of things. So that also will add up to your carbon footprint. Other foods emission factor. That is 467. Other than dairy, fruits, vegetables, eating out, cereals, and bakery products.

So the meat, egg, fish 1452, cereals, bakery and products 741, dairy emissions 1911, fruits and vegetables emission 1176, eating out is 368, and other food emissions is 467. Then we also have grams to pounds conversion is 0.0022. So, depending upon what you eat, if you eat, let us say, cereals and bakery, you spend, so let us say, if you spend, an example would be, okay. You spend $100 in bakery. Then that will be equal to $100 in bakery multiplied by emission factor, which is 741, multiplied by 12, multiplied by 0.0022. This will be for the bakery.

Plus, let's say you spend $200 on dairy. Then there will be $200 on dairy multiplied by emission factor, which is 1911, multiplied by 0.0022, like this and more factors. Now, almost all food has the emissions quantified. So with this, you can do much more finer calculations than what I have shown it to you. But that is the main important aspect of it. So with this, we have come to the conclusion of these basic calculations.

And what we will do now is we will take some simple items about mobile phone usage, web searches, how much it is to travel from place A to place B, what will be the carbon footprint depending upon the type of vehicle, mode of travel. We will do some average numbers, how much it actually would cost to make, generate trash, deforestation. So, some aspects we will study in the next class, so that you have an overall picture of what it is. And then we will do the other, some basic calculation life cycle, product life cycle calculation models in the following sessions.

Thank you.