Abstract

*Report on the information behind the creation of a Carbon Footprint Calculator. A simple calculator can be developed which only requires small quantities of information from the user for an estimated carbon footprint. However due to the vast amount of variables to consider, the calculator’s accuracy can be improved with more detailed information from the user about dietary habits, use of green-energy alternatives, transportation schedules etc.*

Introduction

This report will describe Carbon Emissions and how to calculate Carbon Footprints. Section 1 is a definition and overview of Carbon Emissions and Carbon Footprints. Section 2 describes a simple Carbon Footprint Calculator. Section 3 is a detailed analysis of creating a higher accuracy Carbon Footprint Calculator based on a larger number of emission reducing variables. Section 4 is a conclusion to the report.

Section 1: Carbon Emissions and Carbon Footprints

1.1 Carbon Emissions

‘Carbon emission’ describes the emission of the greenhouse gas Carbon Dioxide (CO2) into the earth’s atmosphere. Carbon Dioxide is the primary greenhouse gas emitted by humans. Greenhouse gases are harmful to the earth’s atmosphere and damage it, which is the primary cause of an effect known as Global Warming. Global warming is the temperature rise and climate change believed to be caused by the greenhouse gases damaging the earth’s atmosphere, allowing more solar radiation to reach the planet.

1.2 Carbon Footprint

The carbon footprint is the total carbon emissions caused by an individual, company or event. Much like a normal footprint, the carbon footprint is a mark left behind on the environment in the form of damage caused by carbon emissions. Carbon footprints are generally quantifiedin metric tonnes of CO2. A source’s carbon footprint is defined by the combination of its direct and indirect carbon emissions, which will be discussed below.

1.2.1 Direct Carbon Emissions

Direct carbon emissions are emissions that the source generates directly through its activities. Examples of processes that directly produce carbon emissions are using transport, production and consumption of food and fuels, manufacturing goods and building roads and buildings.

1.2.2 Indirect Carbon Emissions

Indirect carbon emissions are when the emissions are not directly generated by the original source, but are generated from another source as a consequence of the original source. An example of this is eating food that has been delivered to your local supermarket by a motor vehicle, and has generated carbon emissions during its manufacturing process. Other examples or indirect carbon emissions are using electricity generated by carbon emitting power plants or using a car whose manufacturing process emitted CO2 and possibly also had to be shipped, generating an even larger carbon footprint.

Section 2: Carbon Footprint Calculator

Based on research all around the world many ‘Carbon Footprint Calculators’ have been developed for public use on the internet. Anyone can provide information on their lifestyle, i.e. eating habits, electricity usage, transportation used etc. and based on the studies done on carbon emissions, the calculator will estimate that person’s carbon footprint. An example of a Carbon Footprint calculator’s method is shown below, which was created by Alexandra Shimo-Barry, author of “The Environment Equation” .

Steps to Calculate Carbon Footprint according to Shimo-Barry

1. Multiply your monthly electric bill by 105
2. Multiply your monthly gas bill by 105
3. Multiply your monthly oil bill by 113
4. Multiply your total yearly mileage on your car by .79
5. Multiply the number of flights you’ve taken in the past year (4 hours or less) by 1,100
6. Multiply the number of flights you’ve taken in the past year (4 hours or more) by 4,400
7. Add 184 if you do NOT recycle newspaper
8. Add 166 if you do NOT recycle aluminium and tin
9. Add 1-8 together for your total carbon footprint

There are many different methods for calculating carbon footprint in the form of different equations because the calculators are based on different studies and data and have variable accuracies. Due to all the factors and variables required to get an accurate carbon footprint calculation, a perfect carbon footprint calculator is virtually impossible. However, the more factors that the calculator takes into account, the more accurate it will be.

An ideal low carbon footprint is about 2700 – 7200 kg of CO2 per year. Above 10 000kg per year is excessive CO2 emissions.

2.1 Emission factors

Any source of greenhouse gas emissions has an emission factor, which describes the amount of emitted greenhouse gases per unit of that source. The unit is dependent on the source and can vary even within a single source, for example, air travel has an approximate emission factor of 0.15kg/km [5], so for every km travelled by plane, 0.15kg of CO2 will be released into the atmosphere. Carbon Emission calcualtors use emission factors to have accurate estimations of emissions based on the unit of each source. For example, fuel emissions- the total emissions is given by the formula [7]:

*Emissions = Fuel Consumption \* Emission factor of fuel used*

Equation 1

Emission factors are calculated on a location by location basis, as various environmental and societal factors can play a part in the determination of emission factors, such as power grid specifications.

Section 3. Analysis of factors that influence Carbon Emissions

In the section below several ways for people to reduce their carbon footprint will be discussed. A very accurate carbon footprint calculator should check for these different lifestyle choices because they have a large impact on CO2 emissions.

