The Secret Tesla Motors Master Plan (just between you and me)

Elon Musk, Co-Founder & CEO of Tesla Motors, August 2, 2006

As you know, the initial product of Tesla Motors is a high performance electric sports car called the Tesla Roadster. However, some readers may not be aware of the fact that our long term plan is to build a wide range of models, including affordably priced family cars. This is because the overarching purpose of Tesla Motors (and the reason I am funding the company) is to help expedite the move from a mine-and-burn hydrocarbon economy towards a solar electric economy, which I believe to be the primary, but not exclusive, sustainable solution.

Critical to making that happen is an electric car without compromises, which is why the Tesla Roadster is designed to beat a gasoline sports car like a Porsche or Ferrari in a head to head showdown. Then, over and above that fact, it has twice the energy efficiency of a Prius. Even so, some may question whether this actually does any good for the world. Are we really in need of another high performance sports car? Will it actually make a difference to global carbon emissions?

Well, the answers are no and not much. However, that misses the point, unless you understand the secret master plan alluded to above. Almost any new technology initially has high unit cost before it can be optimized and this is no less true for electric cars. The strategy of Tesla is to enter at the high end of the market, where customers are prepared to pay a premium, and then drive down market as fast as possible to higher unit volume and lower prices with each successive model.

Without giving away too much, I can say that the second model will be a sporty four door family car at roughly half the $89k price point of the Tesla Roadster and the third model will be even more affordable. In keeping with a fast growing technology company, all free cash flow is plowed back into R&D to drive down the costs and bring the follow on products to market as fast as possible. When someone buys the Tesla Roadster sports car, they are actually helping pay for development of the low cost family car.

Now I'd like to address two repeated arguments against electric vehicles — battery disposal and power plant emissions. The answer to the first is short and simple, the second requires a bit of math:

Batteries that are not toxic to the environment!
I wouldn't recommend them as a dessert topping, but the Tesla Motors Lithium-Ion cells are not classified as hazardous and are landfill safe. However, dumping them in the trash would be throwing money away, since the battery pack can be sold to recycling companies (unsubsidized) at the end of its greater than 100,000-mile design life. Moreover, the battery isn't dead at that point, it just has less range.

Power Plant Emissions aka "The Long Tailpipe"

A common rebuttal to electric vehicles as a solution to carbon emissions is that they simply transfer the CO_2 emissions to the power plant. The obvious counter is that one can develop grid electric power from a variety of means, many of which, like hydro, wind, geothermal, nuclear, solar, etc. involve no CO_2 emissions. However, let's assume for the moment that the electricity is generated from a hydrocarbon source like natural gas, the most popular fuel for new US power plants in recent years.

The H-System Combined Cycle Generator from General Electric is 60% efficient in turning natural gas into electricity. "Combined Cycle" is where the natural gas is burned to generate electricity and then the waste heat is used to create steam that powers a second generator. Natural gas recovery is 97.5% efficient, processing is

also 97.5% efficient and then transmission efficiency over the electric grid is 92% on average. This gives us a well-to-electric-outlet efficiency of 97.5% x 97.5% x 60% x 92% = 52.5%.

Despite a body shape, tires and gearing aimed at high performance rather than peak efficiency, the Tesla Roadster requires 0.4 MJ per kilometer or, stated another way, will travel 2.53 km per mega-joule of electricity. The full cycle charge and discharge efficiency of the Tesla Roadster is 86%, which means that for every 100 MJ of electricity used to charge the battery, about 86 MJ reaches the motor.

Bringing the math together, we get the final figure of merit of 2.53 km/MJ x 86% x 52.5% = 1.14 km/MJ. Let's compare that to the Prius and a few other options normally considered energy efficient.

The fully considered well-to-wheel efficiency of a gasoline powered car is equal to the energy content of gasoline (34.3 MJ/liter) minus the refinement & transportation losses (18.3%), multiplied by the miles per gallon or km per liter. The Prius at an EPA rated 55 mpg therefore has an energy efficiency of 0.56 km/MJ. This is actually an excellent number compared with a "normal" car like the Toyota Camry at 0.28 km/MJ.

Note the term hybrid as applied to cars currently on the road is a misnomer. They are really just gasoline powered cars with a little battery assistance and, unless you are one of the handful who have an aftermarket hack, the little battery has to be charged from the gasoline engine. Therefore, they can be considered simply as slightly more efficient gasoline powered cars. If the EPA certified mileage is 55 mpg, then it is indistinguishable from a non-hybrid that achieves 55 mpg. As a friend of mine says, a world 100% full of Prius drivers is still 100% addicted to oil.

The CO_2 content of any given source fuel is well understood. Natural gas is 14.4 grams of carbon per mega-joule and oil is 19.9 grams of carbon per mega-joule. Applying those carbon content levels to the vehicle efficiencies, including as a reference the Honda combusted natural gas and Honda fuel cell natural gas vehicles, the hands down winner is pure electric:

Car	Energy Source	CO_2 Content	Efficiency	CO_2 Emission
Honda CNG	Natural Gas	14.4 g/MJ	0.32 km/MJ	45.0 g/km
Honda FCX	Nat Gas-Fuel Cell	14.4 g/MJ	0.35 km/MJ	41.1 g/km
Toyota Prius	Oil	19.9 g/MJ	0.56 km/MJ	35.8 g/km
Tesla Roadster	Nat Gas-Electric	14.4 g/MJ	1.14 km/MJ	12.6 g/km

The Tesla Roadster still wins by a hefty margin if you assume the average CO_2 per joule of US power production. The higher CO_2 content of coal compared to natural gas is offset by the negligible CO_2 content of hydro, nuclear, geothermal, wind, solar, etc. The exact power production mixture varies from one part of the country to another and is changing over time, so natural gas is used here as a fixed yardstick.

Becoming Energy Positive

I should mention that Tesla Motors will be co-marketing sustainable energy products from other companies along with the car. For example, among other choices, we will be offering a modestly sized and priced solar panel from SolarCity, a photovoltaics company (where I am also the principal financier). This system can be installed on your roof in an out of the way location, because of its small size, or set up as a carport and will generate about 50 miles per day of electricity.

If you travel less than 350 miles per week, you will therefore be "energy positive" with respect to your personal transportation. This is a step beyond conserving or even nullifying your use of energy for transport – you will actually be putting more energy back into the system than you consume in transportation! So, in short, the master plan is:

1. Build sports car
2. Use that money to build an affordable car
3. Use *that* money to build an even more affordable car
4. While doing above, also provide zero emission electric power generation options

Don't tell anyone.