CO2 and (the average) you

Levien van Zon (levien@sustainsubstance.org)

2016-04-22

Source URL: http://sustainsubstance.org/co2footprint.html

By Levien van Zon

This article is also available in Dutch.

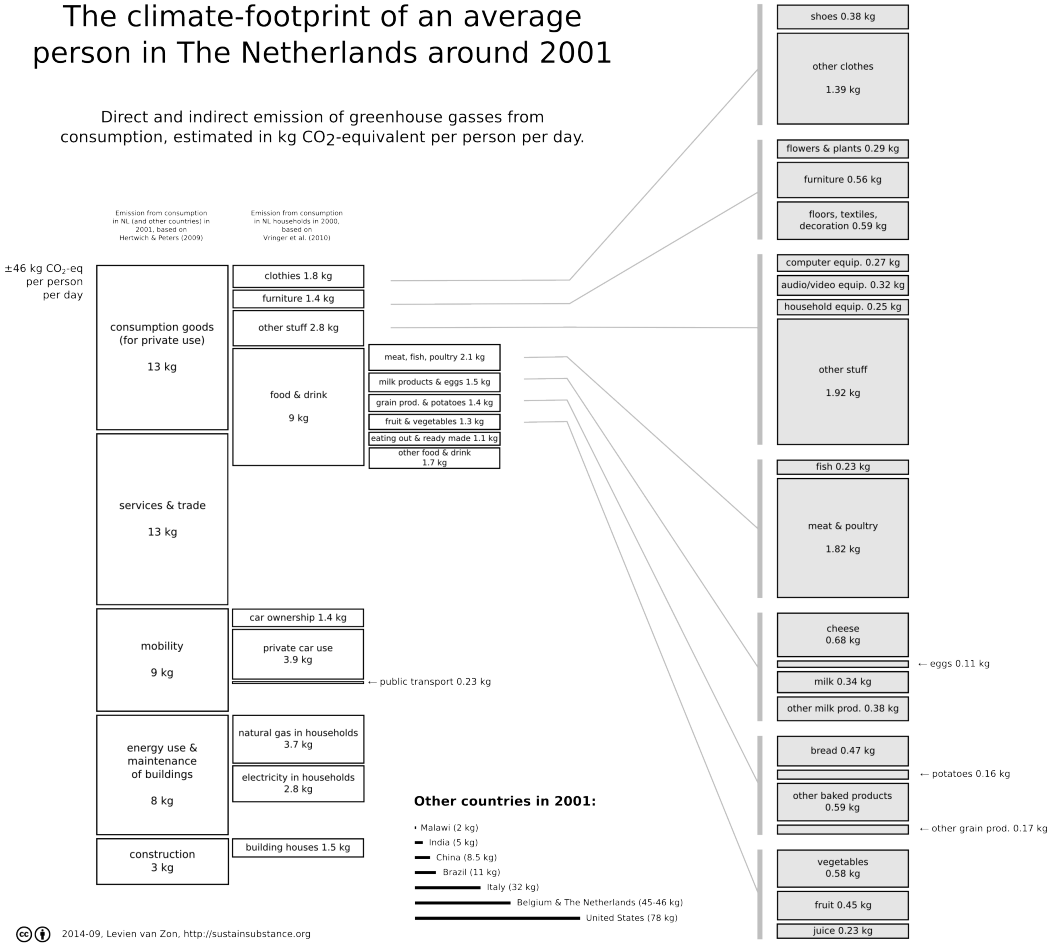
Today, on Earth day, countries will start signing the Paris climate treaty that was reached last December by the representatives of 195 countries. A lot has already been said and written about this Paris Agreement, which in 2020 should succeed the venerable 1997 Kyoto protocol.[1] While the agreement is a great step forward, we're certainly not there yet. There's a lot of work ahead for governments, civil society and the private sector. The key to controlling global warming basically lies in keeping government-owned fossil fuel reserves in the ground, and halting the exploration of new reserves by private companies. This is possible, but not exactly trivial given the huge economic interests involved and the significant challenges inherent in transitioning to a new energy system.