3.1 Paper used

Trees help to reduce the CO2 in the atmosphere because they absorb it. To produce paper, trees need to be cut down and this can create more emissions. In South Africa, paper manufacturing is handled by dedicated forests owned by the manufacturers, who keep the tree population healthy. Therefore the total CO2 emissions is only caused by the production of the paper. [5]

Distance travelled by use of motor vehicle, ship and plane add to one’s carbon footprint. Each form of travel has an emission factor which describes the CO2 emissions per distance travelled using that transportation. A good carbon calculator needs to check all travelling done by the induvial and use the various emission factors to calculate the emissions generated.

Using motor vehicles less directly reduces an individual’s carbon footprint. There are many ways to do this, the most simple being to avoid using a car altogether and walking or biking to destinations. However, in today’s society, this is not always possible and many people have to travel large distances every day to get to work/school. Another method of reducing carbon emissions for such people is to carpool or use public transportation – the less gas is used, the better. Many people try to improve their carbon footprint in this way because it is often also budget friendly, by saving money on gas.

One common way to reduce one’s carbon footprint is a change of diet.  Meats, rice and processed foods compromise a high carbon diet. By reducing the consumption of these food types, an individual can reduce his carbon footprint. The packaging and importing of foods is also a contributor to carbon emissions, so avoiding such products will also contribute to a smaller footprint. Table 1 below shows the results of a study done in 2014 study by Scarborough et al. on the carbon emissions based on different diets.

Table 1: Dietary related CO2 emissions

|  |  |
| --- | --- |
| Diet | Average dietary greenhouse-gas emissions per day (kg of CO2) |
| High meat-eaters | 7.19 |
| Medium meat eaters | 5.63 |
| Low meat-eaters | 4.67 |
| Fish eaters | 3.91 |
| Vegetarians | 3.81 |
| Vegans | 2.89 |

Due to the substantial carbon emissions generated with the manufacturing of goods, a good way to reduce carbon emissions is recycling. Recycling uses resources that already are available for goods production without the need for unnecessary CO2 emissions.

Many companies worldwide supply their customers with their carbon footprint information to show their efforts in reducing the carbon emissions when manufacturing their products. This is a costly process at times to keep their footprint to a minimum, but some consumers consider very carefully the businesses they buy goods from based on carbon footprint, so the costs can be mitigated due to an increase in sales. As such, consumers who buy their products from companies that have a low relative carbon footprint will reduce their indirect carbon emissions.

Technology to Improve Carbon Emissions

Along with improvements in technology, there has been development into CO2 emission friendly alternatives to everyday objects, most notably lightbulbs and cars.

Lightbulbs

There have been several innovations that vastly improve on the **Incandescent Light Bulb technology of the past -** Fluorescent, Compact Fluorescent (CFL), Halogen Bulbs and **Light Emitting Diodes(LED). Incandescent lightbulbs are very inefficient in terms of power because most of the energy they are provided creates heat, instead of light. The different bulbs developed have different efficiencies, carbon emissions, costs to produce and uses. For example, Halogen Bulbs are used in automobile headlights because they provide very strong light consistently over their lifetime, while LEDs are very efficient in terms of power and carbon emissions so using them as the main light source in your house over Incandescent bulbs will vastly improve an individual’s carbon footprint.**

**In table 2 Below, a direct comparsion between Incandescent bulbs, Compact Fluorescent bulbs and LEDs in terms of lifespan, wattage and carbon emissions is shown.[3]**

**Table 2: Comparing Lightbulb Types**

|  |  |  |  |
| --- | --- | --- | --- |
| Energy Efficiency and Environmental Impact | Incandescent Bulb | Compact Fluorescent Bulb | Light Emitting Diode |
| Lifespan(hours) | 1200 | 8000 | 50000 |
| **Watts of electricity used** (equivalent to 60 watt bulb). | 60 | 13-15 | 6-8 |
| Carbon Emissions (30 bulbs, kg per year) | 2040 | 476 | 204 |

Motor Vehicles

The electric car was developed as a ‘greener’ alternative to regular petrol cars designed to have a lower carbon footprint. However, the means at which the car is charged is important. In countries, like South Africa, where the power grid is primarily coal based, charging and driving an electric car has almost the same CO2 emissions as driving a regular petrol car.

Conclusion

The information required to create a simple Carbon Footprint calculator has been discussed. Additional variables that increase the accuracy of the calculator have also been investigated, by looking at the common ways people can reduce their carbon footprint. The more information that is provided by the user in the different categories of emission sources the more accurate the Carbon Footprint calculator can estimate the results.

References

Wikipedia

<http://www.justgreencommunity.com/how-to-calculate-your-carbon-footprint/>

<http://www.designrecycleinc.com/led%20comp%20chart.html>

<http://www.consumerenergycenter.org/lighting/bulbs.html>

<http://www.trees.co.za/carboncalculator/index3.php#carbon_paper>

<http://www.eskom.co.za/OurCompany/SustainableDevelopment/Pages/CDM_Calculations.aspx>

http://www.eskom.co.za/OurCompany/SustainableDevelopment/Documents/V2\_2\_Ch2\_Stationary\_Combustion.pdf