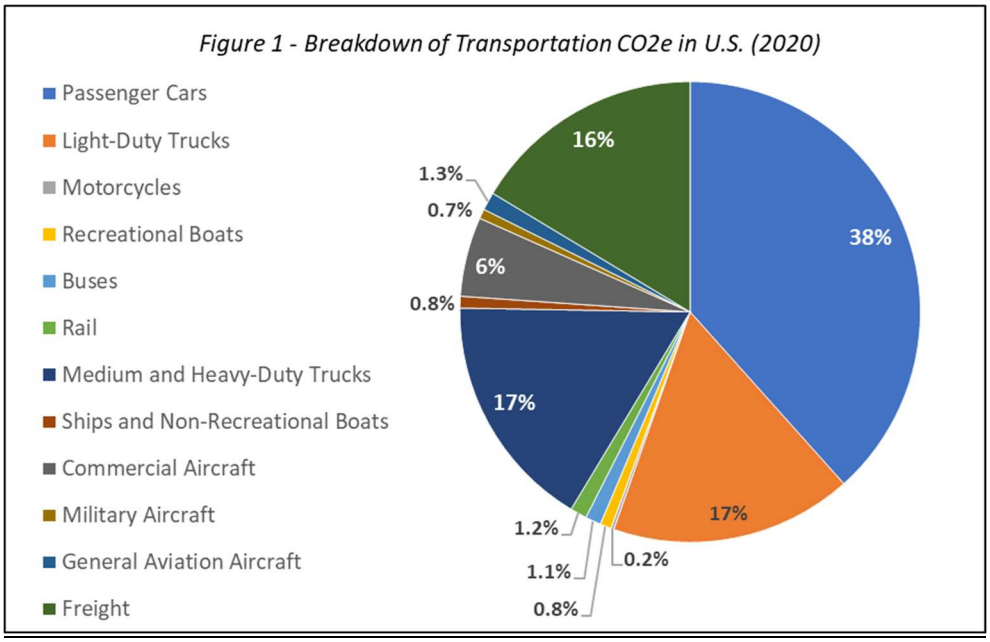
Chapter 20 – Transport Nation

Julie Smith, www.whatwouldjuliedo.blog

Getting Around, Move It, On the Road Again, The Jet Setters, Just Take a Walk, The Dark Underbelly

Getting Around

In the U.S., CO_2e emissions from transportation make up about 30% of our gross carbon emissions. Figure 1 shows how the transportation is broken out into categories, according to the EPA.[1] Personal transportation, which includes passenger cars, light-duty trucks and motorcycles, sum up to 55% of the total transportation, or 14.3% of gross carbon emissions, which is the fourth largest category in the U.S. We definitely spew a lot of carbon driving ourselves around, from point A to point B. The passenger cars make up most of our personal transportation, with light trucks, which includes SUV's, making up the rest, along with a tiny portion from motorcycles. These percentages are for the emissions from each category of vehicles, not the actual numbers of vehicles. Cars make up far more than 38% of total personal vehicles, but they use relatively less fuel than light trucks per vehicle. Conversely, motorcycles make up far more than 0.2% of total personal vehicles, but they use a tiny amount of fuel, so their emissions are a smaller fraction. Recreational boats are technically another category of personal transportation, but over water rather than roads, and not a mode that is used significantly in the big picture.



Buses and trains, both public options for transportation that consume significantly less fuel per person than personal vehicles, make up only 2.3% of transportation, indicating a lot of opportunity to reduce our carbon footprint of transportation simply by taking public transportation. Public transportation can make a huge difference when it's used for regular daily transportation, like going to work or school.

Medium and heavy duty trucks are mainly the big trucks and machines at industrial sites and construction sites, so these emissions are captured within the construction category, the single largest category of emissions, and industry, which includes food, packaging, mining and the raw materials for everything we consume. The percentage of the transportation sector, 17%, does not include emissions from the large trucks used for freight, which are included in the freight category.