In an earlier article I described why it is important to reduce the emission of greenhouse gasses such as CO_2, even if you're sceptical about the warnings of an impending climate apocalypse.[2] Recognising that something should probably be done to reduce emissions is an important step, one that our governments finally seem to have taken. But the more difficult problem is really: how do we do that? Reducing greenhouse gas emissions is much easier said than done. For the most part, they are caused by the burning of fossil fuels to meet our energy requirements. If we want to reduce these emissions, we will need two things: alternative energy sources and more efficient use of energy.[3] Governments will no doubt play an important role in reducing emissions, but the role of citizens and companies will probably be at least as important, if not more so.

An average person exhales roughly a kilogram (2.2 lbs) of CO_2 per day.[4] On top of that however, our activities are responsible for the emission of a lot more CO_2 and other greenhouse gasses. For instance, my home country of The Netherlands is a relatively wealthy Western European country, with a high standard of living, and therefore a high energy requirement. In fact, the activities of an average Dutch person cause the equivalent of around 46 kilograms (100 lbs) of CO_2 to be emitted every day! This is more than our average body weight every two days. In some cases we emit this CO_2 directly, for instance when burning gasoline, diesel or natural gas in our car or heating system. Sometimes

someone else emits it for us, some distance away, for instance if we use electricity or take a plane. Very often however, our emissions are indirect, and often even occur outside of our own country. This happens when we buy things that cost energy to produce. Sometimes *a lot of* energy, as we shall see.

The figure below shows the daily greenhouse gas emission for an average consumer in the Netherlands (click on the figure for more details):

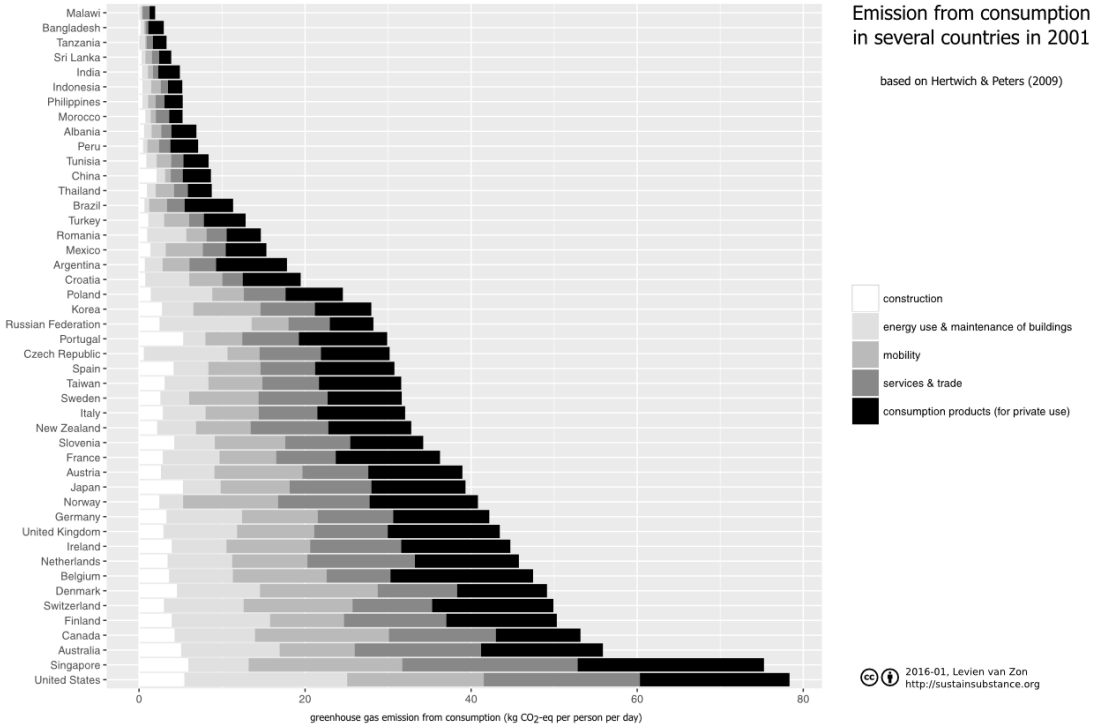


First, I'd like to say two things about these numbers. These are *estimates*, based on two different studies, done using data from 2000 and 2001. These numbers are *not* exact measurements, and results from various studies rarely match exactly. And yes, the data is 15 years old, unfortunately I could not find more recent numbers at this level of detail. Undoubtedly some things will have changed since the start of the millennium, which would cause some minor shifts in these figures. But I don't expect drastic changes in consumption or emission over this period. More importantly, it doesn't really matter if the numbers are a

bit off, as I aim to look at large-scale trends here.

