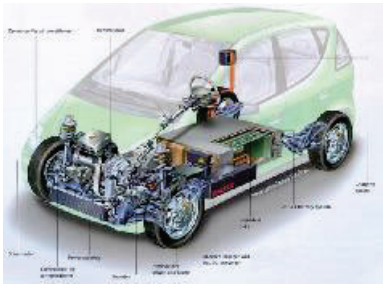
How Much CO_2 Do Electric Cars Produce?



Many people hope that we can maintain our easy motoring lifestyle after Peak Oil, while simultaneously going easier on the environment (i.e. having your cake and eating it too) by switching to electric cars. Not just hybrids that still use fossil fuels, but all-out battery-driven electric vehicles. The assumptions this hope is based on include the following:

- Electric cars are more energy-efficient than fossil fueled cars.
- The electric grid gets some proportion of its power from sources that don't emit as much CO_2 as the combustion of oil- i.e. hydro, wind, solar and nuclear power.

These two factors should make electric cars easier on the environment overall, while reducing local emissions while driving. The latter point is, of course, true – electric cars do cut driving emissions. Is the former point about being generally easier on the environment than a regular car likewise true? How much CO_2 will an electric car generate given the current mix of power sources in the American electrical grid? To determine that requires us to do a bit of arithmetic.

First of all we need to find out how much CO_2 is produced when we generate an "average" kilowatt-hour of electricity. To do that, we find out how much CO_2 each type of power technology produces, multiply that by the proportion of that technology in the overall American generation mix, and add it all up.

Electrical Generation Technology	Grams of CO_2 per kWh (reference - PDF)	Percent of U.S. Generating Capacity (from EIA)	Contribution (Grams)
Coal	1000	49%	490.0
Oil	650	3%	19.5
Natural Gas	500	19%	95.0
Solar	150	0.5%	0.75
Wind	23	1.5%	0.35
Hydro	5	7%	0.35
Nuclear	5	20%	1.0
Total		**100%**	**607**

So an "average" kilowatt-hour results in the generation of about 607 grams of CO_2 - about 1.3 lb.

Now we need to determine how much electricity it takes to drive an electric car 1 kilometer. From Wikipedia, a modern electric car requires 0.2 to 0.3 kWh per kilometer.

That's not quite all we need to consider though. There is about a 10% electrical power losses between the generating plant and the charging station of the car. We will assume the losses related to battery charging are included in the power budget of 0.2 to 0.3 kWh/km. So for every kWh we need to run our car, we need to generate 1.1 kWh at the generating plants.

Bringing all this together, driving an electric car with an energy requirement of 0.2kWh/km results in the generation of 0.2*1.1*607=**135 grams of CO_2 per kilometer**.
By the same methodology, an EV with an energy requirement of 0.3 kWh/km results in the generation of **200 grams of CO_2 per kilometer.**

How does this compare to a regular car? Average new European vehicles range from **195 g/km** for BMW down to **145 g/km** for Citroen. The overall average is about **162 g/km**. Modern American passenger cars are on the upper end of this range. There are energy losses (and associated CO2 releases) involved in getting the gasoline produced and distributed. Let's be generous and say 15% of the gross energy in the gasoline is required. This results in an EROEI ratio of 6.7:1, lower than is usually assumed for gasoline. This additional 20% raises the CO_2 range for ICE vehicles to **167 to 224 g/km**.

167 to 224 g/km or an Internal Combustion Engine vehicle, vs. **135 to 200 g/km** for a pure Electric Vehicle: it's not an encouraging comparison. Given the imprecision of the underlying data they can be viewed as essentially equal.

What conclusions can we draw from this calculation and comparison?

The main one is that **simply switching to electric cars in most places in the United States at this time won't help save the planet from global warming**.

But it's not all bad news. If the electrical grid evolves to include higher proportions of wind power, tidal power and possibly more nuclear, the CO_2 advantage of electric cars will improve. And of course as Peak Oil looms over the horizon in the next few years, there will be distinct cost and mobility advantages to driving electric. There is a caveat, though. Regarding the impact of Peak Oil, one of the most commonly voiced concerns is that as oil supply declines we may turn to more coal-fired electricity. If that happens, driving an electric car recharged from the grid becomes much less attractive..

The Situation in Canada

Canada uses far less coal and far more hydro and nuclear in their generation mix than does the United States. As a result, the emissions per kWh are about a third of those in the USA. The overall Canadian generation mix is:

Electricity Source	Percentage of Total Generation	CO_2 Contribution (grams per kWh)
Hydro	58%	3
Coal	18%	180
Nuclear	13%	1
Natural Gas	10%	50
Alternatives	1%	0
Total	**100%**	**234**

Given the same assumptions about electric vehicles as in the American analysis above, electric cars in Canada could expect *on average* to cause CO_2 emissions of 0.2*1.1*234 = **51 g/km** to 0..3*1.1*234 = **77 g/km,** compared to ICE emissions of **167 to 224 g/km**.

The picture is even brighter is some provinces such as Ontario and Quebec, where a greater proportion of electricity is generated from nuclear and hydro sources, and very little from coal. For example, the CO2 emission range for EVs recharged in Ontario would be **45 g/km to 70 g/km**, and in Quebec would be a mere **2 g/km to 3 g/km**. Quebec's exceptional result comes from their unique position of getting almost 97% of their electricity from hydro power.

Canada in general and Quebec in particular should be fertile markets for EVs.

Conclusion

If you live in a country or region where much of the electricity comes from wind, hydro or nuclear and you can afford the vehicle replacement, think about buying an electric car if and when they become commercially available.

But all things considered, the main action that will help address both Global Warming and Peak Oil right now is still our old friend Conservation. Walk, bike, take the bus and carpool. Buy a smaller, lighter car. Switch to diesel. However you do it, drive less.

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