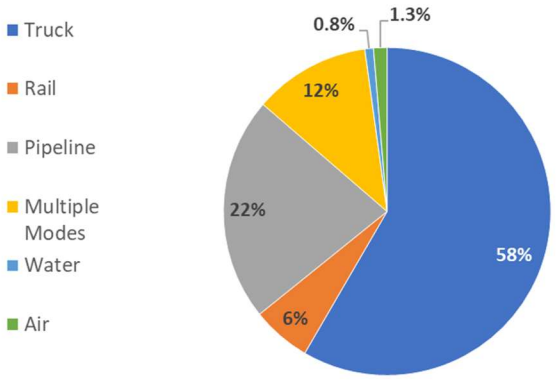
Ships and non-recreational boats are mainly for transportation of passengers, another mode of public transportation that includes everything from cruise ships to ferries to work boats, such as for fishing, research and patrolling off shore. Cargo ships are not included in this category, but are within the freight category.

Aircraft is broken into three categories, commercial, military and general aviation. Freight aircraft is not included in this category but rather included with freight. Commercial aircraft, at 6% of transportation, is the emissions of passenger planes. Military aircraft is 0.7% of transportation, a small fraction of the passenger planes. The general aviation category, at 1.3% of transportation, about twice as much as the military, is the civilian, non-commercial flights. It applies to pretty much everything besides commercial, military and freight, including things like sport aviation, business travel, humanitarian aid, agriculture, environmental conservation, and bush flying.

Move It

Freight makes up 16% of carbon emissions for transportation, or 3.65% of gross emissions in the U.S. In this book, it is allocated for all industrial raw materials and products using average cost per LB-mile for each product and average distances between oil fields or mines and factories and points of sale. It's part of everything we consume. Transportation from point of sale (eg our house to grocery store and back) to point of use is part of personal transportation.

Figure 2 - Breakdown of Frieght CO2e in U.S. (2020)



Most freight emissions are from trucks, with rail making up only 10% as much as trucks. This doesn't mean that trucks haul ten times as much freight as trains, however. In reality, trucks transport about 40% of our goods, while 28%, or about three fourths as much, is transported by rail. The reason the rail emissions is so low compared to trucks is that trains are far more efficient than trucks when it comes to fuel. Pipeline transportation is specifically for fossil fuels, mainly natural gas, which is transported from gas fields through a nationwide network of pipes, mainly underground, ultimately to homes and businesses that consume it. The gas is driven by compressors located along the pipelines. Multiple modes of transportation is a category that includes local delivery trucks and mail trucks.

On the Road Again

Personal transportation is the fourth largest source of greenhouse emissions per capita in the U.S., at 14.3% of the total. Personal transportation includes all of the driving we do in personal vehicles, to go to work, to shop, to take the kids to soccer, for road trips and so forth. The entire category is driven (pun intended) by our personal choices every day, which means, as with food and residential energy, we can make some quick wins when it comes to reducing our carbon footprint.

Table 1 shows how personal transportation is broken out at a high level, similar to the previous categories. Non-combustion emissions, electricity, stationary combustion and land are from the various industrial emissions that result from manufacturing the vehicles and the mining and refining of the raw materials to make them. The emissions of transportation to point of sale is from hauling the new personal vehicles from the factories and distribution centers to the car lots where we buy them. The non-freight transportation is the actual burning of the fuel, gasoline or diesel or fuel oil, when we drive our personal vehicles.

Table 1 - Breakdown of Personal Transportation in the U.S., 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	
4	Personal Transportation	13	46	41	919	4.34	17.8	1,039	14.3%

Table 2 gives us a closer look at how the bits and pieces fit together for personal transportation. Fuel combustion is the largest portion, but the manufacturing of the personal vehicles increases the category by more than 10%.