Another thing to note is that these are numbers for an "average Dutch person". This average person, however, does not exist. It is a theoretical construct of indeterminate age and sex, with no clear place of residence. Or to put it another way, the *actual* emissions will be different for everyone, and the numbers quoted here will apply to nobody exactly. If you're vegan and do not own a car, your average daily CO_2-emission will easily be 10 kg below average. But if you eat meat three times a day and drive around in a big SUV or fly to a different continent four times a year, your emissions can easily be several times the average.

So within a country, the differences in emission between people can be quite large. But *between different countries* the differences can sometimes be enormous. The average American emits one and a half times as much as the average Dutch person. The average Chinese on the other hand causes around five times *less* greenhouse-emissions than the average Dutch consumer, even though China, with its enormous population and industry, is often named as the biggest polluter. The reason for this apparent contradiction is simple: Chinese consumers (on average) buy less, travel less and use less energy than those in the West. However, the Chinese industry produces a lot of the stuff we buy. Therefore much of the emission in China *as a country* is for making *our* consumption goods. The CO_2 from Chinese factories and power plants is mostly part of *our* indirect emissions in the West. The more well-off a country's inhabitants, the more greenhouse gasses are emitted directly and indirectly to support their lifestyle. One average Dutch person emits as much greenhouse gas as 4 Brazilians, 10 people in India or 23 people in Malawi.



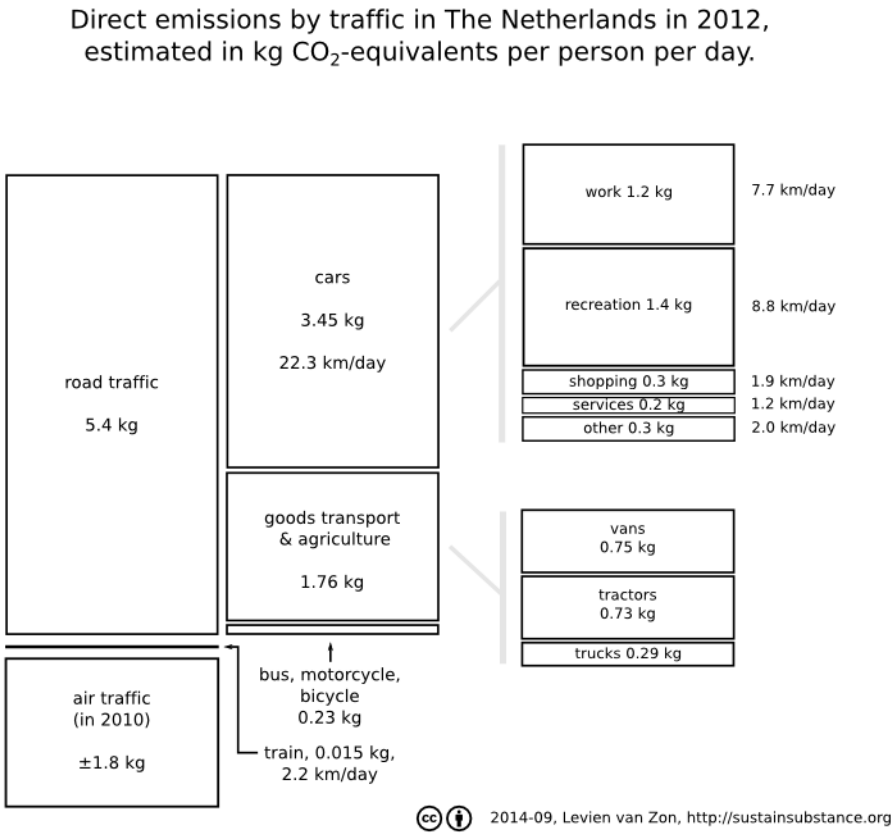
As we can see in the figure above, The Netherlands is fairly representative of rich Western European countries when it comes to greenhouse gas emissions. So, if we assume that being poor is not the preferred way to mitigate climate change, what would be the most effective way to reduce our greenhouse gas emissions? To determine this, it is useful to look at the numbers in a bit more detail. Which things contribute most to our emissions?

