Will plug-in automobiles be a success?

Will plug-in cars be a success?

If by success, we mean "sell lots of vehicles" the answer is probably "no" unless the price comes down a lot–say 50% from today's prices, so that price is in line with what common people can afford. People don't pay more for a car than the loan officer will approve for a loan, plus their available down payment. Today's high price puts plug-ins out of the price range for most people unless there are huge government subsidies–subsidies that governments cannot afford. The cars have other drawbacks–like limited range and the possible need for expensive battery replacement long after the warranty has expired–further cutting back on the marketability of the cars.

The high cost of plug in vehicles is not just the batteries–it is the cost of the cars themselves. Unless these costs can be brought down, the use of batteries with lower capacity to recapture braking energy and to provide an acceleration boost, similar to the way today's Prius does today, may be a better choice, and is likely to produce a car which is salable to a wider range of potential buyers.

Even with their drawbacks, I expect plug-in cars will find at least a small market, for a number of reasons that I will explain in this post. One of these reasons is that many people believe that plug-in automobiles will reduce CO_2 emissions. In my view, this belief is false–but this belief, as well as a number of other hopes and fears, are likely to lead a steady interest in plug-in automobiles by those wealthy enough to afford them, as well as support by politicians who want to appear to be doing something useful.

The Cost Problem with Plug-In Electric Automobiles

A major issue is the high front-end cost of plug-in electric autos. The government cannot possibility afford to pay subsidies to a large number of auto owners, and auto companies cannot expect to offer cut-rate deals, once they are selling very many of the vehicles. The current Nissan Leaf's base list price (before subsidies) is $35,200, which includes the cost of a 24 kWh battery estimated to cost $15,600 (or $650 per kWh). The Chevy Volt has a base price of $40,280, which includes a 16 kWh battery estimated to cost $10,000 (or $625 per kWh).

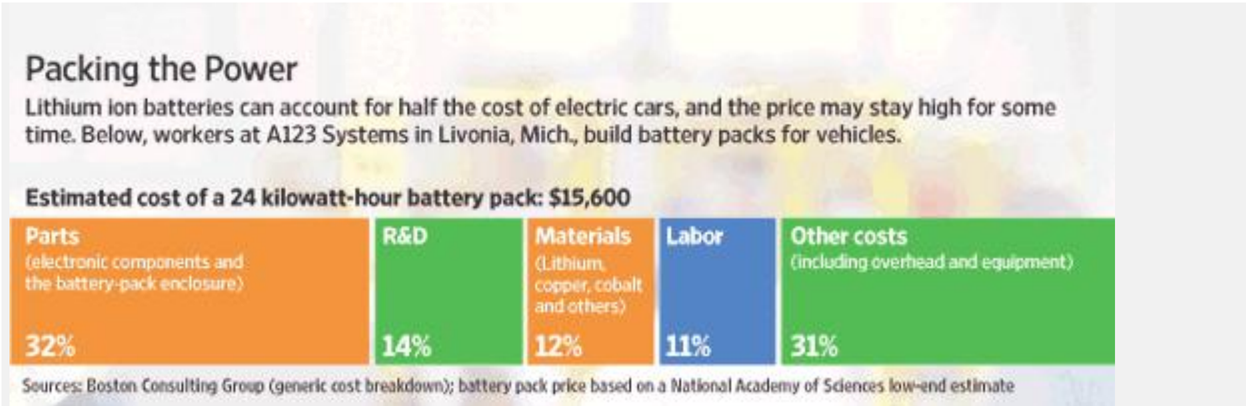

Figure 1. Breakdown of Nissan Leaf Battery Costs according to Wall Street Journal

According to the WSJ article High Battery Cost Curbs Electric Cars

. . . researchers such as Mr. Whitacre, the National Academies of Science and even some car makers aren't convinced [the high cost of batteries will come down], mainly because more than 30% of the cost of the batteries comes from metals such as nickel, manganese and cobalt. (Lithium makes up only a small portion of the metals in the batteries.)

Prices for these metals, which are set on commodities markets, aren't expected to fall with increasing battery production—and may even rise as demand grows, according to a study by the Academies of Science released earlier this year and engineers familiar with battery production.

We know that metals costs are closely related to oil costs, because oil is used in their extraction. So reducing battery costs may be a challenge. And it is not just battery costs that are high–it is the rest of the car cost that is high-priced as well, especially for the Volt, which runs on either gasoline or electricity (but only for 35 miles on electricity). Furthermore, at current pricing, it is doubtful that auto manufacturers are making money on the cars. They likely will need cost decreases, just to be able to keep sales prices at their current levels, if they are to earn a reasonable profit.