Table 2 – Personal Transportation - Carbon Footprint per Capita, mt/person-year, (% of Gross**)*

Category	Non-Combustion Emissions	Electricity	Combustion	Transp. On-Site	Land	Transp. Off Site	Total
Manufacturing Cars and Lite Trucks	0.038 (0.2%)	0.14 (0.6%)	0.12 (0.6%)	0.003 (0.012%)	$1.9x10^{-5}$ ($8.8x10^{-5}$%)	0.010 (0.047%)	0.31 (1.41%)
Fuel Combustion	-	-	-	2.77 (12.6%)	-	0.044 (0.2%)	2.81(12.8%)
Land (Roads)	-	-	-	-	0.013 (0.06%)	-	0.013 (0.06%)
Total	0.038 (0.2%)	0.14 (0.6%)	0.12 (0.6%)	2.8 (12.6%)	0.013 (0.06%)	0.054 (0.24%)	3.14 (14.3%)

**U.S. Population in 2020 was 331.5 million; **Gross Emissions in U.S. in 2020 was 7286 mmt of CO_2e*

The vehicles themselves consume everything from metal to aluminum to glass to plastic to all manner of paints and solvents in their manufacturing, as well as all the energy to mine the raw materials, refine them, manufacture the vehicles, and then transport the vehicles to the sales lots.

The choices to reduce emissions of personal transportation are endless, and most of us have heard them all. It's worth it, though, since 14.3% is a pretty big chunk of the 80% reduction in emissions that we need to save our planet.

- Walk, especially if it's less than a couple miles. You'll be healthier for it.
- Bike, if it's a few miles. For longer trips, you can bike to the bus stop or train station, and the bus or train will usually have a place for your bike while you ride.
- Combine errands if driving is necessary.
- Take advantage of city scooter and bike rentals, and free buses and shuttles.
- Take the train or the bus, depending on what's available.
- Carpool.
- If you don't drive that often, consider a car-sharing service where you only pay when you're using the car. An example is Zipcar.[2]
- When you're ready for a new car, get an EV. They're great. They use a lot less energy and you can charge them at home by just plugging them in to an outlet. No more standing at the gas station breathing those toxic vapors as you gas up.

Starting when I was 10 years old, I used to babysit, and would walk to the job. When I was 14, I got a job at a local restaurant, and my parents had to drop me off and pick me up. They were only too happy when I finally reached 16 and could drive myself. Luckily, the place was only about 3 miles away, but it must have been tedious for them. When I was 18, I started working in downtown Denver, and that's when I started using public transportation for the first time. The bus was a whole lot easier, and for employees of Tiorco, the company that I worked for, it was a benefit, so I didn't have to pay for it. It may seem ironic that an oil field service company would be so supportive of public transportation, but my father, who founded the company, was a huge proponent of public transportation. Actually, a lot of oil companies reimbursed employees to take the bus, and probably still do. I found that I much preferred the bus to driving, because I could read or work on my knitting, and make friends with other "regulars". Obviously in the cold of winter it sucked to walk to the bus stop and wait, especially if the bus was late, but it still beat scraping off the car and dealing with snow and ice and traffic. Later the office moved to Englewood and there was no decent bus route. It turns out that the routes to downtown Denver are really fast and convenient, but not so much in the suburbs. I was about 7 miles from work and had kids by then, so taking the bus didn't work, but I rode my bike a couple times a week when weather permitted. My dad, who lived about 10 miles away, rode his bike too. When I went to work for Coors, I was about 12 miles from work, and lost patience with all that driving pretty quickly. We finally moved to Golden, 7 blocks from the entrance, so I could walk to work in just 20 minutes.

I already mentioned in Chapter 19 that our own carbon emissions for personal transportation is down by 62%, which works out to a reduction of 8.9% of gross emissions. And we even took a cross-country road trip to the East coast last year, as well as several long drives to reach climbing destinations within Colorado and in nearby states. And, the EV miles also include delivery miles for my small business. We combine errands if driving is necessary, and we walk

nearly everywhere within Golden, where we live. We still have a Jeep that we use as a backup if we both need a car at the same time, if we're going to drive on really rough road, or if we're car-camping, since the Jeep has a great set up for that.

