How to Interpret Carbon Calculators

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INTRODUCTION

→ We all know that we produce carbon emissions through our everyday actions – heating our homes, driving to work, using our computers. But how much do we produce? Which aspects of our lifestyle are more carbon intensive than others? And are we responsible for more or less emissions than our neighbors?

These are the sorts of questions that are useful to answer if we are going to make an effort to reduce our carbon. Measuring our carbon footprint makes us aware of our ecological impact, and gives us a benchmark from which to track our progress. Knowing which aspects of our lifestyle are most carbon intensive enables us to focus our efforts where they are most effective. And comparing ourselves with others can provide insight and motivation.

Measuring our emissions for ourselves would be complicated, so most people turn to a carbon calculator. There are many of these available online. Generally, they ask you for information about your household to calculate your energy consumption, and you car mileage and other transport including flights, and some detail about your diet. More sophisticated versions delve more deeply into the different categories, querying the type of vehicle you drive, whether your electricity is from a renewable source, how much local and organic produce you eat, whether you take a daily newspaper, and so on. Some calculators add other features, such as the ability to store your profile at one point in time and compare it with a recalculation after you have taken some reduction measures.

Anyone who has explored the range of calculators that are available on the Web will quickly realize that they don't necessarily give the same answer. Often this is because they ask for slightly different things, or explore to a different depth. Even those that appear to ask the same questions, can come to different conclusions from the same data that you put in it. As a result, critics dismiss them as misleading or useless. This is to misunderstand what carbon calculators are, and what they are trying to do.

THE INEXACTITUDE OF SCIENCE

→ A carbon calculator is essentially a model of the real world. It is an abstraction – a simplification that we perform in order to make the calculation tractable. But the map is not the territory, as the saying goes. In other words, we should not confuse our abstraction or model with the thing itself. The fact that it is a model, and therefore a simplification, makes it both inaccurate and useful. The writer Jorge Luis Borges explored this conundrum in his story The Inexactitude of Science where he describes an empire that created a map "whose size was that of the Empire, and which coincided point for point with it." Although the map was 100

percent accurate, the people of the empire "saw that that vast Map was Useless."

We could create a carbon calculator that counted every single molecule of carbon we emitted as we burnt the fuel in our heating boiler,; or, which precisely allocated our portion of the emissions associated with a flight according to the number of passengers on board, our individual weight, the weight of our baggage, whether we had a vegetarian meal, and so on. But it would take all of our time and effort; and the detail would add little value to our purpose, - which is to identify and reduce the major sources of our emissions.

Carbon calculators are not alone in this regard. There are many other models that abstract and simplify, producing results that are less than 100 percent accurate, yet whose information we still find useful. Motorists who have fitted GPS car navigation systems often discover that the reading on their new device differs from that on their speedometer. This is because car speedometers – the models that calculate the car's speed – deliberately overestimate speed by up to 10 percent, whereas GPS navigation systems are more accurate. (Car manufacturers build in the overestimation to avoid any potential litigation, as well as to accommodate drivers who change the size of their wheels). Until the advent of GPS devices, few drivers (apart from truckers, whose speedometers are usually more precise) were aware of this inaccuracy, and it caused few problems. This is because our slightly inaccurate speedometers give us enough information for our purposes. They tell us more or less how fast we are going in absolute terms, which allows us to judge the safety of our travel and to stay within speed limits. And they also allow us to estimate the speed of others relative to ourselves.

The same goes for our biggest and most complex abstractions – our meteorological models. They will never be entirely accurate. Nevertheless, we have enough confidence in them to plan outings, sports events, rocket launches, and even military campaigns by them.

THE VALUE OF A ROUGH IDEA

→ Carbon calculators will no doubt get better over time as we gather more data on things like the carbon embodied in the production of food and household goods. In the meantime, their rough and ready estimates of our emissions are still very valuable. For a start, they give us a basic idea of how much carbon we are personally responsible for. We can only manage what we can measure, and carbon calculators give us the basic measure from which we can begin to manage and reduce our emissions.

This basic measure is a benchmark – a starting point from which we can track reductions. If we make an initial calculation and then another a year later, after we have taken some action or changed our behavior; we will get a measure of how effective our efforts have been. We can check our progress. Some calculators allow you to do what-if calculations, such as what if I caught the bus to work instead of driving my car? Or what if I ate meat twice a week instead of daily? This enables us to explore the relative effectiveness of different actions, and it can help us prioritize.