If sales prices remain at their current levels, and the government is not able to keep up subsidies, monthly payments to buy the cars will put the cars out of reach for many buyers. For example, if a person starts with a $35,000 car and a $5,000 down payment (or a $40,000 car and a $10,000 down payment), the amount to be financed will be $30,000. The monthly payment will be $753.87 (assuming 6% sales tax on $35,000; 6% interest on loan, and 4 year term). How many buyers can afford this high a monthly payment?

The second problem comes on resale of the vehicle. According to the calculator I used, the market value of the (originally $35,000 car) after 4 years will be $19,600. But how many people will want to buy a four-year old car for $19,600, knowing that they may have to buy a new battery for the car for $10,000 or $15,600 (or a refurbished one, for a little less)? Prius has had very good “lasting power” with its NiMH battery, with batteries said to last up to 180,000 miles, but it is not as clear that lithium-ion batteries will last that long, according to this article.
There are other problems from the point of used car buyers. Many potential used car buyers don’t have garages for their cars, making charging more difficult if there is not a commercial charging location near-by. Apartment building owners could theoretically add charging capability, and put in the capability to bill the costs back to the appropriate owner, but unless there are a lot of potential plug-in buyers looking for this service, it is difficult to see this happen.

Loan terms for a used cars are shorter than for new cars (often 36 months), putting the financing of expensive used cars out of the range of less well-off buyers, as well. Interest rates may also be higher.

Both Nissan and Chevy have put together better than market leasing arrangements for their new Leaf and Volt, in which they apply the full $7,000 rebate to the three-year lease term, and assume generous residual values. But even at these prices, the cost of the lease plus the electricity for the Nissan Leaf is more than the cost of a Nissan Versa (the corresponding non-plug in electric car) plus the cost of gasoline, unless gasoline costs average higher than $5.07 per gallon over the three-year period (or $5.97 per gallon, if the Leaf owner has to pay the cost of road repairs, in addition to electricity).

Lease comparison calculations-for those interested:

A Nissan Leaf leases for $349 month, after taking full credit for the $7,500 rebate and a $1999 initial payment. A Nissan Versa would lease for $200 month, with a $1999 initial payment. The monthly gasoline cost of the Nissan Versa (assuming 1,000 miles of travel, a fuel cost of $3.63 gallon, and 30 miles per gallon for the Nissan Versa) would be $121, and the lease cost plus fuel cost would be $321. The Nissan Leaf would use electricity estimated at 2 cents a mile, or $20, so the cost of the Nissan Leaf lease, plus its fuel costs would be $369 month. Thus, the monthly cost would be $48 higher with a Nissan Leaf compared to a Versa at a fuel cost of $3.63 month.
Road maintenance and repairs average about 3 cents a mile or $30 month for 1,000 miles of travel, based on a comparison of Highway and Public Street construction

costs to vehicle miles traveled. These are to some extent covered by gasoline costs, but are not included in the electric pricing. If the Leaf owner had to pay for road maintenance costs in addition, the total cost of the Leaf would be $78 higher. To bring the Versa cost up to the cost of the Leaf, a person would need a price of an average gasoline price of $5.07 during the three-year period, not including road maintenance costs, or $5.97 including road maintenance costs.

If Saving Gasoline is a Goal

Non plug-in hybrids, such as today's non-plug in Toyota Prius, require much less batter capacity than plug-ins-about 1.5 kWh compared to 16 kWh for the Chevy Volt, and 24 kWh for the Nissan Leaf. This lower battery requirement keeps the cost of the vehicle lower, and keeps the replacement cost of the battery lower. If the real issue is saving gasoline, it may be that use of cars such as today's Prius provide more "bang for the buck," and are also be more salable to second-hand vehicle buyers. According to John Peterson, there are five generic vehicle configurations, each with a typical fuel savings:

Vehicle configuration	Battery	Savings
Stop-start systems use lead-acid batteries to eliminate idling while a vehicle is stopped but do not provide any electric boost.	1.0 kWh	10%
Mild hybrids like the Honda Insight use NiMH batteries to recapture braking energy and provide up to 20 or 30 horsepower of acceleration boost.	1.5 kWh	25%
Full hybrids like the Toyota (TM) Prius use NiMH batteries to recapture braking energy, offer electric launch and provide up to 80 horsepower of acceleration boost.	1.5 kWh	40%
Plug-in hybrids like the GM (GM) Volt use Li-ion batteries to offer 40 miles of electric range before a range extender engine kicks in to power the electric drive.	16 kWh	75%
Battery electric vehicles like the Nissan (NSANF.PK) Leaf use Li-ion batteries to offer up to 100 miles of electric range under optimal conditions.	24 kWh	100%

Figure 2. John Petersen's list of vehicle configurations and fuel savings.