The Jet-Setters

We hear a lot about the impact of aviation on our carbon emissions, and aviation falls within the general category of transportation, so I took a look at it. In total, aviation is 8% of transportation, or 1.6% of our gross carbon emissions for the fuel, before adding the emissions to make the actual airplanes and helicopters. Military aircraft make up less than 10% of the total aviation emissions, leaving the remaining 90%, which is made up of commercial and general aviation. Table 3, which shows a breakdown of non-military aviation, excludes military aviation, because all of us need and own the military piece, and that part of air travel isn't something that we consumers have much direct control over. It's just a small piece of the pie anyway, at 0.15% of our gross carbon emissions.

Table 3 – Non-Military Aviation - Carbon Footprint per -Capita, mt/person-year, (% of Gross**)*

Category	Non-Combustion Emissions	Electricity	Combustion	Transp. On-Site	Land	Transp. Off Site	Total
Manufacturing Planes and Helicopters	0.007 (0.03%)	0.02 (0.08%)	0.02 (0.08%)	8.7×10^{-5} (4.0×10^{-4}%)	3.6×10^{-6} (1.7×10^{-5}%)	0.002 (0.009%)	0.04 (0.20%)
Fuel Combustion	-	-	-	0.34 (1.6%)	-	0.006 (0.03%)	0.35 (1.6%)
Land (Airports)	-	-	-	-	5.7×10^{-4} (2.6×10^{-3}%)	-	5.7×10^{-4} (2.6×10^{-3}%)
Total	0.007 (0.03%)	0.02 (0.08%)	0.02 (0.08%)	0.34 (1.6%)	5.7×10^{-4} (2.6×10^{-3}%)	0.008 (0.03%)	0.39 (1.8%)

**U.S. Population in 2020 was 331.5 million; **Gross Emissions in U.S. in 2020 was 7286 mmt of CO_2e*

One area where I struggle personally when it comes to carbon footprint is flying. We do that maybe once each year or two, but when we fly, it's usually out of country, as we tend to drive our EV or take a train for travel in the lower 48. Last year, Hilary and I flew to Mendoza, Argentina, so that Hilary could climb Aconcagua, the highest mountain in South America, and in the western hemisphere. I went down too, because I love Argentina and wanted to spend time there while working on this book. The flight was 5,600 miles each way, or 11,200 miles total. Quite a long journey on a plane, and an extreme case of travel. The carbon footprint for each of us was a whopping 1.33 metric tonnes, which obviously blew our aviation budget by a factor of more than 3! Ouch! This one trip increased our CO_2e for the year by 6.1% of gross emissions, reducing our overall emission reductions by 4.3%. This reduces our total CO_2e reductions from 52.2% through Chapter 19 to 47.9%, so we're still on a good path towards reducing our total carbon emissions by 80% by 2050, but you can see how just one long flight can spew a lot of carbon.

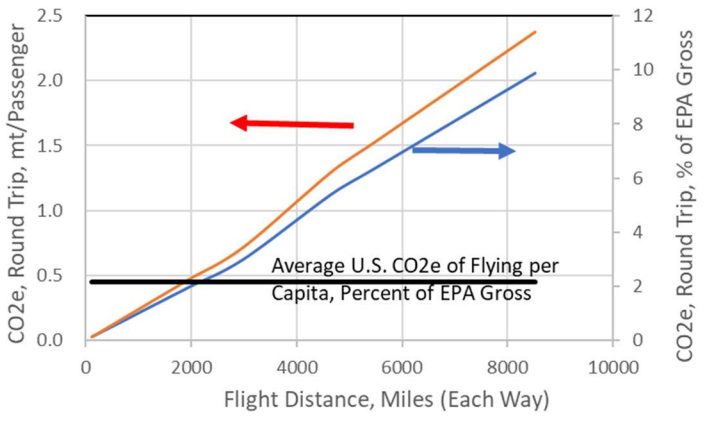
What's worse, is that the contrails from jets are even worse in terms of global warming than the actual burning of the jet fuel. This is because at high altitudes, the water vapor that's emitted in addition to the CO_2 when the fuel is burned freezes and traps heat in the atmosphere. The contrails also contain soot, which exacerbates warming even more. This means that in reality our CO_2e is probably about double the amount that I calculated based on fuel combustion and industrial manufacturing of the planes. Which is why we'll continue to seek alternatives to flying.

