Chapter 16 — Reducing Our Carbon Footprint Per Capita

Where Do We Start?, The Inequity of It All, Breaking It Down, Countries in Balance, The Hogs, Back to the U.S.A., Diving Deep, What About Glass?, Compressed Oxygen Needed!, Let's Do This!

<u>Where Do We Start?</u>

If we need to reduce our carbon footprint per capita in order to save our planet, the first thing we need to do is figure out how much carbon footprint we have now. Then we'll know what reductions we need to make.

But first, we should be clear about what we mean by carbon footprint. This was discussed on a global scale in chapter 1, but now it's time to get into more detail about exactly what a carbon footprint is, and how, exactly, each and every one of us humans on this Earth contributes to it. Then, once we get our arms around that, we'll be in a much better position to figure out what we can do about it.

We saw in chapter 1 that, in 2019, global human activities resulted in 42 billion metric tonnes of CO_2e emissions worldwide. With a human population of 8.1 billion, this works out to an average of 5.37 metric tonnes of CO_2e emissions per capita. We found out that we can get our carbon emissions back into balance with our planet if, in the next 30 years, we reduce our average global carbon footprint per capita by about 40%, to about 3 tonnes/capita. Of course, this will only work if we are able to gradually reduce our population at the same time, by about 30% over 30 years, to around 5.8 billion. Also, keep in mind that we also need to increase our forest cover, ocean sanctuaries, and wildlands for this to work, and reducing our population will help with those issues big time.

If we fail to reduce our population, or if we choose to continue growing our population, then we would, in theory, need to reduce our carbon footprint per capita by a lot more than 40%. For now, we'll make a rather optimistic assumption that common sense and a general sense of concern regarding the condition of the planet that we choose to leave our children will somehow prevail, and that we'll manage to get our population reduced at the same time we reduce our carbon footprint. After all, miracles have happened before. And having kids is getting more expensive than ever, driven, ironically, by the sheer mass of humanity demanding resources that are more and more scarce, thanks to our overuse. Talk about a vicious circle. Think about how expensive fossil fuels are going to get when we're down to our last 10 years' worth, if we don't get off our butts and do something NOW.

What does the "e" stand for?

The "e" in CO_2e stands for "equivalents", which is another way that scientists like to normalize apples and oranges. In the case of CO_2, it is by far the dominant greenhouse gas that we emit, but there are a lot of other greenhouse gases, such as methane, nitrous oxide, and even water vapor, that retain heat, though at different levels than CO_2. For example, methane is much stronger than CO_2, holding about 22 times as much heat. Methane gas is an important source of greenhouse gas and is included with the CO_2 in the total emissions, but the amount has been converted to units of CO_2e.

For me, reducing carbon footprint is like a challenging game. A game that I play against myself. Like solitaire. Only different. More of a "how low can you go" game. And I have fun with it. Pretty much everything I do sticks it to big corp in the end, with a few oopsies in there as well. After all, nobody's perfect, and I never said I was. I only said that I do my best, which is true. And when I figure out something I can do better to lower my carbon footprint on this planet, I get going on it. Because it's important. Because we have to do everything at this point, and I refuse to be that complacent slacker who ruins the planet for everybody else through lazy inaction.

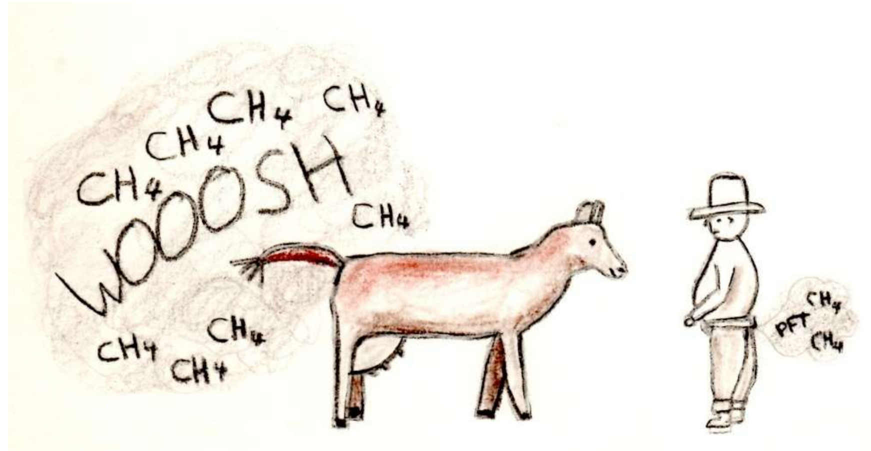
So, what do we mean by carbon footprint? Specifically, it means the CO_2e emissions that each of us is responsible for individually, which are contributing to warming and destroying our planet. Another way to say it is CO_2e per capita, or CO_2e per person, because each and every one of us is responsible for the total CO_2e that humanity is spewing as a whole. I like to use CO_2e because it's a fairly straightforward way to look at the impact each of us has on the total CO_2e that is warming our planet. We can look at carbon footprint as a whole, we can compare average carbon footprint of different countries, and we can look at our own personal carbon footprint. We can see how we compare with others, and we can see exactly how much impact we can make on our own carbon footprint if we take specific actions to reduce our carbon footprint.

By understanding our individual carbon footprints, we can see where our own footprint is highest and figure out how best to reduce it. Instead of trying to do everything at once, or throwing our hands up in confusion and frustration and doing nothing, we can prioritize our actions, pick a few things that will make a difference, and go from there. When you understand what your impacts are and you know how much you're reducing your carbon footprint, it's actually kind of fun, and you're also helping the planet at the same time. Which we desperately need to do, so it might as well be fun, right?

Carbon footprint is a way of turning all our energy-consuming choices into the same units, CO_2e emissions. In engineering, we call that "normalizing." It's a way of getting everything into the same units so we can add them up. We can take our electricity, our natural gas, our gasoline and diesel, even the food and products we buy, and add 'em up like a shopping list. Which a lot of it actually is. Then we can add up the pounds or tonnes (a tonne is a metric tonne (1,000 kilograms), which is 10% more than a typical American ton, which is also called a "short ton"; a ton is 2,000 pounds, while a tonne is 2,200 pounds) of CO_2e and figure our total, then work on reducing it. It turns out that everything we do in life results in a carbon footprint of some sort. One could argue that even breathing increases our carbon footprint because humans, like all animals, inhale oxygen and exhale carbon dioxide. We even spew methane when we fart, like cows, only not as much, at least for most of us. For the purposes of this book, however, we'll ignore that carbon, since all the other animals on the planet breathe and fart too, and we'll stick with human demands and consumption when we talk about carbon footprint. With the exception of cows, because, like other ungulates, they really do fart more than the rest of us because of their unique digestive system. Back to that later.

> What is normalizing? Normalizing is the engineer's way of comparing a bunch of different things to each other by putting them all into the same units. Like apples to apples. Apples to oranges isn't a fair comparison. Maybe they're both fruits, but one grows in the tropics and the other in colder, seasonal climates. Also, they taste different and have different nutrients when you eat them. By the same reasoning, we can't meaningfully compare energy by comparing electricity in kW with natural gas in therms, or even gasoline in gallons. Why? Because even though they are all sources of energy, they have different CO_2e emissions when they are burned, and different amounts of CO_2e are consumed when they are produced. So, if CO_2e emissions are heating our planet, it makes sense, at least to my engineering brain, to get everything that we humans do into the same units of CO_2e. When I was the energy engineer at Coors, we chose to get all our consumption into units of megajoules per hectoliter (MJ/HL), where the MJ was the energy, and HL was the amount of beer produced. This allowed direct comparisons of energy usage across all the different departments and breweries per amount of beer produced. There are many ways to normalize, so that valid comparisons can be made across widely varying circumstances, and since the global comparisons are with CO_2e emissions, I chose to use that for my work. We can compare everything with CO_2e emissions per quantity produced, from a plastic bottle to a gallon of Roundup to a Quarter Pounder to a salad to an airplane. There's a reason we see a lot of talk about carbon footprint and CO_2e when discussing humans ravaging the environment. It turns out to be a fairly simple and straightforward way to compare impacts. And at the end of the day, it's all the CO_2e we're removing from underground storage, if you will, and returning to the atmosphere, where it's running wild on our planet, so it's a valid measure of the impact each and every one of us has as well as our cumulative impact and the historical impact of humanity, from the pre-industrial era, when we were in balance globally, before we started to cause temperature increases and ocean acidification with too much CO_2e emissions.