Peterson makes the following comparison. If a car is driven 12,000 miles a year and gets 30 miles to a gallon, it will use 400 gallons of fuel a year. If there are 96 kWh of batteries available to reduce fuel consumption (the amounts are scalable):

- 96 kWh of batteries would be enough for a fleet of 64 Prius-class hybrids that will each save 160 gallons of fuel per year and generate a societal fuel savings of 10,240 gallons per year;
- 96 kWh of batteries would be enough for a fleet of six Volt-class plug-in hybrids that will each save 300 gallons of fuel per year and generate a societal fuel savings of 1,800 gallons per year; and
- 96 kWh of batteries would be enough for a fleet of four Leaf class electric vehicles that will each save 400 gallons of fuel per year and generate a societal fuel savings of 1,600 gallons per year.

Thus, if high battery costs present a problem from the point of view of automobile salability, or if battery supply is constrained, it would seem to make more sense to use batteries in Prius-style hybrids, rather than in plug-in vehicles.

Can We Expect Plug In Automobiles to Reduce CO_2Emissions?

Many people believe that plug-in automobiles will reduce CO_2 emissions, and will buy the cars, with this belief. I disagree with the assessment, however. I expect that using plug-in cars will raise CO_2 emissions. My argument is as follows:

World oil production is basically maxed out. The world will extract as much oil from the ground as it is able. If you or I don't use a model with a gasoline engine, and instead buy a plug-in model, admittedly there will be a reduction in the gasoline that you or I would use. But we live in a world market for oil. If we don't buy the oil, **the oil will not be left in the ground.** Instead, the price of oil may drop by a tiny bit, and the oil will be bought by someone else. In fact, if we save money by buying electricity instead of oil, we may ourselves use the leftover money to buy something else that uses oil. Because world oil production is now virtually flat (inelastic), regardless of oil price, the fact that we save oil doesn't really make any difference in the whole scheme of things. Unless there is a fairly large drop in price, there will be no drop in world oil production and consumption.

I would argue that what electric cars do is allow us to raise our demand for other sources of energy (mostly coal and natural gas-sources of supply which are more elastic), so that we end up burning those sources faster, in an attempt to allow **more people to have cars**, without exhausting our liquid fuel supply, or to allow people who have cars **to drive them further.**

Of course, if we simply compare the emissions of plug-in cars to emissions of cars with internal combustion engines (ICE), there will be appear to be appear to be a CO_2 emission savings per car, with the amount depending on what fuel is used for electricity (coal, natural gas, nuclear, wind, etc.). We don't have the choice of using more ICEs though-our other choice is to "do without." And furthermore, the oil we would have used stays in the world supply, to be used elsewhere.

But many people do not make the comparison I make, and will want to purchase plug-in vehicles, on the assumption that because of the efficiency of electric engines, there is at least a small savings in CO_2, relative to ICEs, even with coal as a source of electricity.

Other Reasons for Wanting Plug-In Vehicles

Apart from these issues, it seems like there are several other reasons why some people will choose to buy plug-in vehicles or will argue that subsidies should be used, to encourage greater use by many drivers. These reasons include the following:

Save money on fuel. Is the purpose of plug-in vehicles to give the small number of people who are rich enough to purchase them the chance to save money on fuel, if they keep their cars long enough? Some people believe that oil prices will rise to $20 a gallon (and the economy won't collapse at the same time). If this is their concern, and they can afford the high cost of a plug-in vehicle, they may choose a plug-in auto, even if the price is high relative to other cars.

Allow individual drivers to drive longer. Is the purpose of plug-in electric vehicles to provide those who have enough foresight to buy the plug-in electric vehicles a chance to motor around, when others are unable to, because gasoline is unavailable? People may buy them with this view, but I would argue that there is no point in subsidizing costs if this is the purpose–owners will get their reward, if there is a reward of this sort.

Reduce oil imports. Natural gas and coal used to run power plants are mostly fuels from US sources. Wind and solar PV are mostly one-time investments, that don't require much ongoing fuel supply (except for maintenance). If we can use these instead of imported oil to power vehicles, the argument goes, it will reduce our dependence on imported oil.