Carbon calculators also give us a relative measure by which we can compare ourselves with others. If my work colleagues and I all calculate our footprints, we can compare our results. If there are significant differences, we can use the calculator to identify the key factors. Depending on the sophistication of the calculator, we can refine our calculations and explore the factors in greater depth, discovering whether it is our homes, commuting habits or diets that are making the difference.

COMPARING FOOTPRINTS

→ We can also use the calculator to compare ourselves with individuals in other places. We can contrast our individual carbon footprints with the average for our country. Or we could compare our footprint with the average for someone in Sweden, or Mexico, or China. If we are North American, we will see how our average footprint is ten times that of someone in India for example. (Some calculators build these comparisons in; with others you might have to look elsewhere for the information.) This comparative information can be a real eye-opener, and give us greater incentive to reduce our footprint.
The comparative information is also an important reality check. If we are to keep atmospheric greenhouse gas concentrations at a level to avoid runaway global warming (below 500 parts per million to stabilize at 2° Celsius rise in global temperatures), then the average emissions per person on the planet must not exceed 2 tonnes a year. Fifteen minutes spent with a carbon calculator will make it clear what a long way away most of us in the developed world are from this target.

So for all their shortcomings, carbon calculators are still extremely useful tools. Of course, some are better than others. In fact, there is wide range of depth and sophistication among calculators, with some making gross simplifications, while others try to tailor their calculations to the individual as much as possible, drawing on extensive sources of emissions data. Let's look more closely at some of the reasons why they differ in their results.

WHERE THE NUMBERS COME FROM

→ Carbon calculators rely on abstraction, simplification and assumptions. They don't measure exactly how many molecules of carbon dioxide come out of your car exhaust over a year. They usually don't even take into account the make, model or year of your car, but instead use broad categories such as large, medium, small, SUV or hybrid. In other words, they use averages or proxies. It is similar to a car rental firm quoting a Dodge Caliber for its compact car rate, a Ford Fusion for a its standard rate and a Chevrolet Impala for a full size car. These are proxies, and you might not get that exact vehicle when you turn up at the rental point, but it's good enough for you to know what to expect for your money. Carbon calculators use similar proxies when figuring out your emissions from driving.

The information that these proxies are based on is fairly reliable. We know quite a lot about cars and their emissions. Manufacturers give figures for them, and they are measured every time you take your car for its regular roadworthiness test. But it is not only what you drive, but how and where you drive that counts. Speeding down a highway uses more gas, hence produces more emissions, than driving at a moderate pace, as does city driving compared with the open road. So it is not just your mileage, but your gas consumption that counts. Carbon calculators ignore or average these things, and for the way in which most people currently use the calculators, this is adequate.

Flights are more difficult. As with cars, we know a lot about airplane emissions, but because flights are generally so much longer than car journeys – it's easy to clock up an annual car mileage in one long-haul flight – the abstractions and assumptions have a bigger impact.

The first question is, does the calculator use the actual mileage of flights or does it simply have categories such as long- or short-haul? Second, what type of plane does it use in its model? Does it assume it is operating at 100 percent efficiency? Does it assume the plane is full? What 'radiative forcing' factor does it assume, where radiative forcing is the relative global warming impact of releasing carbon dioxide into the atmosphere at high altitudes compared with ground level? (The International Panel on Climate Change suggests that burning fuel at high altitudes could have a 2.7 greater global warming impact than burning it in a car on the ground.) Then, there are the factors we alluded to earlier, such as assumptions about the weight of the passenger, their baggage, their in-flight meals, and so on.

How the designers of carbon calculators answer these questions leads to some of the differences in results that you see between them. However, as long as their assumptions are reasonable, and their data is based on sound science, there should be some convergence in their calculations. There shouldn't be an order of

magnitude of difference between them. And they should all show that flying is one of the major contributors to an individual's carbon footprint.

