

'If we're serious about really addressing climate change, we need to become energy and carbon literate, and get to grips with the implications not only of our choices but also the bigger infrastructures which underpin the things we consume. How can we educate our desires unless we know what we're choosing between? Mike Berners Lee, to my complete delight, has provided just the wonderful foundation we need – a book that somehow made me laugh while telling me deeply serious things.'

Peter Lipman, Director of SUSTRANS

'Enjoyable, fun to read and scientifically robust.
A triumph of popular science writing.'

Chris Goodall, author,
Ten Technologies to Fix Energy and Climate

'Curiously fascinating to both climate geeks
and well-rounded human beings alike.'

Franny Armstrong, Director of *The Age of Stupid*
and founder of 10:10

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**The carbon footprint
of everything**

Mike Berners-Lee

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Contents

Acknowledgements	ix
Introduction	xi
A quick guide to carbon and carbon footprints	1
Under 10 grams	11
<i>A text message</i>	11
<i>A pint of tap water</i>	12
<i>A web search</i>	12
<i>Walking through a door</i>	14
<i>An email</i>	15
<i>Drying your hands</i>	17
<i>A plastic carrier bag</i>	18
10 to 100 grams	21
<i>A paper carrier bag</i>	21
<i>Ironing a shirt</i>	22
<i>Cycling a mile</i>	23
<i>Boiling a litre of water</i>	24
<i>An apple</i>	26
<i>A banana</i>	27
<i>An orange</i>	29
<i>An hour's TV</i>	30
100 grams to 1 kilo	35
<i>A mug of tea or coffee</i>	35
<i>A mile by bus</i>	37
<i>A nappy</i>	38
<i>A punnet of strawberries</i>	39

<i>A mile by train</i>	40
<i>A 500 ml bottle of water</i>	43
<i>A letter</i>	44
<i>1 kg of carrots</i>	46
<i>A newspaper</i>	47
<i>A pint of beer</i>	49
<i>A bowl of porridge</i>	51
<i>A shower</i>	52
<i>An ice cream</i>	53
<i>A unit of heat</i>	54
<i>A unit of electricity</i>	55
<i>Spending £1</i>	59
<i>1 kg of rubbish</i>	61
<i>Washing up</i>	63
<i>A toilet roll</i>	64
<i>Driving 1 mile</i>	65
<i>A red rose</i>	68
<i>1 kg of boiled potatoes</i>	69
<i>A pint of milk</i>	71
<i>1 kg of cement</i>	74
1 kilo to 10 kilos	75
<i>A paperback book</i>	75
<i>A loaf of bread</i>	77
<i>A bottle of wine</i>	78
<i>1 kg of plastic</i>	80
<i>Taking a bath</i>	81
<i>A pack of asparagus</i>	83
<i>A load of laundry</i>	84
<i>A burger</i>	86
<i>A litre of petrol</i>	87
<i>1 kg of rice</i>	89
<i>Desalinating a cubic metre of water</i>	91
<i>A pair of trousers</i>	93
<i>A steak</i>	95
<i>A box of eggs</i>	96

<i>1 kg of tomatoes</i>	97
<i>1 kg of trout</i>	99
<i>Leaving the lights on</i>	100
<i>1 kg of steel</i>	101
10 kilos to 100 kilos	105
<i>A pair of shoes</i>	105
<i>1 kg of cheese</i>	106
<i>A congested commute by car</i>	107
<i>A night in a hotel</i>	108
<i>A leg of lamb</i>	111
<i>A carpet</i>	112
<i>Using a mobile phone</i>	113
<i>Being cremated</i>	115
100 kilos to 1 tonne	117
<i>London to Glasgow and back</i>	117
<i>Christmas excess</i>	119
<i>Insulating a loft</i>	121
<i>A necklace</i>	123
<i>A computer (and using it)</i>	124
<i>A mortgage</i>	127
1 tonne to 10 tonnes	131
<i>A heart bypass operation</i>	131
<i>Photovoltaic panels</i>	133
<i>Flying from London to Hong Kong return</i>	135
<i>1 tonne of fertiliser</i>	138
<i>A person</i>	139
10 tonnes to 100 tonnes	141
<i>A car crash</i>	141
<i>A new car</i>	143
<i>A wind turbine</i>	146
<i>A house</i>	149

