The Great Wellhead to Wheels Debate
by Lee H Goldberg

GM's grossly-overstated claim of 230 miles per gallon for its Chevy Volt PHEV is one of several recent incidents that highlight the pressing need for some sort of standardized fuel efficiency rating method that allows a meaningful comparison between conventional, electric, PHEV, and alternate-fuel vehicles. While the 230 mpg claim may be vaguely true according to some weasel-worded criteria that only look at the gasoline the Volt burns on a 40 mile trip and assumes the battery power it uses is free (and has no environmental impact), it does not reflect the real cost of driving the car, let alone its cost to the planet. Yet GM's gaffe is only the latest example of exaggerated mileage claims routinely being made for cars like Nissan's Leaf and Raser Technologies' so-called 100 mpg Hummer.

What's needed is a metric that captures more than the cost of the fuel that powers a car and actually looks at the all the resources involved with producing and delivering the different kinds of energy used by the vehicle. For cars that are exclusively powered by petroleum or bio-fuels, this is often referred to as Wellhead-to-Wheels mpg which takes into account the energy required to extract, refine, produce the fuel, as well as the energy required to get it to your local filling station. For petroleum-based gasoline, these factors typically eat up around 17% of the energy before they get to the pump so you'd have to multiply a vehicle's so-called Pump-to-Wheels mileage we traditionally use by a factor of about 0.83 to calculate the actual amount of fuel used to get your car from point A to point B. Because the energy required to produce biofuels varies so greatly (I've seen efficiencies as low 0.2 and as high as 0.8) it would be difficult to come up with any meaningful metrics at the moment with anything short of a doctoral thesis so we'll leave this topic alone: at least for the moment.

Things get a little more complicated when you start to add electricity into the equation for an electric or plug-in hybrid vehicle (but certainly not as confusing as trying to figure out what the real conversion efficiency of celluosic ethanol production will be when the technology matures). Perhaps the simplest way to get a somewhat meaningful equivalent miles-per-gallon (mpg-e) rating for an EV or PHEV is to take the 33.6 kW-hr worth of energy contained in a typical gallon of gasoline and multiply it by some coefficient that accounts for the losses involved with generating and delivering the electricity to the battery. Most fossil-fueled generation systems convert 30% - 40% of the fuel they burn into electricity but the newer combined-cycle plants actually deliver efficiencies approaching 60%. Transmission efficiency varies widely, usually ranging between 50% and 90% depending on distance and the type of lines being used. When multiplied together, you get overall generation efficiency which is generally believed to average about 33% in the US. This does not account for the losses involved with charging the vehicle battery but that's on the vehicle side of the equation anyway.

I've used a variant of this inexact metric to try to make some sense out of the manufacturer's mileage claims when I reviewed the all-electric Tesla Roadster and the Vectrix electric scooter. Getting a meaningful mpg-e figure for a vehicle like the Chevy Volt would involve adding up the number of kW-hr it pulled from its batteries and converting it to an equivalent number of gallons of gasoline before adding it to the amount of actual gasoline it burned to go a given number of miles. (To explore some of the other challenges involved with calculating a realistic mpg-e, visit Jory Squibb's blog entry where he discusses how he rates vehicles for the 2009 One Gallon Challenge eco-vehicle rally.)

Using this more global metric means that, unless you are charging your batteries directly from a local wind generator or solar panel, you need to take a vehicle's raw electrical equivalent mpg and multiply it by 1/3 to get its mpg-e. Using the 135 mpg-rated Tesla electric roadster as an example, its real-world mileage would be around 42 mpg-e. That's still not bad for an electric bullet that eats Corvettes for breakfast – especially when you apply the 0.87 honesty factor to a typical 30 mpg gas-powered economy car and its mpg-e is around 26.

While this relatively simple calculation does produce a more realistic mpg-e, it still does not take into account what kind of fuel was used to produce the electricity or what percentage of the electricity comes from nuclear plants or renewable sources. This would be essential to coming up with an accurate picture of a vehicle's carbon footprint. There is lots of research being done on this topic at Argone National Labs, including a handy little modeling tool called the Greenhouse Gases, Regulated Emissions, and Energy Use in Transportation (GREET). After over a decade of development, this free, publicly-available tool can used to evaluate the energy and emission impacts of advanced vehicle technologies and new transportation fuels. Its detailed accounting documents the fuel cycle from wells to wheels and the vehicle cycle through material recovery and vehicle disposal. The data it produces will be invaluable in developing realistic metrics that indicate a vehicle's mpg-e and carbon footprint.

It's probably unreasonable to expect the average consumer to use GREET or even a simpler Wellhead-to-Wheels mpg calculation as the standard efficiency metric for vehicles, but it is essential that we adopt a reasonably accurate method for calculating both a vehicle's mpg-e and pounds-per-thousand miles of carbon it is responsible for emitting. The development of such metrics would be a valuable tool for consumers, as essential as the labels showing the caloric and nutritional content that are required on all packaged foods these days. At the moment, the EPA's Green Vehicle Guide does provide useful information about both a vehicle's fuel economy and its environmental impact but it's no substitute for an eco-labeling system, perhaps something like the very successful EnergyStar program for electrical products.

If this information is not available for the first wave of EVs, PHEVs, and alternate fuel vehicles that are about to enter the mainstream market, consumers will not be able to make informed choices about the cars they buy. Worse yet, a badly-defined mileage rating system would likely allow manufacturers to build cars to meet imaginary efficiency standards that have nothing to do with how they perform under real-world conditions.

Comments? Questions? Guesses about what the Chevy Volt's actual mpg-e is? Write me at **lhg at en genius dot net** or post your comments on our blog. And, if you want, you can also follow my exploits on my newly-minted LinkedIn home page.