In the developed world, most of us live in some sort of housing, with electricity to power lights, refrigerators, cell phones, leaf blowers, electric knifes, and other stupid crap that we may or may not need and that probably didn't exist 100 years ago. It takes lots of energy to power all that because electricity is mainly generated with fossil fuels that are burned to spin turbines in power plants to generate the electricity. When those fuels are burned, they release CO_2e into the atmosphere, adding to atmospheric carbon. We never seem to be satisfied with whatever the temperature happens to be within our dwellings, since we're really a bunch of Goldilocks at the end of the day, so we also like to heat or cool our homes, and heat or cool our water, which results in even more energy and even more carbon.



Unless we are growing our own food without the use of machinery, water, or chemicals, every time we eat we are consuming products that require energy to grow, process, package, and transport to the nearest store. Every time we buy something, we are adding to our carbon footprint, because energy was needed to make it and ship it. Unless we walk or ride our bike, we consume energy every time we hit the road, whether to go to work, go shopping, or drop the kids off at soccer practice, because our vehicles burn gas, which releases carbon. And when the bike or vehicle was made, carbon was consumed. When we turn on the tap or flush the toilet, we're consuming carbon, even if it seems like we're just consuming water, because it takes energy to produce clean water and then pump it to that tap. It's not magic, as we learned in chapter 13. In the U.S., our water usage accounts for nearly 2% of our carbon footprint. Every move we make adds to our carbon footprint. Every time we take a dump we add to our carbon. The list goes on and on.

So, what's a concerned, forward-thinking human who actually cares about the planet we are intricately linked at the hip with to do? We can't just stop everything, can we? I mean, we need to eat and live and breathe and pee, right? The good news is that we can still have a carbon footprint. We just need to reduce it. And it turns out that it's not really that hard to do. We just need to choose lower carbon alternatives with our consumption. And reduce our population. It's not gonna happen if we don't reduce our population. Just saying.

<u>The Inequity of It All</u>

A complicating factor when we talk about global carbon footprint, and footprint per capita, is that carbon footprints per capita across the globe are different in different countries. It's well-known that developed countries have higher carbon footprints than undeveloped countries because of differences in economic status. There are a lot more air conditioners and Ford Expedition gas hogs in, say, the U.S. and Canada, than there are in Burundi or Chad. And within a given country, carbon footprint is higher for people with more money than for those with lower incomes. After all, a little old lady in a tiny apartment or trailer park isn't going to consume nearly as much as some overly rich, big-corp bigwig with a dozen mega-mansions and a fleet of Learjets, right?

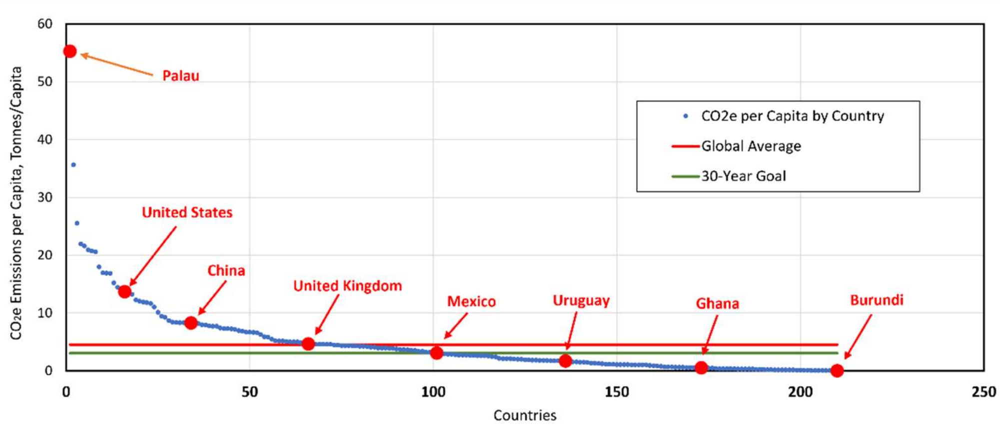


Figure 1 - CO_2e emissions per capita by country - 2020.

Across the globe, many human populations are already emitting less carbon with their activities than others, and significant numbers of humans already have a lower footprint than we need the global average to be. Basically, the people with the highest carbon footprints will have the biggest reductions to make. I'm pretty sure those Maasai tribesmen in Tanzania don't need to address their carbon footprint very much since they're already below 1 tonne/capita/year. I'm also pretty sure that Jeff Bezos has some serious work to do. Though he is unlikely to bother, since he's better than the rest of us and deserves to emit more carbon. Just saying. Hell, it might be a sign of status among the wealthy to spew more carbon than the next-richest human, sort of like big apes thumping their own chests to demonstrate their power and dominance. Ya think?

So, what is the range of carbon footprint per capita, anyway? Well, based on World Population Review data for 210 countries,[1] as shown in Figure 1, it ranges from a low of 0.02 tonnes/person in Burundi to a whopping high of 55.29 tonnes/person in Palau. When you look at it, you have to admit it's a pretty extreme range against a global average of 4.54 tonnes/capita. Like, WOW. How can it be this extreme? It turns out that the U.K., a developed country, is pretty much at the current global average, sitting on the red line in Figure 1, while the United States and even China are far and away higher. Mexico, on average, is basically already where we need to be in terms of carbon per capita, on the green line in Figure 1, while Uruguay is way below where we need to be, and Burundi is nearly zero at the low, low emissions per capita of just 0.02 tonnes/capita. So, what the hell? Why the difference? What's going on here? We know that developed countries tend to be energy hogs and undeveloped countries not so much, but this is a huge range. You gotta wonder.

Breaking It Down

There must be a million ways to break down or sort out our carbon usage so that we can better understand the many ways we spew. I guess a good place to start would be: What do I mean by "breaking down"? Basically, when I think of breaking something down, whether it be a big project I might be working on, what I'm going to do today, or the carbon footprint for the planet, I'm taking a big monstrous thing that I can't tackle all at once and it breaking into digestible pieces that I can dig into one by one. It's like turning something big that can't be handled in a single bite, like a pizza, into slices that can be taken on one at a time. Until it's gone. One can only hope. Anyway, getting back to climate change, I'm breaking it down into digestible portions, or sectors, to understand exactly what we're doing to cause the emissions. So, instead of getting hit from all directions by random bits of information that tell us we're destroying the planet with every move we make, I'm trying to break it down into digestible chunks of how exactly we're destroying the planet. How fun is that? I'm trying to turn a forest into some trees that we can see individually. I'm hoping it will seem less futile and more doable if we can break it down. It's always worked for me, and I hope it will work for you.

Like I said before, there must be a million ways to break down our carbon footprint, and we'll get deeper into that. For now, let's look at a fairly ubiquitous system that is used a lot by several international organizations, including the United Nations.[2] Because it's used so commonly, it provides an easy way to compare the U.S. and other countries at a high level, and it will help to get us started understanding how our individual actions impact our planet and what we can do differently to help. Below is a description of each sector and what it includes.[2]

- **Buildings** include all commercial and residential buildings. Greenhouse gas emissions from businesses and homes are primarily from fossil fuels burned for heat, the use of certain products that contain greenhouse gases, and the handling of waste. This is mainly natural gas, or methane, used for heating and cooking, propane, and any biofuels, such as good old-fashioned wood. Every time we flush the toilet, the carbon that's emitted, either in the form of CO_2 if our waste goes directly to a municipal wastewater treatment plant or in the form of methane (same as natural gas) if we're on a septic system that doesn't recover the methane, which is about 25% of U.S. households, is included in the "buildings" sector.[3]

- **Transportation** is from burning fossil fuel in non-stationary machines such as cars, trucks, ships, trains, planes, motorboats, four-wheelers, and snow-blowers.[4,5] Every time we go somewhere unless we're walking, riding a bike, sailing a boat, or riding a horse, the carbon we emit is included in the "transportation sector" of our carbon footprint. Transportation also includes hauling all our stuff to us from wherever it came from, including our food, unless we happen to be growing our own food at home, organically.