To mitigate our carbon footprint of transportation, including driving, trains and flying, every year we donate enough money to reduce carbon footprint globally to offset our impact, which in 2024 was 1.6 mt (metric tonnes). We do this in two ways. We donate to "One Tree Planted"[3] to plant enough trees to increase carbon absorption and provide habitat to wildlife, and we donate to "Population Connection"[4] to provide birth control to women who want to avoid unplanned pregnancies. This is how we basically try to increase two of the three legs of sustainability (Chapter 3) to make up for adding to the third (carbon footprint per capita). It costs $1/tree to plant a tree that will absorb an average of 0.25 mt of CO_2 in its lifetime, so by donating $20 (the minimum donation) we've increased CO_2 absorption by 80 mt, a pretty good deal for offsetting 1.6 mt of carbon.

For birth control, annual costs can range widely from $10 - $300, depending on what part of the globe we're talking about, and we use an average cost of $180 per unplanned pregnancy avoided, which prevents 5.26 mt/year of carbon emissions for an average global human. Given that gross CO_2e for flying in the U.S. is 129 mmt/year, we figure that if everybody who flies did this we'd increase our carbon sink by 4.3 mmt per year (assuming a 30-year life for a tree, which is extremely conservative) and reduce global population growth rate by about 0.3% per year, which would be a nice move in the right direction towards reducing our current growth rate by 1%. And this is a lot less money than the airline tickets cost. Think about that. We could make a pretty decent dent in our carbon emissions with these simple actions, now couldn't we?

When it comes to flying, I think most of us don't do a lot of it, largely because of the cost, and if we just do a flight or two per year, especially within the country, we're not really doing much harm. The main contributors would be multiple flights annually. If you do a lot of business flying, you might want to think about the value of a personal visit compared to a Zoom meeting, for example. People with higher

Figure 3 - CO2e Emissions of Flying on Commercial Jet



Flyer Miles From Denver (One Way)

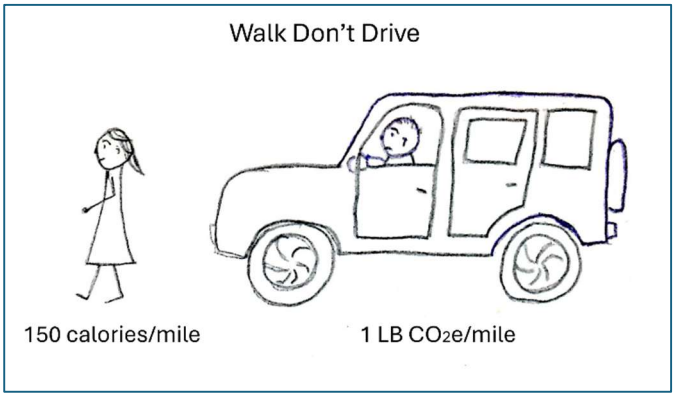
Pueblo, Colorado – 125
Oklahoma City – 500
Milwaukee, WI – 900
Cleveland, OH – 1,200
Mexico City – 1,700
Miami, FL – 2,000
Anchorage, AK – 3,000
London, England – 4,671
Mendoza, Argentina – 5,530
Arusha, Tanzania – 8,516

incomes are more likely to fly more often on personal trips than the rest of us, as you'll see in Chapter 25.