In the above figures, I have divided consumption-related emissions into five main categories. Generally the smallest of these represents the emissions from constructing houses and other buildings. This is a bit misleading, as constructing a building (and producing all its components) actually requires an *enormous* amount of energy. But most people have only one house, which lasts at least a few decades and is usually shared with other people. This is why the emissions associated with construction *per person per day* are fairly small: 3 kg for someone in The Netherlands, even though this is still more that the *total* daily greenhouse gas emissions of someone in Malawi!

When people talk about saving energy or installing solar panels, a lot of attention is given to the direct usage of electricity in buildings. But actually our home electricity use tends to make only fairly small contribution to our total greenhouse gas emissions (for an average Dutchman less than 3 kg per day). Heating actually has a bigger impact. In The Netherlands, buildings predominantly use natural gas for heating rather than electricity, and this provides for an emission of almost 4 kg CO_2-eq. per person per day. Taken together, the direct energy use of Dutch households (gas + electricity) generates almost a sixth of Dutch greenhouse gas emissions, or ±6.5 kg per person per day.

Mobility, especially road and air traffic, contribute around the same order of magnitude as our housing. In The Netherlands, mobility is responsible for 9 kg CO_2-eq. per person per day, around a fifth of the total emissions. The figure below shows the source of some of these in more detail for 2010/2012 (click on the figure for more details):

Greenhouse gas emissions by transportation



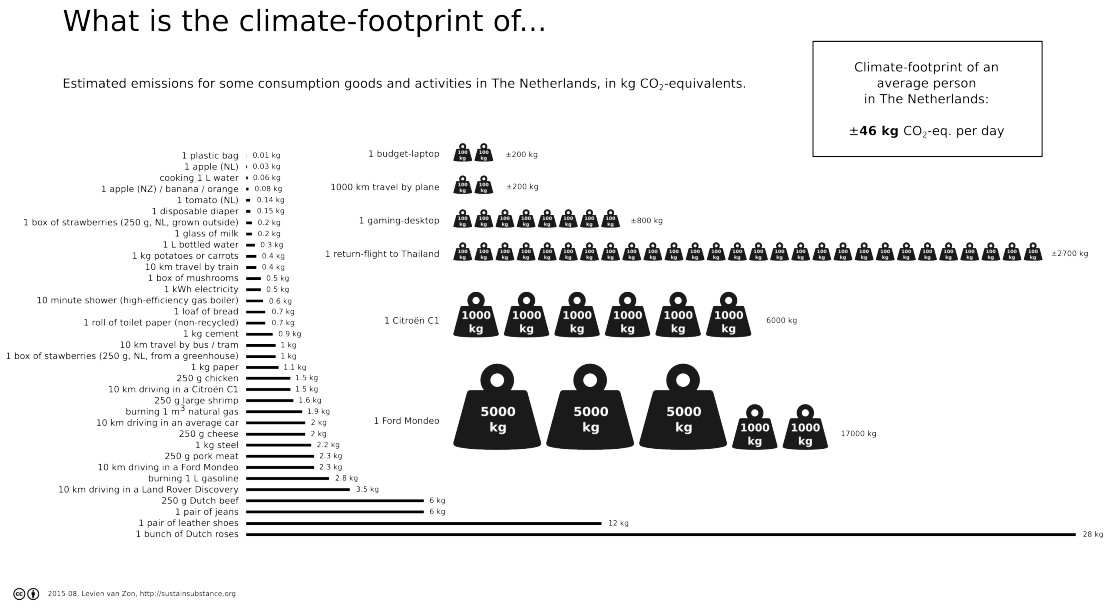
We should note that the contributions of especially air traffic and transport of goods are underestimated here, because only traffic within the country counts in this figure. Nonetheless, you can clearly see that air travel contributes significantly (probably more than 2 kg), but that cars contribute even more to emissions (almost 3.5 kg). Emissions from public transport on the other hand are almost negligible. Commuting and private car-use emit about as much as electricity use at home does. And this is despite the fact that only around half of land-based travel in the Netherlands is by car.[5] Compared to other European countries, a relatively high percentage of Dutch people travel mainly with public transport or on bicycle. The average emission figures actually include a lot of people that either have no car or hardly use their car, so the daily emission *per car driver* will certainly be higher than 3.5 kg!