- **Power industry** includes all electricity production, which is primarily from burning fossil fuels, mostly coal and natural gas. This means that every time we turn on a light, TV, computer, air conditioner, or blow dryer we're using this electricity. Refrigerators and air conditioners are the biggest hogs of all. In the U.S. we blatantly waste about 7% of our electricity by leaving things on that we're not even using, known as "phantom energy." Air conditioners use nearly 10% of electricity globally,[6] and if we keep on heating this planet with our excesses, air conditioner use will continue to increase. Basically, the warmer the planet gets, the more AC we'll need, which will warm the planet even faster with the emissions. If that doesn't feel like being between a rock and a hard place, I don't know what does.

- **Other industrial processes** includes basically everything else, mainly agriculture, materials for buildings, cars, planes and all our stuff, including all our shoes, clothes, blow dryers, single-use containers, and whatever food or soap or toxic pesticides happens to be inside them. There's a ton of opportunity here for reducing our emissions. Basically, don't buy crap we don't even need, and if you want something, try to get it used instead of new. I don't mean a computer, but clothes and housewares and a lot of building materials for small household projects are really easy to buy used. And it's amazing how much money you save when you go to Goodwill instead of the mall. If you eat food that is not organic, the carbon footprint lands here, in the form of the toxic chemicals used to grow industrial foods, because they are mainly manufactured from CO_2-emitting fossil fuels.

- **Non-combustion** includes certain chemical reactions that are necessary to produce goods from raw materials, such as cement, glass, carbonate use of limestone and dolomite, nonenergy use of fuels and other combustion, chemical and metal processes, solvents, agricultural liming and urea, waste, and fossil-fuel fires, which are mainly flares on natural gas wells and facilities. Also, all the leakage from storage and transmission of fossil fuels falls into this category.

Figure 2 shows how, globally, the total annual carbon emissions break down into the different sectors. An important thing to notice is that the names of the sectors reflect the usage, and fossil fuels are the underlying cause of nearly all of these emissions with a few exceptions, like wood burning and cows farting. We can see that, on average, most of carbon emissions globally are from power plants that produce electricity, which means this sector would be a big one to start working on. Ways to reduce power plant emissions would be to reduce demand in homes and buildings, and by using renewable energy sources, such as wind and solar.

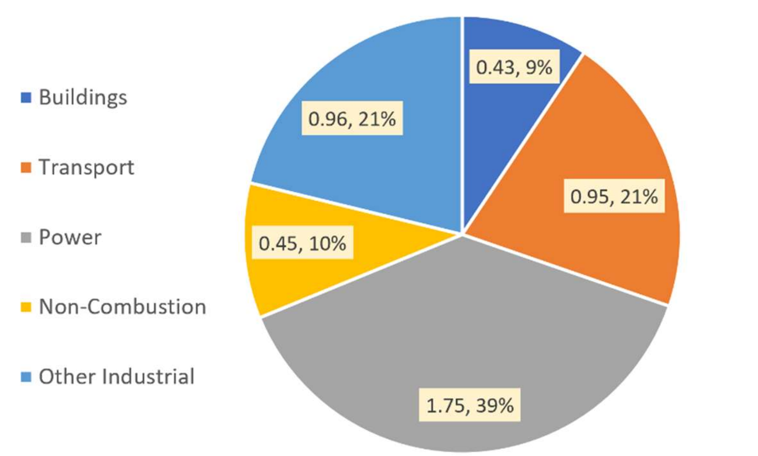


Figure 2—Global breakdown of CO_2e emissions per capita by sector.

The next biggest sectors are transportation and industrial, which can be reduced by finding ways to reduce how much we drive and travel and how much stuff we consume, given that when we consume, the carbon footprint hits pretty much all the sectors: transportation (to get the stuff to our door), industrial (to make the stuff), buildings (they gotta make it somewhere, also all the stores and distribution centers), power (all the electricity to make the stuff and power the buildings), and non-combustion (if fossil fuels, food, or cows are involved). The smallest sectors globally are buildings and non-combustion. As consumers, we can impact these largely by reducing the amount of natural gas we use to heat our homes and our hot water. We can also impact non-combustion simply by reducing product consumption, since it's a part of everything at the end of the day. Industrial agriculture with the land-use practices and toxic pesticides play big in this sector, as well as cows farting.

Now, let's look at some individual countries and see how they compare in carbon footprint per capita in the different categories. This will help us see how some countries can be lower in carbon footprint, while others are higher. Currently, 52% of all the countries on the planet have carbon footprints per capita that are already lower than the goal of 3.05 tonnes/capita that we need in order to balance with our planet, and the rest of the countries are higher. The countries that are higher can learn from the countries that are lower, so that all of us can be in balance with our planet and maintain a planet that is pleasant and viable for future generations—not only of humans, but of all the wildlife that we share this planet with, so we can stop decimating them and help them recover.

Countries in Balance

Since there are 210 countries and just one of me, I decided to start by picking a few examples in different ranges of emissions per capita and looking at them individually. We'll start with some examples of countries that emit less than 3 tonnes/capita, since that's where we need to be globally, on average. This would include Mexico, a country that is already where we need to be, followed by Uruguay, Ghana, and Burundi, all of which are significantly lower than where we need to be, globally. Table 1 shows a breakdown of carbon footprint per capita for these countries with lower carbon footprints per capita.

Table 1 – Breakdown of carbon footprint per capita in metric tonnes per year, low emitters (2020).

Country	Carbon footprint per capita	Buildings	Transportation	Power	Industrial	Non-combustion
Mexico	3.05	0.18	0.98	0.85	0.7	0.32
Uruguay	1.68	0.16	0.35	0.65	0.36	0.17
Ghana	0.54	0.04	0.27	0.10	0.07	0.05
Burundi	0.02	0.0042	0.0108	0.0016	0.0027	0.0007

In Table 1, the emissions per capita are broken down into the sectors that show how the average person emits carbon. In Mexico, for example, with a total carbon footprint per capita of 3.05 tonnes/person, on average, 0.18 tonnes of carbon emissions comes from buildings, 0.98 from transportation, 0.85 from power, 0.7 from industrial use, and 0.32 from non-combustion.

Uruguay has about half the carbon footprint of Mexico, yet Mexico and Uruguay have similar building footprints, so they use a similar amount of energy to heat or cool buildings. Also, it looks like the main reasons Uruguay has about half the carbon footprint per capita of Mexico is that Uruguay's citizens use about a third as much energy in transportation, 25% less electricity, and half as much stuff, since the emissions from industrial combustion and non-combustion are half as much for Uruguay as for Mexico.

However, we have to consider that, with industry, not everything that is manufactured within a given country is actually used by the citizens in that country; some may be exported, but the total industrial footprint hits the per capita metric for the country where they're made.[9] At least, this is true for the way I'm calculating it, which is by taking the total amounts for each country and dividing by the population. For example, in Mexico, the imports and exports are about even, at around 39% of GDP,[7] while in Uruguay, the imports are about 22% of gross domestic product (GDP), while exports are 28%.[8] This means that the industrial footprint per capita for Mexico is fairly reflective of the consumption of its citizens, with a similar amount coming in and going out. On the other hand, in Uruguay, the actual individual carbon footprint of consumption is about 20% lower than the calculated industrial carbon footprint.