Figure 3 shows average CO_2e emissions for flights from Denver, Colorado, increasing with flight distances on the left axis, and the Percent of gross U.S. EPA emissions on the right axis. The solid black line is the U.S. CO_2e emissions per capita for domestic commercial flights. At a flight distance of 2,000 miles, which is the distance from Denver to Miami, the carbon footprint is equal to the national average, which equates to round-trip CO_2e emissions of just under 0.5 mt/passenger. If we take shorter flights, we can take multiple flights, like to Pueblo, within the state, or to Oklahoma City or Milwaukee, WI, we can take more than one flight and stay within the average emissions for personal transportation. We can even fly to Mexico City and stay within the average. If we venture further, like to Mendoza, Argentina or Arusha, Tanzania, we exceed our average CO_2e emissions for flying, which adds to our carbon emissions overall. We can either make that up by reducing more in another category, or we can choose to only take long flights like that every few years to keep things even. Also, we can offset the emissions of flying, similar to what Hilary and I do, as described in the box.

My point is that there are ways to continue to enjoy travel and flying and still reduce our carbon emissions by 80%. We have options. As long as we take care of global warming now. If we wait much longer, we'll run out of options.

Just Take a Walk



When we choose any alternative to personal transportation, it increases our exercise, pretty much by definition. Walking or biking is pretty obvious, but even if we take a bus or a train, we'll probably walk or bike to the stop, and then walk from the drop-off to our destination. Our bodies are actually meant to move regularly, and if we don't, we don't challenge our heart, lungs, bones, joints, muscles and nervous systems, which in turn leads to deterioration of our basic functions from lack of use. In reality, we should be walking daily, and we should be walking an absolute minimum of 2 to 3 miles per week.

In the U.S., 52% of all car trips are less than three miles, with 28% of trips less than 1 mile,[5] which is easily done by walking or taking a bike. Seriously. When we rely on our personal vehicles to do even the shortest errands, we are failing our bodies and ourselves, as well as the planet. It's another way to get us outside, and research shows that time with nature lowers blood pressure, reduces stress and increases immune-system function. It also reduces inflammation and improves mood and self-esteem. Think about how you can replace a portion of your driving with walking or biking. Start small and grow to longer walks. Have fun.

And, speaking of biking, I hope you're not one of those clueless bullies that runs up against a biker on the road that may or may not be in your way, and then honk at them. Nothing pisses me off more. Except maybe an obnoxious climate denier in a big diesel truck getting in front of me in my EV on the highway and blowing black smoke, just to prove how stupid and clueless he really is. Back to the biker, who is actually out there using his body to transport himself with no carbon footprint, other than the manufacturing of the bike. Do drivers have to be impatient jerks, as they cluelessly consume copious amounts of fossil fuels to haul their fat bodies, as well as their thousand-pound vehicles, around the planet? Is it really that horribly inconvenient to wait or be delayed in any way by a biker, or a walker, for that matter? We definitely need to be better than that. If you are one of those losers, could you maybe stop and thank them for doing their part to reduce carbon emissions next time? It's never too late to change, is it? Hello? McFly?

According to the U.S. Census Bureau, the average travel time to work is about 26 minutes, which works out to a round trip of 52 minutes every single day, sitting in a car, in traffic.[6] Time we never get back, if we're part of the mindless grogs who choose to put themselves through this. No wonder we have so much depression and mental health problems, in addition to the physical deterioration of our bodies. Even worse, almost 10% have travel times of 1 hour each way, or two hours a day. Think about that if you do this. One or two hours per day of your life that you'll never get back.

And now it's even worse, with idiots moving out to the boonies taking yet more land from wildlife so they can live in a much bigger house than they need, hogging excessive energy to keep it warm or cool in addition their absurd gas miles. If you do this, your carbon emissions are likely to be at least double the national average. The transportation fuel emissions is yet another reason to give the country back to the wildlife and keep humans who need to work for a living in the cities. By definition, everything is far away, since it is, after all, the country. Why not let the wildlife have it back and go visit the country from the city once in a while, instead of living in the country, taking space from wildlife and spewing CO_2 emissions every single day while languishing behind the wheel of a car for hours. Do you have nothing better to live for? I'll bet the wildlife does.