Construction, direct energy use and mobility together are responsible for just under half of the Dutch greenhouse gas footprint. The other half is due to the remaining two categories. One bears the somewhat mysterious title “services & trade”, and includes things like infrastructure and the things we do and use outside our homes, in as far they do not fit in the

other categories. For most of us, these are mainly the things we do at work, and our use of public services such as hospitals, schools, government services, universities, roads and public lighting. All in all these things cause about a quarter of our greenhouse gas emissions. And unfortunately we have little control over this category, with the possible exception of the things you do at work.

However, the remaining category covers many things we *can* control: Roughly a quarter of the CO_2-emission of European consumers comes from making the stuff we consume. The largest part of this is for food and drink, around 9 kg CO_2-eq. per person per day in The Netherlands. More than a third of this is for producing animal protein: things like meat, fish, eggs and milk products. Of course the reason why food contributes so much to our daily emissions is that everyone needs food on a daily basis. Other consumption goods like clothes and electronics often require more energy to produce, but we simply buy such things less often. So it follows that an obvious way to reduce your CO_2-emissions is by simply buying less stuff, especially buying less *new* stuff.

Because it's not so easy to think in averages, it's good to see how much greenhouse gas is emitted by individual products and activities (click on the figure for more details):



Here the same caveats apply: these are not exact figures, and estimates for emission will vary between studies, between products and between countries. But again, it's the large-scale patterns that are important.

For most of us, this figure will contain a few surprises. The emissions from public transport, taking a shower or using electricity are perhaps surprisingly small. On the other hand, things like paper, cheese and food or flowers grown under glass have an unexpectedly large

emission footprint. Most people will not be very surprised by the fact that meat, shrimp and driving a car all have a relatively large carbon-footprint. The contribution of driving however depends very much on the size of the car (and its speed, but that is not shown here). And many people probably wouldn't guess that, as a passenger, we emit roughly the same amount per kilometre when we fly as when driving an average car. But because we generally travel much longer distances when we fly, one trip by plane will have a large impact on our emission figures. However, the impact of an intercontinental trip is dwarfed by the amount of CO_2 released when making a new car. Buying a car has a huge impact, even if no-one ever drives in it, especially if the car in question is big and luxurious. Finally, because our first two figures use data from 2000/2001, they may somewhat underestimate the current contribution of electronics devices. As an example, producing one computer emits roughly as much CO_2 as 1-3 months' worth of food, or driving an average car for 12-40 hours.

Figure 1:

And in case you were wondering why roses have such a large climate footprint (relative to many other producs), this is a matter of energy and climate. A single-stem rose takes roughly two months to grow, and it requires additional lighting and heating in winter, when most roses are bought (think Valentines Day!). Although heat pumps and modern LED-lights can significantly reduce energy use in modern greenhouses, a single greenhouse complex easily requires several megawatts of electrical power just to keep the lights on.

If we want to keep climate warming below 2°C, we will basically have to reduce our direct and indirect emissions to zero within a few decades. This is going to be a real challenge for governments and companies. They will have to figure out where to get sufficient, affordable energy to keep their infrastructure, their transportation, their services and their factories running, and to keep growing their food. This is going to take time. But of course we don't have to sit around waiting, there are plenty of ways in which we can help as individuals.

Which lessons can we learn from the above figures, how can we start reducing our carbon footprint as individual consumers and employees? The main categories we can influence directly are consumption goods, mobility and our direct energy use at home and at work. There are several things you should consider, if you want to significantly reduce your greenhouse gas emissions:

1. In many countries, saving energy at home is a high-profile issue. But energy savings at work often receive a lot less attention. In many offices the heating or climate control is turned on night and day, computers are never switched off, and perfectly functional equipment is replaced every few years, even when this is not strictly needed. As we spend a lot of our time at work, our energy use and CO_2-emission at work is often higher than at home. Maybe now is a good time to start discussing this in your organisation.