When we look and Ghana and Burundi, the lowest of the low, when it comes to emissions, the only measurable emissions sector is for transportation, which is a fraction of Mexico or Uruguay. It turns out that Ghana, despite its major wealth in terms of natural resources, is one of the most undeveloped countries in the world, mainly because of the attitude of the population,[10] and most people rely on growing their own food to survive, spending most of their time in doing so.[11] Also, this is one of the many undeveloped countries where people may walk for miles to collect water in buckets for daily use, and where many villages have no electricity. In Burundi, people struggle to grow enough food, and about 56% of children under five years old are malnourished, 70% live in poverty, and 90% work in agriculture, which is pretty brutal, with constant swings from droughts to deluges.[12,13] Does that sound fun? Not to me.

The Hogs

Now, let's look at some examples of countries with higher emissions per capita, shown in Table 2. Of note are Palau, with a whopping 55.29 tonnes/capita. It's interesting that their transportation alone is 50% more than the global average for TOTAL carbon footprint per capita. Their power is about half the total, and their industrial footprint is more than the entire footprint of a U.S. citizen. They obviously make a lot of power, and they do a lot of hucking around of people and stuff. But, for who? After all, there are only 22,000 citizens in Palau,[14] so how can they have such a high carbon footprint? There's no carbon footprint for buildings, which means they don't generally heat anything with natural gas.

It turns out that planes and motorboats are a huge mode of transportation between islands, which explains the high transportation footprint, and these are mainly used by tourists, since more than 18,000 tourists visit Palau annually. Imported fossil fuels are used to generate power in Palau,[15] renewables are less than 1%,[16] and transmission and distribution losses are a whopping 20%[17] because of the distances between the islands. It turns out that Palau has lots and lots of fancy hotels and resorts to handle all those tourists, so that accounts for the high electrical power per capita. Since the average Palauan annual income is around $15,000,[16] it's likely that the tourists are using a lot more power for air conditioning and such in those hotels than the actual citizens of Palau, causing the high per capita carbon footprint to be greatly exaggerated.

This is an example of how the approach of adding up all the energy within a country and applying it to the population can result in an exaggerated carbon footprint per capita that isn't truly reflective of the footprint of the actual citizens within the country. It also demonstrates that the actual carbon footprint per capita of wealthier countries, whose citizens can afford to travel to remote locations like Palau, are likely significantly higher than the usage within the country indicates. The story is similar to the impact of all the stuff we buy in the U.S. that's made in other countries, which makes our emissions seem lower than they are, and theirs higher.

Table 2 — Breakdown of carbon footprint per capita - high emitters (2020).

Country	Carbon footprint per capita tonnes	Buildings tonnes	Transportation tonnes	Power tonnes	Industrial tonnes	Non-Combustion tonnes
Palau	55.29	3.87	28.75	18.8	3.87	0
United States	13.68	1.55	4.50	5.66	1.55	0.44
China	8.26	0.52	0.61	3.39	2.48	1.21
United Kingdom	4.66	0.81	1.17	1.81	0.68	0.20

Then, we look at the U.S., with a total carbon footprint per capita of almost three times the global average. In the U.S., our per capita carbon footprint of transportation is alone about what the total global average is for all the sectors combined. That's just embarrassing. At least to me. Our ridiculously high emissions also means that in order to get down to where we need to be globally, to three tonnes per capita, we have to reduce our carbon footprint by nearly 80%. Something about the bigger they are, the harder they fall. And that's assuming we decrease our population.

Lower transportation in the U.K. compared to the U.S. is due to less urban sprawl, which reduces daily personal transportation, and far better public transportation systems with a lot more trains. In China, the main modes of transportation are bikes, scooters, buses, subways, taxis, trains and planes. Note the lack of personal cars in this list. Also, high-speed rails are overtaking planes in China.[18, 19, 20, 21]

U.S. electricity is 50% more than the global average total carbon footprint. When we look at China, with a carbon footprint per capita that is double the global average, we can see that most of it is from power, or electricity generation, and industry, since China makes a lot of products for export. A significant portion of China's carbon footprint in reality belongs to the U.S. and other countries who trade with China. On average, China uses very little natural gas in buildings, even though the range of climate latitudes in China is huge, from extremely hot in the south to extremely cold in the north. Believe me, I've been there in winter, and it's definitely bracing. The U.K., which is about equal to the current global footprint per capita, uses far less CO_2e in each sector, compared to the U.S., and significantly lower power, industrial, and non-combustion compared to China.

Back to the U.S.A.

OK, now that we know what our obscene footprint is here in the U.S.A., let's focus on what we can do about it. I'm a U.S. citizen, and I believe strongly in cleaning one's own house first, before pointing fingers. Also, we're one of the worst nations in terms of carbon footprint per capita anyway, so to me, at least, it's an obvious place to start. We can make an enormous global impact right here at home if we change our ways. And we have to change a lot, as I mentioned above. An 80% reduction may seem intimidating and maybe a little scary, but it can be done. We just need to have the right information to act on.

An absolutely awesome document that helped me dig into the U.S. carbon footprint in more detail is the EPA's "Inventory of U.S. Greenhouse Gases and Sinks,"[22] which is readily available online and free, since I already paid for it with my tax dollars. This is data on anthropogenic CO_2e emissions that the EPA has been painstakingly collecting for decades, in compliance with the requirements of the United Nations Framework Convention on Climate Change (UNFCCC), initiated in 1992. The 840-page document compiles emissions from every U.S. sector, a huge help for my project. An absolute dream! If you want your mind boggled, have a look at it and be amazed at the enormous level of effort and dedication required to collect all this information and to verify its accuracy. Large industrial plants are required to report their energy usage, and when I worked at the Coors Brewery in Golden, as the Energy Engineer I was the one who collected and submitted the data for the EPA report, so I can verify the reality of actual data collection and reporting. We were audited once by the EPA during my tenure. And we passed.

We can't control what we can't measure, so the EPA data is invaluable to understanding how we emit carbon so that we can figure out how to reduce it and then measure the results of our efforts. Wouldn't it be awesome in a couple of years to see emissions stabilize and then begin to decrease? If only! And, as it turns out, you'll see that it's not all that hard. I'm hoping that an understanding of how our emissions work and how our actions fit together in a logical way will inspire us all to do the right thing and reduce emissions per capita. Which means each of us changing our ways enough to make a difference. With the understanding that there's no need to go as low as Burundi, if we change now rather than waiting until the last minute, which is in less than 20 years. Following the philosophy of cleaning my own house first, we've managed to go zero waste and nearly zero energy, including our transportation, at home. Also, we don't eat any more. Just kidding. But we do stick mainly with local bulk unprocessed organic foods, mainly plants. And, speaking for myself, I've discontinued all paper towels, napkins, Kleenex, and, yes, toilet paper. Which is huge. I'll explain later.

I chose to work with a baseline of 2020 for CO_2e emissions, mainly because I started working on the book in 2022 and the only complete data sets were from 2020. It turns out that it takes a significant amount of time and effort to collect and compile and verify all this data, which makes sense. Even though the book wouldn't be finished until 2025, and I knew the numbers would be slightly different, the story wouldn't be, and I decided it wouldn't add value to keep updating the numbers to a more recent year, a bit of a "run-in-place" proposition when there's just one of me. Hell, the book will go out of date with every year after it's published anyway. And, personally, I hope it goes out of date sooner than later, and becomes totally irrelevant over time, because if that happens it might mean that we finally started reducing our carbon footprint. Imagine that! A world where population and carbon emissions start decreasing, and fish and wildlife start increasing. The planet getting back into balance! Just Wow! Maybe I could even eat some seafood more than once annually with a clear conscience. Think about that. My mouth is watering as I write this.

