Getting Serious About Reducing Carbon Emission at the Household Level

By Bill Menke, May 12, 2016

Aspiring to reduce one's carbon emissions is one thing. Actually reducing them is another. Part of the problem is knowledge. We can only succeed by making substantial cuts in the *largest* sources of our emissions. Lowering, or even eliminating, emissions from minor sources accomplishes very little, except perhaps for giving us an excuse to *feel good*. Here I discuss reducing the four largest sources of household carbon emissions: driving, air travel, home heating and home electrical usage.

The typical car has a fuel efficiency of 25 mpg and is driven 12,000 miles per year with an average occupancy of 1.7 people. I'm going to work by household, not person, so I'll attribute all of those 12000/25=480 gallons of gasoline to a single household.

Gasoline weighs 6.3 pounds/gallon and is 83% carbon. This 2500 pounds of carbon is a very significant part of the total that a household releases into the atmosphere. It's easy to see why switching to a really fuel efficient car significantly lowers carbon emissions. A 50 mpg hybrid reduces emissions by 1250 pounds of carbon per year. Economizing (driving less, carpooling) also reduces emissions, with a 10-15% reduction causing very little disruption of daily life. This level of reduction can be accomplished by cultivating the practice of doing several errands on the same trip.

Switching to a high m.p.g. car when your old one wears out will reduce your carbon emissions. Don't rush to switch, however, because the manufacture of cars consumes energy and emits carbon (roughly the equivalent of half a year of driving).

Air travel uses a significant amount of aviation fuel (which is pretty close to gasoline in its chemical composition). The industry average is about 60 passenger miles per gallon, so a cross-country round trip of 6000 miles uses about 100 gallons and emits 520 pounds of carbon. I make about five flights in a typical year, so I'm emitting as much carbon during my air travel as with my driving. Reducing air travel is tough; we all need to conduct our business and take our vacations and visit distant friends and family. But making multiple-purpose trips or shorter trips is possible. Ski, then visit relatives on the way home. Go to the Colorado Rockies, which are a closer ski destination to New York than are the Alps or the Sierras, and arguably every bit as good.

Home heating also emits a substantial amount of carbon. A house heated with oil (also close to gasoline in its chemical composition) burns about 600 gallons of that fuel per year, so the carbon emission of 3100 pounds is actually greater than driving. Switching to natural gas reduces emission, because natural gas emits only 73% as much carbon per unit of energy produced. Insulating a house will also reduce carbon emissions, by up to 20-30% if the house is poorly insulated to begin with.

Depending upon the method of production, electrical consumption can also emit carbon. Coal is the worst emitter; natural gas has only half coal's emission per unit of energy produced. Nuclear, hydro wind and solar emit none (though each has other environmental issues). Electrical utilities in southern

New York use very little coal; about 40% of production is from natural gas and the rest is from nuclear, hydro and wind.

Household electrical usage in New York is about 6500 KWH/yr, of which 2600 KWH/yr comes from natural gas (the rest being carbon-free). It takes 26 MCf (26,000 cubic feet) of natural gas to generate that electricity, an amount that emits 2570 pounds of carbon.

Installing a solar array large enough to offset one's entire electrical needs is feasible, so it's possible to eliminate this entire source of carbon emissions. However, solar panels don't work at night; a 100% offset is possible only if your electrical utility lets you trade your daytime production for its nighttime generation, or if you have a big array of batteries for storing power (which is not very practical). A more modest reduction of 40-50% is possible if you just use your solar panels to eliminate the need for your utility's power during the daytime.

Improvements in electrical efficiency (fluorescent lighting, energy-saving appliances, fans instead of air conditioners, etc. can also reduce household electrical consumption by as much as 10-15%.

Overall, a target reduction of 30% is practical. It can be accomplished by switching to a hybrid, taking one flight less per year, switching from oil to gas heat (or insulating or both) and improving electrical efficiency.

While household-level efforts at reducing carbon emissions are important, they are only one part of the picture. The overall pattern of our lives – our commuting and business travel patterns, the availability of energy-efficient appliances, the food we eat, the size of our families – are set by broad trends and policies that only society as a whole can influence. Individual action can slow down the rate of increase of atmospheric greenhouse gases such as carbon dioxide, but only global actions by governments will succeed in stopping it.

Carbon source	Carbon, pounds/year	Improvement method	Pounds saved
Automobile	2500		
		switch to hybrid	1250
		economize driving	250
Air Travel	2600		
		one less trip	520
Oil Heat	3100		
		switch to Natural Gas	840
		insulation	750
Electricity	2570		
		efficiency	300
		solar array, offset	2570
		solar array, day only	1000
Total	10,770	target reduction	3000 (30%)

Addendum

A correspondent asks whether being vegan significantly reduces emissions.

I would answer a qualified “I think so”. However, a definitive answer is not yet available. Modern agriculture requires about 3 kg (6.6 pounds) of petroleum-based fuel to produce 1 kg of grain. 1 kg of grain, if eaten by a vegan, might provide 3500 kCal of food energy, about what's consumed by a typical American in one and a half days. So your vegan friend might be emitting about 3 pounds of carbon per day, or 1500 pounds of carbon per year, by eating a diet rich in grain. Fifteen hundred pounds of carbon is a significant amount, similar say to automobile usage. The feed ratio for meat, meaning the amount of feed needed to produce an equivalent number of calories of meat, is at least 2:1 (for chicken) and as much as 7:1 for beef. Thus, I think that the notion that becoming a vegan reduces emissions is reasonable one.

However, the sort of systems-level carbon-accounting needed to answer this question definitively is extremely difficult.

Vermeulen, S.J. et al. (2012) provide an excellent food systems analysis of just where greenhouse gas emissions arise (but they do not compare specific diets). They calculate that food systems contribute 19-29% of emissions (similar to my back-of-the-envelope calculation, above) and so constitute a significant fraction of total household emissions. Surprisingly, agriculture, per se, accounts for only about half of emission, with transport and packaging, processing, refrigeration, retail, domestic food management, waste disposal and fertilizer manufacturer accounting for the rest.

Scarborough et al. (2014) take a stab at quantifying the relative emissions of meat-eaters and vegans, and find that the former have about twice the food-related emissions of the latter. The strength of their analysis is that they, through extensive surveys that quantifies ~65,000 people’s consumption of ~100 food categories, determine what meat-eaters and vegans actually eat. The weakness is that their database of greenhouse gas emissions associated with each food category is drawn from tables contained in a World Wildlife Fund / Food Climate Research Network report (Audsley et al. 2009) that has not been validated, or at least not extensively so. My assessment is that the 2:1 emission differential between meat-eaters and vegans is a reasonable preliminary estimate, but that much more work needs to be done on this subject before it can be considered well-validated.

Audsley, E., Brander, M., Chatterton, J., Murphy-Bokern, D., Webster, C., and Williams, A. (2009). How low can we go? An assessment of greenhouse gas emissions from the UK food system and the scope to reduce them by 2050. WWF-UK.

Scarborough, P., Dietary greenhouse gas emissions of meat-eaters, fish-eaters, vegetarians and vegans in the UK, Climatic Change 125, 179-192, 2014.

Vermeulen, S.J. et al., Climate Change and Food Systems, Annual Review of Environment and Resources 37, 195-222, DOI: 10.1146/annurev-environ-020411-130608, 2012.