2. If you own or regularly use a car, only use it when really necessary. If you live in a country with decent public transport, consider taking the train or the bus to work. Work from home on a regular basis, if your job allows it. For some odd reason it is generally considered normal that employees come to work by car, even in companies that consider themselves "sustainable". Likewise, it is generally considered acceptable that we drive several hours just to visit a client or attend a meeting. Such trips easily amount to several hundred kilometres, and the average car emits 20 kg CO_2-eq. per 100 km. In other words, driving for 2-3 hours can easily double your greenhouse gas emissions on a given day. The same trip by a combination of train and bus (or folding bicycle), easily emits a factor 5 less carbon and is very doable in countries such as The Netherlands. This has the added advantage that you can work on the train. Of course, using public transport isn't always a viable option for attending meetings. As an alternative, you may want to research the possibilities of conference calls or video conferencing. Current-day technology makes this almost trivial on any laptop, smart phone or tablet.[6]

3. For holidays, the distance you travel has a much greater impact than the form of transport you choose. If you do want to travel to far-away places, consider making one longer trip (e.g. a few weeks), rather than several separate short trips. Even better, consider destinations that aren't so far away. And for distances up to a few hundred kilometres, the impact of travelling by train or bus is much less than that of travel by car or plane.

4. If your climate has cold winters and especially if you live or work in an old building, consider investing in insulation and an upgrade of the heating system. Even small modifications can have a large effect on energy use. In some cases you can already save around a third on heating energy by simply closing cracks and gaps, tweaking your central heating and lowering the thermostat by a few degrees when you're in bed or away from home. Such measures can save you a lot of money, with just a few hours of work and almost no material. But if you're able to invest a bit more, insulating your outer walls and ceiling/roof can have a huge impact on your energy bills. If you're

putting up a new building, or are planning a renovation, consider insulation as well as floor- or wall-heating. A large heating surface is more efficient and comfortable than using a radiator, and the lower water temperature will make it easier to install a heat pump at some point. A heat pump is basically a fridge in reverse: it extracts heat from the ground, water or air outside, and uses this to heat your house or workplace. In theory, a heat pump can be up to 3-4 times more efficient than using natural gas or an electrical radiator for heating[7], especially when combined with a thermal solar-collector and a heat-buffer. Moreover, a heat-pump can also function as a cooling-system in summer.
For older buildings where floor-heating and heat pumps are not an option, local heating with thermal infra-red panels or similar systems can be an efficient and comfortable alternative.

5. If you own your roof, consider placing solar panels. A solar photo-voltaic (PV) installation usually pays back its investment costs within 5-12 years or so (the payback time varies greatly between countries), while it will produce power for 20-30 years. Even better, consider placing a thermal solar collector as well, or a install a hybrid system that can produce both electricity and heat. If you do not have the funds to invest in a PV-installation, you could consider leasing one (through companies such as Sungevity). If you do not own your roof, you could consider joining an energy cooperation.

6. Don't buy things you don't need. This may sound obvious, but check with yourself how many of the things you bought recently (for yourself, your family or for work) were things that you ***really*** needed. If you do need (or would ***like*** to have) something, try checking first if you can get it second-hand. And if you do buy something new, you may want to consider product quality and expected life span. Sometimes you end up spending a lot less in the long run if you buy something that is a bit more expensive, but of higher quality. Cheap things tend to be cheap for a reason, and quite often something is cheap because the quality of the materials and the construction isn't very good. Low-quality products won't last very long and need replacing more frequently. This applies to items such as shoes and bags, but also to electronics equipment and mechanical devices such as washing machines and bicycles. If you cannot assess the product quality yourself, try asking someone who can, or check out some reviews. If you buy devices that use energy, their energy efficiency is as important as their life span. More efficient devices tend to be a bit more expensive as well, but may save you a lot of money in the long run. This applies to things such as refrigerators, freezers, heaters, washing machines, dryers, lamps and especially cars. When selecting a car, remember that a small, light vehicle will require significantly less energy (to build and run) than big and heavy vehicles. Moreover, electrical vehicles tend to be more energy-efficient than comparable vehicles with a combustion engine.