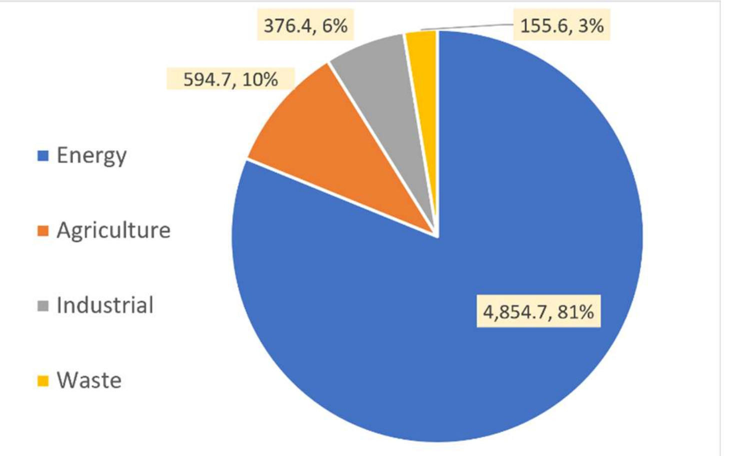


Figure 3 — U.S. CO_2e emissions by IPCC sector.

The basic EPA breakdown of U.S. 2020 CO_2e emissions by Intergovernmental Panel on Climate Change (IPCC) sector is shown in Figure 3. The first number for each sector is in units of million metric tonnes, or mmt, which is the common international unit for country-level emissions reporting. The second number is the percentage of the sector compared to total emissions. For instance, the biggest sector, energy, emitted 4,854.7 mmt in the U.S. in 2020, which was 81% of all U.S. emissions. Agriculture was 10% of emissions, industrial was 6% of emissions, and waste was 3% of emissions. You'll notice that we've switched from carbon footprint per capita, which we used in comparing countries, to total annual emissions for the U.S., which are much bigger numbers. To get carbon footprint per capita, we simply divide the total national numbers by the population of the U.S. in 2020. I'm not bothering to do that for this high-level analysis because the percentages won't change and the story won't change, so there's no point in adding complexity. Complexity only increases potential for errors, so for now we're keeping it simple.

While I guess this breakdown seems OK for high-level reporting of emissions for countries, it seemed pretty basic to me, like a black box that is hard to decipher and act from. I mean, what does agriculture include? Is that all our food, or just what happens on the farm? Does it include livestock? Are all livestock, including free-range on public lands, included? Hmmm. Same for industry. How do they figure? Why is it so low? I mean, all our stuff is produced by industry, including trains, plains, automobiles, computers, blow-dryers, construction materials and food. So WTF? And energy looked pretty vague, just a big blue slice that takes up most of the pie. So that's all our electricity, natural gas, and transportation? How much of that is for industry? And how does waste fit into all this? Or single-use packaging? Again, while I completely trust the accuracy of the data, it's mainly for high-level tracking at a national level, and not necessarily for an individual like myself to actually use to reduce my own footprint.

By the way, there's another category that's not on the pie chart in Figure 3 because the emissions are negative, so the chart shows only the gross, or total emissions. This is the LULUCF sector, which stands for land use, land use change, and forestry. It's negative because it represents the ability of U.S. land to take up, or absorb, CO_2e by vegetation via photosynthesis, and amounts to about 13% of our gross, or total, carbon emissions in this country. In a balanced U.S. dreamworld, we'd be taking up the same amount that we emit, which would mean our LULUCF would be four times what it is now, meaning four times as much open, undisturbed land, and our emissions would be about a third of what they are now. This would also by extension mean that our beleaguered wildlife would have four times as much land to recover on. However, we're not quite there.

On further digging I learned that the reason the CO_2e emissions for industry and agriculture are so low is because they only include emissions from non-combustion chemical reactions. So agriculture only includes the emissions from our absurd backwards industrial agriculture land use practices and nasty toxic chemicals applied thereupon, and actually does include cow farts, but doesn't come close to completely representing our entire food consumption. Not by a long shot. Most of that is actually lost in the big blue energy portion of the pie. Same for the industry sector. It's strictly chemical reactions to make whatever products involve chemical reactions, like glass and aluminum, but not the energy to actually produce the products in the factories, or to haul the products to a nearby store. At least we know the cow farts are accounted for.

I decided to use a slightly different kind of breakdown that's in the same 840-page EPA report, a few pages further in. This time, our emissions are broken down into "economic sectors," which is a little better. The economic sector breakdown in Figure 4 shows a bit more detail on how the actual energy that we burn is broken down, into residences, commercial buildings, and transportation, which is a lot more helpful. The agriculture sector still only includes non-combustible emissions, assuming nobody lights a match near a cow's butt, but industry includes any on-site combustion of fuels like natural gas. The commercial and residential buildings also include on-site combustion, but these sectors don't tell us everything about our home usage, as one example, because they only include combustion and not electricity, which we all use a lot of. So which do we use more of? Electricity or gas? Hell if I know. At least not from this breakdown. It turns out that all the electricity is in the electric power industry sector, which provides electricity to anything attached to the grid, including all the homes, buildings, farms, and factories in the country. Oh. OK. Also, the electricity is generated by a number of sources, including coal, natural gas, biofuels, renewables, and water. Again, the data is great and it's real, but what do I do with it?

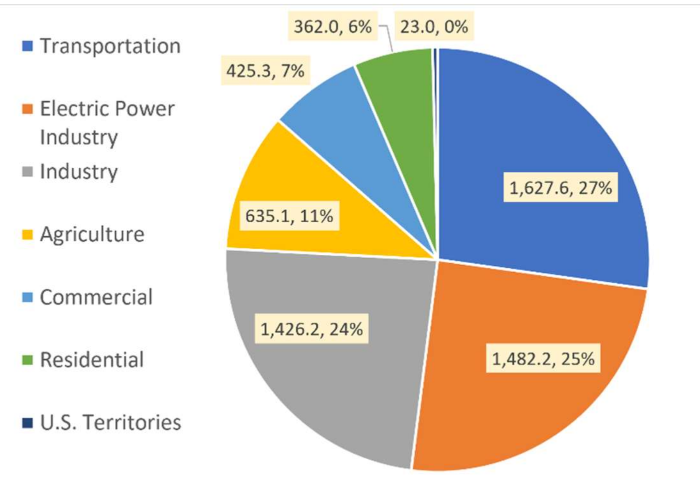


Figure 4 —U.S. CO_2e emissions by economic sector.

Then, on page 55, the same data was presented with the electricity allocated to the rest of the economic sectors, shown in Figure 5. So now, between Figures 4 and 5, we can see how much electricity is generated in total, and how much is consumed in each sector, at least, by difference. This is much better, because we can at least see that at home we emit about 16% of CO_2e in this country with lights, heating and cooking. Industry is a lot higher, at about 30% of our emissions with the electricity included. Interestingly, agriculture isn't much different because it turns out that they don't use that much electricity on the farm. At the farm, it's mainly about the massive machinery, which falls mainly within transportation. Still kind of confusing and not broken down the way I'd like.

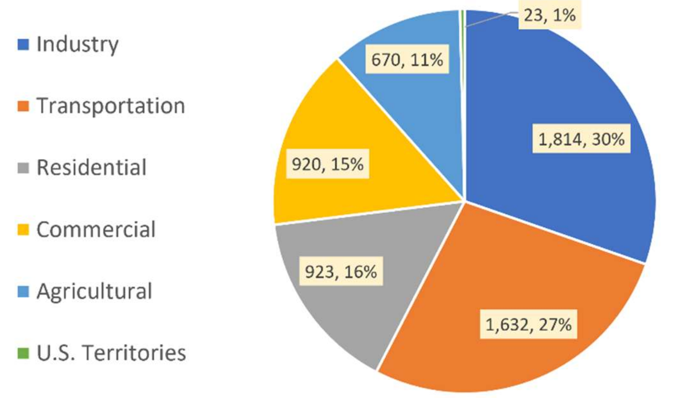


Figure 5 — U.S. CO_2e emissions by economic sector with electricity allocated to each sector.

I finally decided that I would have to buckle down and allocate the usages to the sectors myself. Luckily, I was able to use data from the same EPA report, a big old table on page 18 that listed every single category of emissions. I went through every single line item, everything neatly listed, from coal to methane to gasoline to fuel oil to substitutes for ozone depleting substances, allocated to each individual economic sector and subsector. I dumped all the data into a spreadsheet and allocated each item to the appropriate sector, creating the more detailed breakdown shown in Table 3. Those who know me well can easily imagine that I was in heaven! I just love analyzing data in spreadsheets. I even went so far as to allocate the carbon emissions associated with the production of the fossil fuels, since the breakdowns only included the actual burning of the fuels for energy, while the energy needed to mine and refine the fuels, which is nearly 12% of the emissions on average, was buried within the industry sector. Since my entire goal was to determine complete carbon footprints of different industries and the products produced, it made sense to start with complete footprints of the fuels, including burning and production. This made it so much easier when I started working through the individual industries.