As we said earlier, much of the value of a carbon calculator can be in the relative values it gives. It is similar to the calorie counter on a treadmill or stationary bicycle at the gym. These counters are notoriously imprecise, differing as much as 25-30 percent between machines. Again, these calculators are based on assumptions that can differ between equipment manufacturers, and over time as physiological science advances. But the real value of the calorie counter lies not in its precise accuracy, but in what it can tell you about your effort today relative to your session on the treadmill yesterday. This insight is probably more valuable to you than knowing exactly how many calories you burnt.

WHAT IS A TONNE?

→ There are even more fundamental issues when designing carbon calculators, such as the choice of measures and their definitions. Carbon dioxide emissions are generally measured in tons. But what exactly is a ton? There is a British or long ton, which is 2240 pounds, and a U.S. or short ton, which is 2000 pounds. (Curiously, both are defined in the same way – 1 ton equals 20 hundredweight – but in Britain there are 112 pounds in the hundredweight, whereas in the U.S. there are 100 pounds.) There is also a third type – the metric ton, which is equal to 1000 kilograms, or approximately 2204 pounds. The metric ton is officially called the 'tonne', and this is what is generally used in carbon emissions calculations. If a carbon calculator uses one of the other types of ton, it will obviously produce a different answer from the one using tonnes. (Although it is simple to convert from one to the other.)

Although the metric tonne is commonly used in calculators, other measures aren't always metric. Calculators, especially those developed in the US and UK often use miles rather than kilometers, and gallons rather than liters. This shouldn't really matter, as long as you are aware of the units when you are filling in the calculator.

Then there are the conversion factors that calculators use. How does the calculator convert your electricity consumption into carbon emissions, for example? There are national and international databases for these things, such as the Greenhouse Gas Protocol, which gives conversion factors for a vast range of activities and processes. Although these are based on solid science, even they make many assumptions and simplifications. For example, the UK government's conversion factor guidelines for cars, concede that they take "no account of real-world effects, such as use of accessories (air con, lights, heaters, etc.), vehicle payload, poor maintenance (tire under inflation, maladjusted tracking, etc.), gradients, weather,

more aggressive/harsher driving style, etc."

We are back at the point about calculators being models and not the real world. Just as a map with a scale of 1 mile to 1 mile would be too cumbersome for any practical purpose, so a 100 percent accurate carbon calculator would have little real value. Meanwhile, there are reliable data sources that calculators can use for their approximations and proxies. Calculators can differ in how much they try to customize the data they use in their calculations to your particular circumstances – where you live, your type of house, the type of car you drive, etc. In the end, they will give you an estimate with varying degrees of precision of the tonnes of carbon emissions for which you are responsible.

OUR WIDER FOOTPRINT

→ So far, we have just discussed calculators in the context of carbon. Some calculators focus on water, waste or other environmental impacts; while others, take a broader view and calculate an overall ecological footprint that can include carbon, water, waste, trees and other factors. These calculators have their own issues in terms of the units of measure, estimations and proxies, and the conversion factors they use. For example, some water footprint calculators measure consumption in gallons per day, others in cubic meters a year. Some take into account whether you recycle, some don't. Ecological footprint calculators often convert your individual footprint into the number of planets that would be required if everyone followed your lifestyle.

As with carbon calculators, the idea is to make you aware of your impact, to give you some insight into the primary reasons for the size of your footprint, and to give you a benchmark by which you can compare yourself with others and your progress in making reductions over time. The first time many people use a water calculator, they are shocked at just how much of an impact their diet has on their footprint. Seeing just how many planets will be required to sustain a universal version of your lifestyle can also be quite sobering and inspire a change in behavior.

CONCLUSION

→ Carbon calculators are advancing in their sophistication and precision, and designers are finding better ways to gather and present information. They are also creating innovative auxiliary functions, such as social networking tools that enable us to form communities around carbon reduction initiatives. But even in their simplest form, carbon calculators make us aware of our environmental impact, and provide insight that can motivate us to change our carbon intensive ways. By focusing on their relative measures, the comparisons they provide, rather than

worrying about the precision of their absolute measures – whether our footprint is exactly 12.423 tonnes or not – we will get the most value from them.

ABOUT ZEROFOOTPRINT

→ Zerofootprint is a socially responsible enterprise whose mission is to apply technology, design and risk management to the massive reduction of our environmental footprint. We operate both in the for-profit and charitable domains through two entities, Zerofootprint Software and Zerofootprint Foundation using shared technology.