7. Eat less meat. You don't immediately have to become a vegetarian or vegan[8], but it certainly doesn't hurt to eat a meal without meat every once in a while. If you don't know how to cook a nice vegetarian meal, try looking up some good recipes, or talk

to a vegetarian who cooks well. Another option is to simply reduce the portions of meat you use, or replace part of it with alternative products. In fact, most people will hardly notice if you replace half a portion of minced meat or factory-farmed chicken by a decent, vegetable-based product. My own experience with eating less meat is that after a while, you really start to enjoy both cooking a good vegetarian meal and occasionally eating a meal with good-quality meat. It's a win-win situation, although of course your mileage may vary. Just give it a serious try!

8. Buy fewer products out-of-season. Especially in cold climates, a lot of food is imported, and a lot of energy is wasted on growing vegetables in greenhouses during the winter months. Greenhouses are great at capturing light and providing a controlled environment, but they tend to be very badly insulated and in winter they require artificial heating and lighting. If certain fruits and vegetables can't be grown outside in season, then it may actually be better to buy frozen or canned products, or to look for alternatives. This applies especially to soft fruit and leafy vegetables that do not keep well and are hard to transport.

9. Produce less waste. Instead of throwing something away, try selling it, give it away, eat it[9], bring it to a second-hand store, recycle it where possible, but don't throw it in the general trash unless you have no good alternative. In most countries, municipal waste is either burned or used as landfill. Both disposal methods tend to produce a lot of greenhouse-gas emissions, while (at least in principle) a modern society should hardly have to produce any rest-waste. Most of what we consider "waste" is actually a mix of high-grade resources, which can be used in producing all kinds of new products. Metals are a well-known example, but also plastics can be seen as a concentrated source of carbohydrates, glass is basically silicon, paper provides cellulose and organic waste contains all kinds of valuable nutrients, not to mention energy. Reusing these "waste"-materials can sometimes save a considerable amount of energy in producing new products. Moreover, everything you give away or sell second-hand, won't have to be bought new by someone else.

10. Last but not least, do you feel that your work does not make a positive contribution to society? Consider looking for a different job.[10]. The government, the service-sector and the private companies are responsible for much of our emissions, and we want them to start changing the world for the better. But in the end, governments, companies and other institutions are all run by us. There is such a thing as "the system", but you should never forget that you're a part of it, and therefore you can help change it.

Interested in more articles? Follow us on Facebook, or via our Atom-feed.

Notes

[1] *A lot has already been said and written about this Paris Agreement, which in 2020 should succeed the venerable 1997 Kyoto protocol.*

The Guardian has provided excellent coverage of and commentary on the Paris talks and the resulting agreement. Read their 5 reasons to be glad, 5 to be gloomy for a short summary. While James Hansen and George Monbiot see the Paris agreement as grossly insufficient, others have pointed out that it represents a flame of hope, that its goals can be reached if governments and the private sector increase energy efficiency and scale up renewable energy to 36% by 2030, and that the agreement at least provides a reason to run harder.

[2] *In an earlier article I described why it is important to reduce the emission of greenhouse gasses such as CO_2.*

The effects of having more CO_2 in the atmosphere are hard to predict, and the effects of more CO_2 in surface waters are almost certainly negative. It is fairly certain that more heat is being retained by the climate system, but the effect of this will vary by region, and is partially still unknown, which in itself is a problem. It is certain however that this extra heat is a big problem for life in the oceans. And as example of possible nasty surprises, the climate in Europe may actually cool down due to global warming, as the melting ice of Greenland may slow down the gulf stream in the Atlantic Ocean.

[3] *If we want to reduce these emissions, we will need two things: alternative energy sources and more efficient use of energy.*

There are alternative sources of energy, but their contribution is currently very small. Globally, solar, wind and geothermal energy contribute around 1% to the global human energy supply. Fossil fuels, by comparison, contribute around 80% globally, and over 90% in countries such as the Netherlands. The role of renewable energy sources is increasing fast, but a lot of technical and social problems still need to be overcome if solar and wind power are to contribute significantly to the global human energy supply. A realistic expectation is that fossil fuels will continue to play an important role for at least the coming decades, although this role will probably decrease over time. Because we cannot simply cease being dependent on fossil fuels to some extent, it is important to use the available energy more efficiently. Luckily there is enormous scope for improvements in energy-efficiency. Even with existing technologies and methods, the way we heat and cool our buildings, the way we power our transport and the way we produce food can be made much more efficient, provided that we start using better technologies and methods on a large scale.