Table 3 — U.S. CO_2e emissions by sector, million metric tonnes (mmt), 2020.

Economic sector	Stationary combustion	Mobile combustion	Electricity generation	Non-combustion reactions and fugitive emissions	Total
Industry	610.3	28.9	363.8	547.7	1,551
Transportation	0.0	1,666	4.9	40.2	1,711
Residential buildings	408.3	0.0	573.3	41.9	1,023
Commercial buildings	289.5	0.0	505.0	198.6	993
Agriculture	13.0	41.3	27.3	593.3	675
U.S. territories	21.6	0.0	6.2	0.0	28
Total	1,343	1,736	1,481	1,421	5,981

To my calculating mind, Table 3 is a beautiful thing because now we get to see just how much of each general category of emissions is consumed in each sector. We can see that industry is a whole lot more than non-combustion reactions. A huge amount of stationary combustion and electricity are also consumed, and even some mobile combustion. Stationary combustion is any fuel burned within a facility and includes things like heaters, furnaces, and boilers, while mobile combustion is what it sounds like, fuels burned in moving vehicles, otherwise known as transportation. In the case of industry, which includes mines and logging, for instance, a significant amount of energy is consumed in mobile heavy machinery, like tractors, combines, and front-loaders, which is in the category of transportation.

Industry emits most of the stationary combustion emissions and uses a huge portion of electricity, and is the second largest emitter of CO_2e, surpassed only by transportation, a portion of which lies within industry. Industry makes all our consumables, including our processed food, our construction materials, our clothes, our electronics, our toys, our toilet paper, and all the other stuff we may or may not need in life. At a high level, you can begin to see why it's important to only buy what you need, and to buy used whenever possible. Obviously, some things can't be avoided. After all, we all need to eat, and used food is pretty hard to come by. Actually in reality it's not—it's all at the sewage plants, where it's not all that appetizing. I digress.

Diving Deep

Even though we have a lot better idea of how much of our emissions are coming from different categories of different sectors, we still have a bit more to figure out. For one thing, how much of industry emissions is from food processing? How much is for packaging? What about construction materials? Textiles? Mining? How much emissions is from water and wastewater treatment, which falls within industry? What about all the other stuff?

I began researching this by digging through information on the internet, as much information as I could find about glass manufacturing, aluminum, paper, plastic, and other common single-use packaging materials. I dug into the gory details of logging and wood pulp, chemicals used in pesticides and fertilizers, cement, electronics, lime. The list goes on and on, and I was beginning to feel like I would be running in place forever trying to get through all this, when I found yet another amazing government publication that saved the day. This time, is was the "Manufacturing Energy and Carbon Footprints (2018 MECS),"[23] a document provided by the U.S. Department of Energy, using U.S. Energy Information Administration data. The carbon footprints of 20 different industries, many of which I hadn't even thought of, were detailed in there by category. I mean, foundries is a separate industry from fabricated metals? Who knew? All the emissions were calculated as CO_2e for my happy convenience, so I didn't even have to do the conversions. Talk about pay dirt! The one small issue was that everything was for 2018, and everything else I had done was for 2020. Not a huge deal, I simply scaled the data to 2020 as best I could, using total production for each year.

I also needed the total quantities of products produced, from mined metals and minerals to chemicals to cement, and found a lot of that data in related government documents[24,25,26] and from on-line resources.[27] I worked hard to find the best answer, sometimes after evaluating several references to arrive at something that made sense and seemed to be from a reliable source. The total quantities of production allowed an estimate of carbon footprint per weight of product, which took me to the next level, which was to determine complete CO_2e emissions for industrial production of specific products.

What About Glass?

Since the production of glass is pretty familiar to me, I started there. While working at Coors, I took a brewer's diploma course and we toured the company glass plant, and learned, at a high level, how the basic process works. I learned that the main raw materials for making glass are sand, soda ash, and lime, and that these are mined materials that must be refined, sorted, and ground to fine, consistent sizes at the mine, then transported by rail from Wyoming and Oklahoma to the glass plant. At the plant, they're blended and heated to about 3,000 ºF in natural gas-fired furnaces to melt the mixture into glass. The melted glass is then extruded through electrically driven equipment to form the bottles. I also learned that it's possible to recycle glass bottles indefinitely, time after time, with no reduction in quality or consistency. In fact, ground-up recycled glass, which is called cullet, actually seeds the blended raw materials and significantly reduces the melting temperature, which in turn reduces the natural gas requirements, saving both energy and costs.

Later, after retirement when I began to get involved in local City of Golden sustainability initiatives, I visited the glass plant and interviewed operators in an effort to help drive more local glass recycling. I learned that glass recycling in Colorado is significantly below the national average, mainly because we have lots of land for landfills, so we don't worry about it too much. In an effort to get more recycled glass into their process to reduce natural gas requirements, they literally have recycled glass delivered from more progressive states, like Oregon, Michigan, and Wisconsin. I mean, seriously. Are you kidding me? Because we in Colorado can't be bothered? Good gravy! At any rate, I researched glass manufacturing as my first industrial deep dive to get the full carbon footprint of the entire process, from cradle to grave, including raw materials, shown in Table 4.

Table 4 — Complete embodied carbon footprint of glass production, U.S., 2020.

Production	CO_2e emissions, million metric tonnes (mmt)/year						
	Chemical reactions	Electricity	Stationary combustion	Transportation in plant	Transportation to factory	Land	Total
Glass Plant	1.86	6.05	7.13	0.02	0.61	0.00056	15.7
Sandstone quarry	0	0.0167	0.0039	0	0.11	0.0485	0.18
Lime production	2.54	0.0278	1.07	0	0.051	0.0002	3.69
Limestone mine	0	0.022	0.0052	0.0052	0.0015	0.064	0.10
Soda Ash production	1.11	0.0049	0.00015	0	0.037	0	1.15
soda Ash Mine	0	0.0057	0.0013	0.0013	0.037	0.017	0.06
Total CO_2e	5.51	6.12	8.21	0.027	0.85	0.13	20.8
Total glass production	CO_2e emissions, pounds CO_2e/pound Glass						
10.25 mmt	0.54	0.60	0.80	0.0026	0.083	0.013	2.03

The process of pulling the information together for glass was a great start to get me into the swing of figuring out the carbon footprint for other industrial processes that weren't listed specifically in the U.S. Office of Energy Efficiency and Renewable Energy (EERE) and EPA reports. For example, the petrochemical industry is huge and involves a lot of specific products, like pesticides, paints, and such that weren't singled out, so I had to research those separately using my general knowledge of how most factories function and use energy. I've been in a lot of factories of different varieties, in addition to breweries, the glass plant, the can plant, and the can ends plant that are located near the brewery and provide all the containers for the beer. As the energy engineer at the brewery, I also toured a huge variety of manufacturing plants in Colorado as part of the Colorado Industrial Energy Challenge (CIEC) that Coors was a member of. We even toured an indoor marijuana growing facility! I just love plant tours and will never miss one if the opportunity presents itself. It's just so interesting to see how things are made! I've been through a few power plants too, and was very familiar with the 40 megawatt (MW) cogeneration power plant at the brewery, being the energy engineer. I've toured my share of mines as well, and have obviously spent a fair share of time in oil and gas fields. Hell, I've even been through a Japanese polymer factory, in Japan, back in my oilfield days! How many of us can say that? That kind of background puts me in a pretty good position to decipher the carbon footprint of most products, with a little research on the internet.