Basically all big cities provide commuter trains or buses to mitigate traffic and pollution. Which begs the question: Why are so many people driving long distances to work when they can take the train? You gotta wonder. The U.S. average commute takes 26.4 minutes. People supposedly don't live near work because of the housing prices, which are in turn driven by population, yet another vicious circle we've created with too many people on the planet. Think about that.

The Dark Underbelly

To be clear, EV's themselves demand materials in construction, which means that they alone won't save the day. We still need to drive significantly less and reduce our population. The reality is, like any new technology, EV's and all renewable technologies in general, other than biogas and biomass, are demanding unprecedented levels of specialized metals that all have to be mined and refined like any other metal. While it's probably fair to assume that your basic EV requires essentially the same types of materials for the vehicle as your basic ICE, for the frame, windows, body, interior and such, EV's also require additional specialized metals that are referred to as 'green rocks', or 'green metals' in some circles, mainly for the batteries. However, these metals aren't actually 'green' in the sense of being responsibly produced, like the reference 'green' typically means. The 'green metals' for EV's and solar technology are actually rare metals that are needed for the 'green' technology. If that makes sense.

So, my dear friend John pointed out to me that by changing from an ICE to an EV all I'm doing is moving the problem from petroleum to coal, which is an even dirtier fossil fuel. Kind of a mean thing to say, but it's worth mentioning here because it illustrates the small-minded thinking that's holding some people back from switching to EV's. I used to think that, too. While it's true that coal is dirtier and less efficient than gasoline, it's also true that we are transitioning away from coal in power plants for that very reason. It's also true that natural gas, which we are transitioning towards, is 25% more efficient than gasoline. However, the biggest CO_2 reductions for EV's is from higher motor efficiencies and lack of engines, as well as the fact that we are also transitioning to renewable energy which, after the vehicle is manufactured, means a zero-carbon footprint. Across the U.S., EV's spew an average of 5.5 times less CO_2 than ICE's. At the Smith house, we charge our EV from solar panels on our roof, so the only time we spew CO_2 is when we travel outside our home range.[7,8]

We're talking about a lot of cars in the U.S. alone, where we have a goal of half of the 17 million vehicles sold to be EV's by 2030. A lot of cars means a lot of earth metals. And, remember, these are also needed for solar and wind technology. Examples are lithium, cobalt, copper, nickel and rare earth elements. Currently, these minerals are mainly mined in other countries, like China, the Congo, and Indonesia, yet more examples of our U.S. carbon footprint showing up in other countries' metrics. Mining companies are now trying to mine these materials in the U.S., mainly in western states, which will ruin the water and land even more for wildlife, since pretty much all mining uses chemicals that ultimately result in acid mine drainage. Cobalt mining can release radioactive and carcinogenic particles, and lithium mining uses incredible amounts of water.[9] And then there's the NIMBY syndrome as nobody wants this going on in their hood.

This is why it's so important to recycle and recover metals from all electronics. However, at this point when we're demanding extreme increases in the numbers of vehicles because of our gigantic growing population, we're a long way from becoming a full circular economy when it comes to rare metals, if we even manage to get to 100% EV's and renewables at the end of the day. Demand for lithium is expected to increase by about 50 times in the next 20 years. And who even heard of lithium, other than a chemist, before the turn of the century? Now we're desperate for lithium to save the day, and are considering mining in the Western U.S. in addition to what we already import from South America and Australia. And lithium isn't even the highest supply chain risk. Cobalt is. Another element

that only a chemist would be aware of, we import most of it from the Congo, where human rights and environmental practices (not) are horrendous. Researchers are investigating the possible use of phosphorous, which is more plentiful, but also in high demand as fertilizers, so who knows where that will go. Yeesh. Can we feel good about anything? Not these days. Not with human overpopulation taking over the world.

At the end of the day, EV's are yet another great technology that can help a lot with reducing carbon footprint per capita, but not if we cancel out the benefits by continuing to grow our population. And if we continue to grow our population, the next great technology that comes along will help for a short while until it gets cancelled out too. If there actually is a next great technology. And in the meantime we'll completely lose our intricate web of life. Let's please not do that.