100 tonnes to 1 million tonnes	151
<i>Having a child</i>	151
<i>A swimming pool</i>	152
<i>A hectare of deforestation</i>	154
<i>A space shuttle flight</i>	155
<i>A university</i>	156
1 million tonnes and beyond	159
<i>A volcano</i>	159
<i>The World Cup</i>	160
<i>The world's data centres</i>	161
<i>A bushfire</i>	162
<i>A country</i>	164
<i>A war</i>	169
<i>Black carbon</i>	170
<i>The world</i>	171
<i>Burning the world's fossil fuel reserves</i>	175
More about food	177
<i>How the footprint of food breaks down</i>	177
<i>Low-carbon food tips</i>	182
<i>A guide to seasonal food</i>	183
Some more information	187
<i>Some assumptions revisited</i>	187
<i>The cost efficiency of selected carbon-saving options</i>	191
<i>Where the numbers come from</i>	193
<i>Carbon tables for countries, people, industries and products</i>	197
Notes and references	205
Index	229

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Introduction

A few years ago I agreed to go round a supermarket with a journalist who wanted to write an article on low-carbon food. We trailed up and down the aisles with the dictaphone running and she plied me with questions, most of which I was pitifully unable to answer.

‘What about these bananas? ... How about this cheese? ... It’s organic. That must be better ... isn’t it? ... Or is it? ... Lettuce must be harmless, right? ... Should we have come here by bus? ... At least we didn’t fly! How big a deal is food anyway?’

It was not at all clear what the carbon-conscious shopper should do. There was clearly a huge gap in the available consumer knowledge and on that day we couldn’t fill it. The article never happened, and it’s probably just as well. Since then, I have looked long and hard into all kinds of carbon footprints, and carried out numerous studies, including one for a supermarket chain.

This book is here to answer the journalist’s questions, and many more besides. It’s not just a book about food and travel. I want to give you a sense of the carbon impact – that is, the climate change impact – of everything you do and think about. I want to give you a **carbon instinct**. Although I have discussed the footprint of just under one hundred items, I hope by the time you have read about these you will have gained such a sense of where carbon impacts come from that you will be able to make a reasonable guesstimate of the footprint of more or less anything and everything that you come across. It won’t be exact, but I hope you’ll at least be able to get the number of zeros

right most of the time. There are messages here for personal lives, for businesses and a few sprinkled in for policy makers too.

Some basic assumptions

I'm hoping I can take three things for granted:

- climate change is a big deal;
- it's man-made
- and we can do something about it.

However, out of respect for the still widespread confusion over these assumptions, I have put more about them in an appendix in case you want to check them out before moving on.

Perspective

A friend recently asked me how he should best dry his hands to reduce his carbon footprint; with a paper towel or with an electric hand drier. The same person flies across the Atlantic literally dozens of times a year. A sense of scale is required here. The flying is tens of thousands of times more important than the hand drying. So my friend was simply distracting himself from the issue. I want to help you get a feel for roughly how *much* carbon is at stake when you make simple choices – where you travel to, how you get there, whether to buy something, whether to leave the TV on standby and so on.

Picking battles

I'm not trying to give you a list of 500 things you can do to help save the planet.¹ You could probably already write that list yourself. You will find at least 500 possibilities in here, but this is a book about helping you work out where you can get the best return for your effort. This book is here to help you **pick your battles**. If you enjoy the read and by the end of it have thought of a few things that can improve your life while cutting a decent chunk out of your carbon,

then I'll be happy. The book isn't here to tell you what to do or how radical to be. Those are personal decisions.

Is carbon like money?

In one sense, yes it is.