[4] *An average person exhales roughly a kilogram (2.2 lbs) of CO_2 per day.*

This is roughly 1.6% of our average body weight. Apart from CO_2, we humans also emit small amounts methane directly, as a result of flatulence. While methane is a stronger greenhouse gas than CO_2, the amount we emit in our daily farts is almost negligible: roughly 6% of a litre, which comes down to a fraction of a gram per person per day.

[5] *only around half of land-based travel in the Netherlands is by car.*

Statistics on car ownership and use in The Netherlands in 2010 can be found in the CBS-publication *Sociaale-conomische trends, 1e kwartaal 2012*, chapter *Personenautobezit van huishoudens en personen*. The StatLine database shows that in 2007, 84% of Dutch people owned a bicycle, 63% had a drivers' license and 45% owned a car.

[6] *you may want to research the possibilities of conference calls or video conferencing. Current-day technology makes this almost trivial on any laptop, smart phone or tablet.*

Google Hangouts is probably the easiest option for video conferencing, as it's free, it handles video, audio, text-based chat and screen-sharing, works for two or more people, and works on almost any device. The only drawback is that it does require a Google-account. Unsurprisingly, many free services are coupled to social networks: Peer uses LinkedIn and ooVoo requires Facebook. Cisco WebEx and Skype for Business are targeted specifically toward hosting business meetings. Other options for group-meetings are Fring, Jitsi and Viber. For one-to-one meetings, the free version of Skype works just fine, as does Facetime on Apple-devices, or basically any other video chat service. And for meetings where you don't need video, you can just use Skype, or even a plain old phone, smart or otherwise.

[7] *A heat pump is basically a fridge in reverse: it extracts heat from the ground, water or air outside, and uses this to heat your house or workplace. In theory, a heat pump can be up to 3-4 times more efficient than using natural gas or an electrical radiator for heating*

Specifically, the theoretical coefficient of performance (COP) of a heat pump can easily be 3-4 times higher than that of other heating devices. A COP of 1 would mean that all the energy you put into a heating device is actually used for heating living spaces. Modern high-performance gas heaters tend to have a COP above 0.85, which means that less than 15% of the heat escapes up the chimney. Modern heat pumps can have a COP above 3, which means that they can actually pump at least three times as much thermal energy as the electrical energy you put in. In practise however, this does not lead to a factor 3 decrease in energy use or CO_2-emission. Part of this is due to the fact that electricity is often generated using gas or coal, with 40-70% efficiency. Furthermore, the efficiency of a heat pump goes down if the outside temperature is low and the heat requirement is high. Still, a heat pump tends to be a good long-term investment, as it makes the heating-system of a building less dependent on gas supply and prices, and it allows a heat buffer to be installed. A heat buffer is basically a large mass of water or rock that can be used to store heat in times of abundance (i.e. summer), and extract it when needed (i.e. winter).

[8] *Eat less meat. You don't immediately have to become a vegetarian or vegan*

Of course, with respect to greenhouse gas emissions, general pollution and soil degradation, biodiversity and animal welfare, being vegetarian or vegan is a lot better than eating meat! But what to eat and not to eat is a choice that everyone must make for him- or herself. In The Netherlands, the percentage of vegetarians and vegans combined is around 4.5%. But the percentage of people that choose to skip eating meat on a regular basis is much higher, around 35% (source: fact sheet and report, LEI 2012).

[9] *Produce less waste. Instead of throwing something away, try selling it, give it away, eat it*

My grandmother, who had to feed several children during the "hunger winter" of 1944-1945 in Amsterdam, is one of the people who raised me never to throw away food unless it has really gone off. Therefore I am always shocked when I see people, especially friends, dump large quantities of perfectly edible food into the trash after dinner without giving it a second thought. To me, this is a completely unnecessary waste of good ingredients. Try using leftovers in your next meal, make them into soup, put them in the freezer (this works especially well with rice) or eat them as lunch or even breakfast.

[10] *Last but not least, do you feel that your work does not make a positive contribution to society? Consider looking for a different job.*

One could argue that this measure is actually the one that can make the most difference. But changing your job or even your career will not be easy for most people, which is why I mention it last. This does not mean that you shouldn't give it some serious thought.