Back to glass, I mentioned earlier that on the high-level EPA breakdown of CO_2e emissions in the U.S., the industrial carbon footprint is strictly from the chemical reactions between the raw materials when they are melted to form the glass. The energy to actually melt the raw materials to nearly 3,000 ºF, typically using natural gas, is in the "stationary combustion" sector, and the electricity consumed to run the bottle-making machinery is within the "electricity" sector. Transportation is also used within a glass plant, like most factories, to haul supplies and materials around within the facility and for maintenance of equipment. Transportation is also used for hauling raw materials from their source to the factory, and finished goods to point of sale. All those additional emissions increase the emissions of making glass in the U.S. from 1.86 mmt/year for the chemical reactions included in the EPA industry sector to a total of 15.7 mmt/year when everything is included.

And then there are the raw materials. After all, you can't make glass without soda ash, sand and limestone, which have to come from somewhere, and don't just show up by magic at the glass plant. So a complete embodied carbon footprint of glass should include those, too. And it turns out that making lime and soda ash from mined rock also has chemical reaction emissions. Who knew? When we add the raw materials to the glass manufacturing emissions, it increases the total emissions by about 30%, to 20.8 mmt/year. This is the complete embodied carbon footprint for glass manufacturing, and is a lot more than the 1.86 mmt/year allocated to industrial glass manufacturing in the high-level numbers shown in Figure 5. I went through this process for every industrial product that I could find. And this isn't even a complete carbon footprint because it doesn't include any of the construction of the factories or the machinery used in production, which must be replaced regularly. I chose not to go that deep because it doesn't change the story that much, and will be addressed at a high level in chapters 22 and 27.

Now, these big numbers actually aren't going to mean much to the average consumer, certainly not enough to drive action to help our climate. They are simply a tool, or a starting place, if you will, to make personal purchasing choices. At the bottom of Table 5 are emissions in a more convenient format for the everyday consumer, in pounds (LBS) of CO_2e per LB of glass. This tells us that for every pound of glass that we buy in the form of bottles and jars and such, 2 pounds of CO_2 are emitted. For example, an average 12 oz beer bottle weighs about 7 ounces empty, so for every bottle of beer you buy, that's 14 oz of carbon emissions, just for the bottle. Think about that. I can tell you that the carbon emissions from making the bottle are a helluva lot higher than the emissions from making the beer, which is only about 0.0000044 LBS of CO_2/LB of beer, which is literally just 1/200,000 the amount of CO_2e that's spewed in making the glass bottle. By the way, if 12 oz of beer is ¾ LB, then the emissions to make 12 oz of beer is just 0.00004 oz. This is why it's so very important to buy bulk whenever possible and to reuse our bottles.

If we can't buy bulk, then we should at least recycle the containers. There's a lot of opportunity here, since in the U.S. we only bother to recycle about 40% of our single-use glass containers. In the case of glass, recycling eliminates the raw materials and the chemical reactions and significantly reduces the amount of natural gas for combustion. If we assume recycling reduces natural gas by 20% (actually it can be more, depending on how much recycled glass is in the blend), then we're left with about 8 oz of carbon for that 12 oz bottle, a 40% reduction in emissions. Which is still higher than the beer itself. Of course, eliminating the bottle altogether by buying bulk is the best ultimate solution, and while it's not always possible, there are ways. When we travel, for example, or eat out in general, we favor local microbreweries and restaurants that serve beer from taps, which are pulled from reusable kegs. Many microbreweries these days will refill jugs with beer, and it's starting to become a thing, especially in larger towns and cities, to refill kombucha and wine from dispensers. Check into options near you. You never know. The concept is nothing new. After all, restaurants have been drawing soft drinks from dispensers for decades, haven't they?

Compressed Oxygen Needed!

Once I had the "almost" complete carbon footprints of the various commodities, goods, and energy that we constantly consume in the U.S., it was time to take the next step and dive even deeper by looking closely at complete industries to determine where we emit the most CO_2e. For example, I knew what the complete carbon footprint of agriculture, food processing, and transportation of food is, but what about all of that together, what would that add up to and how much of our gross CO_2e is actually our food? After all, while it's true that we all need to eat, it's also true that a lot of food goes to waste in this country, 12–50%, depending on how the food waste is calculated.

The point of all this number-crunching work is to help us prioritize our efforts, by figuring out what causes the highest emissions, so we can work on those first. What about other big emitters, like construction, building energy, and transportation? Of course, let's not forget about single-use containers. I had an absolute blast pulling these numbers together to see what's really going on around here. Don't forget, I can get pretty excited when it comes to numbers.

Prioritization – what's that?

From years of big-corp engineering, I learned a lot about prioritization. Everybody has a great idea for a project, something they want to see happen for the company, to make their jobs easier, make things safer, save money, improve quality, whatever. Could be anything, from better radios for operating teams to a more efficient can line for filling empty cans with beer. Yet there is only so much money to spend each year on projects, so they all have to be rated and prioritized so the best projects are done first.

Most of us do the same thing at home. We have only so much money to spend, so we have to pick and choose what we're going to spend it on. This month, we might want to replace the two front tires on our car, because they're bald, or rotate them with rear tires, until we can afford to replace them. The refrigerator has failed entirely, so we get it fixed so our food doesn't rot, and hold off on the tires or take the bus to work for a while. You get the picture.

We can prioritize with the environment too. What are the biggest things we are doing to add CO_2 to the environment? If we can figure that out, we can get the most gains faster than if we simply recycle our plastic and hope for the best. The "hope for the best" approach is what we've been doing for the past 50 years, and our environment is getting worse—we've killed more than half of our wildlife, so we might want to change it up a bit.

Another big-corp thing is to never have more than 10 goals, and not to work on more than three at a time or nothing will get done. Another way to think of it is "big rocks, little rocks" and to make sure the big rocks are the main focus, with the little rocks either small pieces or distractions. If food is our biggest source of CO_2 emissions, we should start there, and figure out some small things in that category that we can change to do better, then go from there. This may require more work and concentration with food, and it's up to each of us to figure out what distractions, or "little rocks," we can do without in our lives, or let go of, or reduce, to give us more time for food. Then, when we've nailed the food, make the new practices habits and move on to the next big rock. Again, it's possible to have more than one big rock, or priority, at a time, like working on food, home energy, and transportation, but we should be careful not to try to do too much at once because we'll get discouraged and burnt-out, and hopelessness could set in and make us do nothing, which is, I believe, our collective problem when it comes to climate action. I truly do think that most of us care about our planet, we just feel overwhelmed by it all, which drives us to inaction and hand-wringing.

Table 5 shows the priorities, from the highest consumption to the lowest, from top to bottom, with totals at the bottom. You'll notice that the total CO_2e is 7,286 mmt, which is 22% higher than the EPA's total of 5,981, before correcting for LULUCF. This is because, instead of using LULUCF, which accounts for *changes* in land use, I chose instead to account for all *current* land use. I think this paints a more accurate and complete picture of our carbon emissions, because if the land is being used for human purposes, it's not absorbing carbon like it would be if it were intact in a natural state. This actually increases our carbon footprint by 1,305 mmt, or 22% over that reported by the EPA, and that's the total I'm using throughout this book. In terms of CO_2e per capita, this works out to 22 metric tonnes (mt)/capita per year.