Carbon is just like money in that you can't manage it unless you understand it, at least in broad terms. Most of the time we know how much things cost without looking at the price tag. I don't mean that we have an exact picture, but we know that a bottle of champagne is more expensive than a cup of tea but a lot cheaper than a house. So most of us don't buy houses on a whim. Our financial sense of proportion allows us to make good choices. If I really want champagne I know I can have it, provided that somewhere along the line I cut out something just as expensive that is less important to me. Our carbon instinct needs to be just like the one we have for managing our money.

That's where the similarity ends. Unlike with money, we are not used to thinking about carbon costs. It's also much harder to tell how much we are spending because we can't see it and it's not written down. Furthermore, unlike what happens when we spend a lot of money, we don't personally experience the consequences of our carbon impact because it's spread across nearly seven billion people and many years.

Enjoy the read

These pages are written for people who want to love their lives and for whom that now entails having some carbon awareness alongside everything else that matters to them.

Dip in. Keep it by the loo. Read it from cover to cover or flit around. Use it as a reference if you like. Talk about it. Take issue with it. Let me know how it could be improved (info@howbadarebananas.com). Think of it like an early map, full of inaccuracies but better, I hope, than what you had before.

If there's a fourth premise behind the book, it is that nearly all of us, including me, have plenty of junk in our lives that contributes nothing at all to the quality of our existence. It's deep in our culture. Cutting that out makes everyone's life better, especially our own. I got a big win by swapping my solo car commutes for bike rides and lift shares. That works for me, but I'm not prescribing that particular solution for you because we are all different. I hope you enjoy the read and that while you are at it you bump into at least something you can use.

So how bad are bananas?

As it happens, they turn out to be a fine low-carbon food though not totally free from sustainability issues to keep an eye on: see page 27.

A quick guide to carbon and carbon footprints

Carbon footprint is a lovely phrase that is horribly abused.¹ I want to make my definition clear at the outset.

Throughout this book, I'm using the word **footprint** as a metaphor for the total impact that something has.

And I'm using the word **carbon** as shorthand for all the different global-warming greenhouse gases.

So, I'm using the term **carbon footprint** as shorthand to mean the *best estimate* that we can get of the *full climate change impact* of something. That something could be anything – an activity, an item, a lifestyle, a company, a country or even the whole world.

CO₂e? What's that?

Man-made climate change, also known as global warming, is caused by the release of certain types of gas into the atmosphere. The dominant man-made greenhouse gas is carbon dioxide (CO₂), which is emitted whenever we burn fossil fuels in homes, factories or power stations. But other greenhouse gases are also important. Methane (CH₄), for example, which is emitted mainly by agriculture and land-fill sites, is 25 times more potent per kilogram than carbon dioxide. Even more potent but emitted in smaller quantities are nitrous oxide (N₂O), which is about 300 times more potent than carbon dioxide and released mainly from industrial processes and farming, and

refrigerant gases, which are typically several thousand times more potent than carbon dioxide.

In the UK, the total impact on the climate breaks down like this: carbon dioxide (86 per cent), methane (7 per cent), nitrous oxide (6 per cent) and refrigerant gases (1 per cent).

Given that a single item or activity can cause multiple different greenhouse gases to be emitted, each in different quantities, a carbon footprint if written out in full could get pretty confusing. To avoid this, the convention is to express a carbon footprint in terms of **carbon dioxide equivalent** (CO₂e). This means the total climate change impact of all the greenhouse gases caused by an item or activity rolled into one and expressed in terms of the amount of carbon dioxide that would have the same impact.²

Beware carbon toe-prints

The most common abuse of the phrase carbon footprint is to miss out some or even most of the emissions caused, whatever activity or item is being discussed. For example, many online carbon calculator websites will tell you that your carbon footprint is a certain size based purely on your home energy and personal travel habits, while ignoring all of the goods and services you purchase. Similarly, a magazine publisher might claim to have measured its carbon footprint but in doing so looked only at its office and cars while ignoring the much greater emissions caused by the printing house that produces the magazines themselves. These kinds of carbon footprint are actually more like carbon ‘toe-prints’ – they don’t give the full picture.

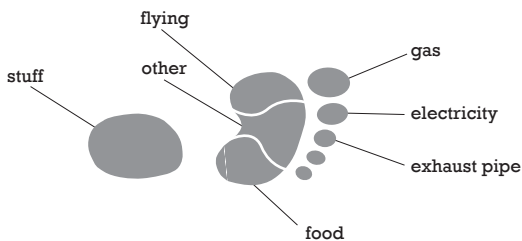


Figure 1.1. The footprint of a lifestyle is bigger than its toe-print.

Direct and indirect emissions

Much of the confusion around footprints comes down to the distinction between ‘direct’ and ‘indirect’ emissions. The true carbon footprint of a plastic toy, for example, includes not only direct emissions resulting from the manufacturing process and the transportation of the toy to the shop: it also includes a whole host of indirect emissions, such as those caused by the extraction and processing of the oil used to make the plastic in the first place. These are just a few of the processes involved. If you think about it, tracing back all the things that have to happen to make that toy leads to an infinite number of pathways, most of which are infinitesimally small. To make the point clearly, let’s try following just one of those pathways. The staff in the offices of the plastic factory used paper clips made of steel. Within the footprint of that steel is a small allocation to take account of the maintenance of a digger in the iron mine that the steel originally came from ... and so on for ever. The carbon footprint of the plastic toy includes the lot, so working it out accurately is clearly no easy task!

To give another example, the true carbon footprint of driving a car includes not only the emissions that come out of the exhaust pipe, but also all the emissions that take place when oil is extracted, shipped, refined into fuel and transported to the petrol station, not to mention the substantial emissions caused by producing and maintaining the car.

A note about high-altitude emissions

Emissions from planes in the sky are known to have a greater impact than those that would arise from burning the same amount of fuel at ground level. The science of this is still poorly understood. Nevertheless, because our measure is setting out to be a guide to climate change impact it is essential to try to take this into account. That is why in this book I have multiplied all aviation emissions by 1.9.³ (Some experts believe the true impact of plane emissions could be even higher, and suggest a multiplier of up to 4.)

In the Some more information section you'll find a slightly more technical discussion of the methodologies I have used to get the numbers (page 187).

The essential but impossible measure

The carbon footprint, as I have defined it, is *the* climate change metric that we need to be looking at. The dilemma is that it is also impossible to measure. We don't stand a hope of being able to understand how the impact of our bananas compares with the impact of all the other things we might buy instead unless we have some way of taking into account the farming, the transport, the storage and the processes that feed into those stages. A key question, then, is this: 'How should we deal with a situation in which the thing we need to understand is impossibly complex?'

One common response is to give up and measure something easier, even if that means losing most of what you are interested in off the radar. The illusionist Derren Brown refers to one of his core techniques as the *misdirection of attention*: by focusing his audience on something irrelevant he can make them miss the bit that matters. Examples include an airport waxing lyrical about the energy efficiency of its buildings without mentioning the flights themselves. The same thing can happen by accident. If you settle for a toe-print, there is a very good chance it will *misdirect* your attention away from the big deals.

An alternative response to the dilemma, and the approach that this book is all about, is to do the best job you can, despite the difficulties, of understanding the whole picture. This book is about making the most realistic estimates that are possible and practical, and being honest about the uncertainty.

Blurry numbers ...

First and foremost, I am trying to get the orders of magnitude clear.

In my work I put a lot of effort into developing a realistic picture of different carbon footprints using a variety of methods. This book draws upon a lot of that, as well as the most credible secondary sources that I have been able to find. However, huge uncertainty remains. So when you see a number like '2.5 kg CO₂e' on an item such as a burger, bear in mind that it is a best estimate. What it really means is something like 'best estimate of 2.5 kg CO₂e, probably between 1.5 and 4 kg CO₂e and almost certainly between 1 and 10 kg'. That is the nature of all carbon footprints. Don't let anyone tell you otherwise.