Table 5 — Complete embodied carbon footprints of U.S. consumption (2020)

Priority	Description	CO_2e, million metric tonnes/year (mmt/year)							Percent of gross
		Non-combustion emissions	Electricity	Stationary combustion	Transportation, non-freight	Land	Transportation to point of use or sale	Total*	
1	Food	614	79	93	74	579	68	1,506	20.7
2	Construction	266	118	173	186	292	173	1,210	16.6
3	Residential Buildings	61	578	453	12	24.1	0.01	1,127	15.5
4	Personal Transportation	13	46	41	919	4.34	18	1,039	14.3
5	Commercial Buildings	129	485	326	10	43	0.01	992	13.6
6	Single-Use Containers and Paper	49	29	86	5.8	241	9.1	421	5.8

7	Non-Military Aviation	2.2	5.9	6.2	113	0.19	2.5	130	2.2
8	Textiles	81	17	14	5.0	3.3	2.4	123	1.8
9	Water and Wastewater Treatment	60	33	5.7	1.9	2.2	0.96	103	1.4
10	The Rest	147	90	145	171	83	0	635	8.7
	Total	1,422	1,481	1,343	1,497	1,271	272	7,286	100

**EPA gross emissions for 2020 was 5,981 mmt of CO_2e, before accounting for LULCF, and 7,286 mmt with current total land use included.*

And the winner is (drum roll please) our food! Not a huge surprise, actually, but now consider it verified. And even though many of us would have guessed the "what," even more important is the "how." Table 5 shows that that there's a whole lot more to the all-in food carbon footprint than just the non-combustion emissions from agriculture. When we include all the details and the bells and whistles of food production, a more complete picture emerges. The total footprint of our food includes the electricity and combustion, which happens mainly in factories that process and package food, in fertilizer and pesticide factories, in the farm machinery, which is captured in non-freight transportation, and in the transportation of raw foods to the processing plants and the processed and fresh food to the ultimate point of sale, in other words, distribution centers and stores.

Land use is also captured, and the capacity of the land to absorb carbon that was lost when it was converted to agriculture is added. It turns out that the industrial farming practices that result in the non-combustion CO_2 emissions of synthetic fertilizers and toxic pesticides applied to the land, combined with the loss of carbon uptake capacity, are by far the biggest components of our food production. And to think I figured the food processing and transportation would be the worst of it. They're not. I'd be wrong on that. By a long shot.

If we look at the big picture, if we all consumed only organic food, that alone would reduce our food emissions by 42%, translating to an 8.7% reduction in our total carbon footprint. By only producing organic food, we'd go a long way towards allowing our wildlife to recover by not constantly poisoning them with our toxic pesticides. And by not wasting 12% of our food like we do now, we could reduce our carbon footprint by another 2.5%. If we did both, that's about an 11.2% reduction in carbon footprint right there. Without making severe changes in our lifestyles. How's that for some low-hanging fruit?

I hope that you can see the potential here, and how every one of us can make a difference right now in our individual purchasing choices. Buy only organic and don't waste the food. When we buy local fresh food, the issue pretty much takes care of itself, because many local growers are organic, or at least mainly organic. You can ask them about that. The thing about organic farming is that it's safer for the actual growers, and they usually don't want to handle dangerous toxic chemicals. One thing you can be pretty sure of is that they're unlikely to fly over massive fields spewing poisons that make the entire landscape toxic and uninhabitable, like they do in Iowa on the industrial farms. Don't believe me? Just drive through there sometime and view the gargantuan monocultures of farm fields. And if there are planes flying overhead, you might want to close your windows and turn off the vent. Unless you're on a bike, in which case your life will be shortened by probably at least a year. Anyway.

As for big corp if we only buy organic, and refuse the toxic products, they'll have to change, to meet the requirements of the consumers, whether they like it or not. Or go out of business. Think about how the percentage of organic products has gradually increased in most of the big chain grocery stores in the past few decades. Increasing, but not fast enough. While increase is good, we need more. We need all the food to be organic, and we can demand that as consumers. Yes, it costs more, but if we don't waste half our food, and eat only fresh foods, not processed, we'll ultimately spend less. And this covers just some of the high-level issues with our food. We'll be diving deeper into our food, revealing even more potential to reduce our carbon, in the next chapter.

The runner-up in Table 5 goes to construction, which shouldn't be much of a surprise either. Construction includes not only the massive energy used on site, but all the mining and manufacturing of materials, transportation of materials, and the land we consume as we continue to take over the planet with our species, displacing wildlife. The absurd level of construction in the U.S. is driven by continuous population growth, since obviously with more people we need more homes, more schools, more stores, more hospitals, and more of every other building you can name. Even if our population growth comes to a screeching halt immediately, we'll continue to need more and more and more for the next generation that's already here. However, we would see a gradual drop over the next couple decades if we stabilized our population now, and that would help a lot since we'll be feeling the impacts of running out of fossil fuels by then for sure. If we can stabilize our population and then reduce it, construction would be limited to remodels and replacements of obsolete buildings, and I'm guessing that would be about 20% of the massive new developments that we're doing now. This translates to an 80% reduction in construction carbon emissions, at least, or 13.3% of our gross emissions, while giving even more land back to wildlife. There's even more potential with construction to recycle all construction materials. Most construction materials are recyclable, but we still remain pretty lazy as far as actually doing it.

The residential and commercial building energy and the transportation are all driven by our individual choices. We can eliminate all of this by switching entirely to renewable energy, some combination of solar, wind, and geothermal. Yes, we have installation costs, but not as much as it's going to cost when we run out of fossil fuels, if we're not prepared to do without. And, these technologies pay out in 10–15 years, sometimes less, depending on where you live. So, we'd better get on it. We've completely switched our own home entirely to electrical equipment, including a heat pump, tower heaters, and on-demand hot water, powered by solar panels and a backup battery. We're still connected to the grid, which is mainly also powered by solar and wind in Colorado, because we make more energy than we consume in summer, so we send it back to the grid so that somebody else can use it. We also have an EV that we power from our own system as well. This reduces our carbon footprint by 36% and gets us mostly off the big oil tit. For commercial buildings, in Golden we have started a citizens group, Sustainable Golden, to work with the city to figure out how to encourage homeowners and commercial building owners to convert. This is called "local activism."

I was a bit surprised to find that single-use packaging, including cardboard and paper, comprise 5.8% of our carbon footprint. All so we can avoid washing dishes and reusing containers. Also, a large portion of this is toilet paper (more on that to come in chapter 21). Buying bulk avoids a lot of this, though I won't lie: more work and organization is required because the reuse containers do need to be cleaned and maintained, and when we cook and prepare our foods with unprocessed fresh ingredients, it takes more time. But personally, I find it's not that hard, especially if you share the work. It's also cheaper because you don't pay for the containers. And it's a helluva lot healthier to throw a quick sandwich together than to get a Big Mac on your way home. Cheaper too. If you live alone, like our son, then you take a little time on your days off and make a big pot of soup or something, then eat from that all week. When I was working full-time, attending college, and raising kids, I did a combination of that, and of organizing ingredients before work for my lunches. It turns out that toilet paper and other single-use paper are unnecessary evils promoted by big corps to get consumers to regularly buy more stuff, advertising convenience. I was raised in the first "single-use" generation, and didn't know any better, until I did.

Flying and textiles each emit around 2% of our carbon, and water and wastewater treatment is at 1.4%. It's all important, and most of us have the capacity to reduce these emissions by at least half. I'm actually a bit encouraged about the flying usage, as we do like to travel, though we keep air travel to just once per year, and I don't feel as guilty about it as I did before I ran the numbers. With water, we hear a lot that it consumes about 3% of electricity in this country, which is true, but I wanted to know the entire carbon footprint, because electricity is only a fourth of our total consumption. Our textiles footprint seems low to me, given all the information out there that says it's a lot higher, but this might be because we consume textiles that are actually made somewhere else, where the energy consumption hits another country's emissions metrics, like China, India, and Vietnam, making their carbon footprint per capita look like it's more while making ours look like it's less.

The rest of the emissions are all the other stuff we consume that I didn't deep dive into individually. This would be all the stuff we buy for kitchen, household, personal care, commercial and office furnishings, transportation, and computers. Machines utilized in factories aren't accounted for in the deep dives, mainly because I didn't feel like the added complexity would change the story very much, so that last 8.7% is all thrown into the same miscellaneous bucket. After all, what's a list without a miscellaneous category? It kind of makes it all real, at the end of the day.

Let's Do This!

What do you think of the deep dives? Do you have a better clue? Are you encouraged or discouraged? Personally, I'm encouraged, because it looks to me like we don't have to do all that much to reduce our carbon emissions pretty quickly, and by a lot. I hope you are too.

At this point, you might be good to go. If not, chapters 17–23 have more detail and tips on what each of us can do. Again. It’s not hard.

What are we waiting for? Let’s do this!