Some of the numbers you'll see are even flakier still. This generally happens when I'm trying to bring the beginnings of a sense of scale to important questions that are almost impossible to quantify. Sometimes my calculations and assumptions are highly debatable but I've included them because I think that just going through the thought process can be a useful reflection on something that matters. Examples include the footprint of having a child, a nuclear war or a text message.

If you think you can offer an improvement on any of the numbers in this book, I'll be very happy to hear from you.

... but they will do ...

Let me be emphatic that the uncertainty does not negate the exercise. Real footprints are *the essential measure* and nothing short of them will do. The level of accuracy that I have described is good enough to separate out the flying from the hand drying. And even if you use the numbers here to make finely balanced decisions, most of the time those choices will be better informed than if you had no guidelines at all.

... for now

That we find footprinting tricky is a problem for us all. The situation

we are in is like sailing round the world with a map from the 1700s. How should we respond? Throw that map away and have nothing? Definitely not! Use a high-quality map of just a small part of the ocean and ignore the rest? No way. Use the maps we have but treat them with caution? Absolutely. Try to make better maps? Of course – and the work is ongoing. This book is just an early map. Better ones will follow. And this book is trying to help you improve the carbon map that you carry around in your own head.

Making sense of the numbers

So far we've established what we need to try and measure, but a tonne of carbon is still a highly abstract concept. I'm now going to try to give it a bit more real-life meaning.

What does a tonne of CO₂e look like?

If you filled a couple of standard-sized garden water butts to the brim with petrol and set fire to them, about a tonne of carbon would be directly released into the atmosphere. (The carbon footprint of burning that petrol by driving is a bit more than that, for reasons explained later.) If you did the same with a pint milk bottle, that would release just over a kilogram of carbon dioxide, and if you burned a blob about the size of a chickpea, that would release about a gram.

1000 grams (g) = 1 kilogram (kg)

1000 kilograms = 1 tonne

How many tonnes do we each cause?

To give a quick sense of scale, the average UK person currently has an annual carbon footprint of around 15 tonnes. The Chinese and Malawians emit less but the Americans and Australians more. There is more detail on this later on. You get smaller numbers if you only include the obvious bits of your footprint such as household energy and travel or you miss out emissions on goods you buy that are manufactured overseas.

The 10-tonne lifestyle

I'm not here to set you a particular target or to make you feel guilty. How you decide to live is a personal choice that only you can make. I just want to help you understand carbon so that you can do whatever you decide to do with more knowledge.

However, to help get a sense of perspective I have adopted a 10-tonne lifestyle as another unit of measure for this book. I am going to refer to it from time to time, because it gives an alternative and sometimes clearer way of conceiving of those abstract kilograms and tonnes of CO₂e.

Apart from being a round number, there is not much that is particularly magic about a 10-tonne lifestyle – that is, a lifestyle causing 10 tonnes of CO₂e per year. It's certainly not a long-term sustainable target for everyone in the world: if everyone went in for 10-tonne living all over the globe, emissions would skyrocket by 40 per cent.

On the other hand, truly sustainable long-term targets aren't practical or helpful in the short term. For example, the UK has a target to cut carbon emissions by 80 per cent by 2050. If you apply this to the stuff we import as well as to the emissions within the country itself, that would take us down to around 3 tonnes per person per year. Some commentators think we'll need to go even lower. Ultimately, though, it's virtually impossible for an individual in the developed world to get down to a 3-tonne lifestyle any time soon. That kind of cut requires the whole economy to be made greener.

Ten tonnes, by contrast, is a modest aspiration target that most people could meet with enough effort. In the UK and many other European countries, adopting a 10-tonne lifestyle would mean reducing your emissions to about one-third below average. In Australia and the US, it would mean a reduction of closer to two-thirds below average.

One way of thinking about the footprint of an object or activity is to put it in the context of a year's worth of 10-tonne living. For example, a large cheeseburger, with a footprint of 2.5 kg CO₂e, represents about 2 hours' worth of a 10-tonne year. If you drive a fairly thirsty car for 1000 miles, that is 800 kg CO₂e, or a month's ration. If you leave a

couple of the (now old-fashioned) 100-watt incandescent light bulbs on for a year, that would be another month used up. One typical return flight from London to Hong Kong burns up around 4.6 tonnes CO₂e. That is just under 6 months' ration in the 10-tonne lifestyle.

A short car commute, a daily cheeseburger, and some wasteful lighting habits could easily use up a quarter of the 10-tonne budget. Then if you also take the flight to Hong Kong, that would leave just 3 months' ration left in the 10-tonne budget for *everything* else that year: other food, heat, buying stuff, health care, use of other public services, your contribution to the maintenance of roads, any wars around the world that your government is involved in (like it or not) – *the lot*.

You might be wondering whether there are any better ways of spending this or any other sized budget than blowing most of it on burgers, commuting and flying. If that question is of interest, this book has been written for you.

How many tonnes for a life or a death?

I hope the comparisons so far have helped to make a tonne of carbon seem a bit more tangible. But let's see whether it's possible to get a handle on how much it might actually *matter*. Our species is good at understanding the direct, immediate and visible consequences of our actions. We are a lot less smart at grasping the consequences when they are dispersed across billions of people whom we will never meet. This might not have mattered when we lived in caves but it won't let us live well in a global society. Our impacts used to be local and visible. Today they are not. Perhaps we need to find it as shocking when we see dispersed suffering inflicted through needless carbon emissions as it would be to see the same suffering inflicted all in one place in front of our eyes by, let's say, a street stabbing.

I did some 'back of the envelope' sums and arrived at a figure of 150 tonnes CO₂e per climate change-related death. I've spelled out my calculations in the endnote that follows this sentence.⁴ If you look it up and follow my sums, you'll see that I don't have even the beginnings of a rigorous argument to justify my figure. But it was an interesting thought process and one that, if you do decide to follow

it, you might even find faintly plausible. Or you may think my line of thought is hopelessly unrealistic. And maybe you would be right. I was just playing with ideas. It is up to you to decide what meaning to take from them. For me, even a possibility of any realism in this line of thought throws up a challenge.

The 150 tonnes per life figure would mean that if your lifestyle had the footprint of the average UK citizen, one person would have to die from climate change somewhere in the world every 10 years. If you were to fly to Hong Kong and back 11 times first class – that would be another death.

How much would it be worth paying to save a tonne of carbon?

This is not going to be an easy question to answer. An unknown number of lives depends on our response to climate change, and even if we did know how many, it is not as if our society has a consistent approach, even in the very broadest of terms, to determining the kind of value that each one of those lives might have. So, putting a financial value on the saving of a tonne of carbon is going to be tough, to put it mildly. Nevertheless, it's a question worth pondering because unless we understand there to be real and tangible value in cutting emissions, we will simply never bother and, for better or worse, money has become our language for understanding value.

As I write, £12 per tonne is the maximum price of CO₂ that companies in the UK could have to pay.⁵ Let's see what happens if we work on that £12 figure. With global emissions at 50 billion tonnes, does that mean that the world might be prepared to pay just 600 billion pounds to eradicate our emissions completely? Is that really all it's worth to us? That's about three-quarters of a per cent of global output in economic terms to have a miracle cure for climate change? Surely on this basis carbon is worth a lot more than £12 per tonne.

Let's see what £12 per tonne implies if you link it in to my estimate of 150 tonnes per death. That would put the value of a life at just £1800. The value of the world's population under this analysis is a mere £12 trillion, or about six times the Gross Domestic Product of

the UK. My home town of Kendal has about 24,000 people. Would it really be a good deal to blow up everyone in it if it would liberate £43 million? This analysis places the value of the UK population at just £108 billion. In other words, the people living in the UK are valued at about 5 per cent of their GDP.

So how much should it be worth in financial terms to save a tonne of carbon? A great deal more than the £12, clearly!