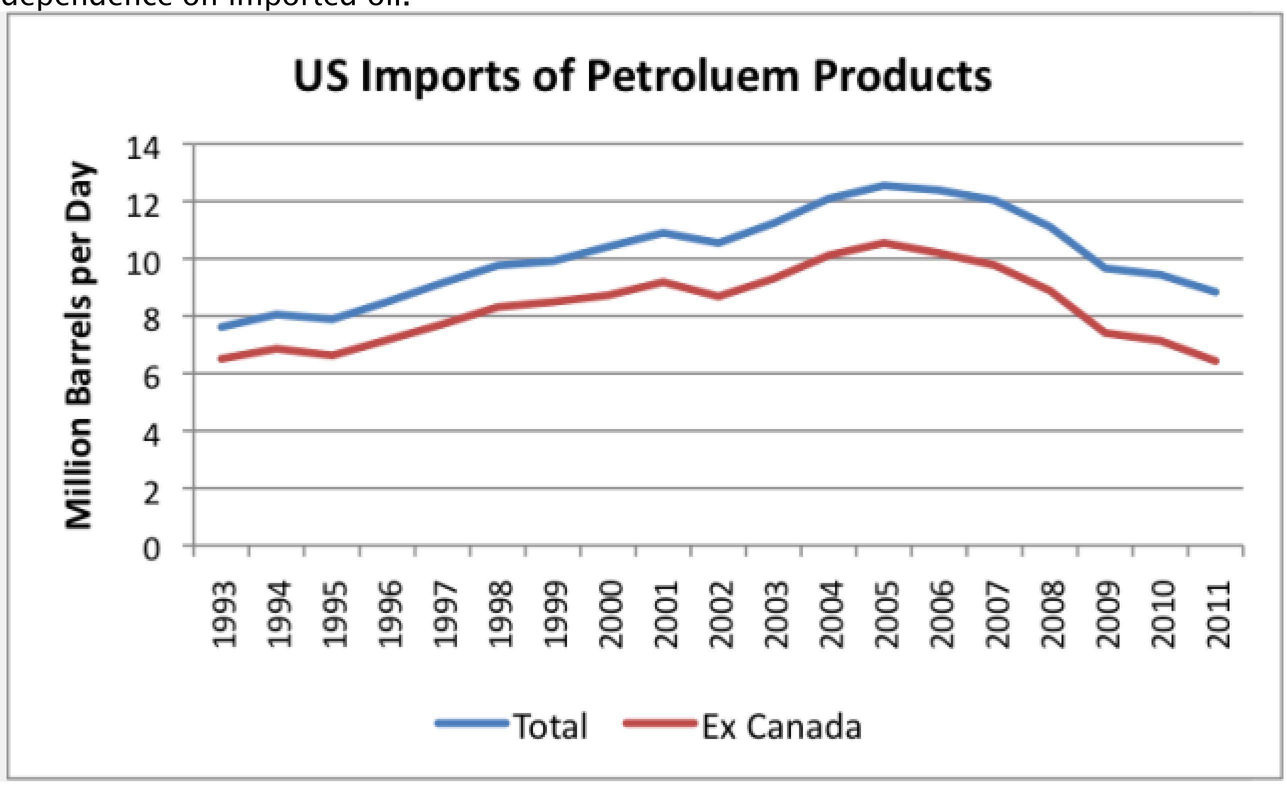

Figure 3. US imports of petroleum products, based on EIA data. 2011 data is for the partial year.

I would argue that oil imports will decline, regardless of what we do. The issue is really one of making whatever we do have go farther (which is next on my list of reasons).

Allow more people to drive vehicles, and drive them further. Anything that allows what liquid fuel supply we have to go farther, such as supplementing oil powered cars with cars powered by electricity, allows more people to drive cars, and to drive them further. I would argue that this is a primary reason for both plug-in autos and for higher mileage standards for cars in general. If we are entering into a period of fuel shortages, this might be a major reason for electric vehicles, if the price of electric vehicles can be brought down low enough. The efficiency arguments given earlier would suggest that non-plug-ins should be given preference, but if batteries can be made cheaply and total vehicle costs can be brought down, this difference may not be an issue.

Show Off. I would argue that for some people, a major motivation for buying a plug-in vehicle today is to be first in the neighborhood with such a car. A related purpose might be "to have the latest electronic toy." Providing subsidies (based on taxes of people less well off than the drivers of these vehicles) would seem silly if this is the main purpose for at least some of the cars.

Allow business as usual (BAU) to continue longer. It seems to me that this may be what is in the back of some people's minds. If we don't have enough fuel for gasoline vehicles, perhaps electric vehicles will solve our problems, and we can continue to motor along for the next 50 or 100 years.

I don't think this is a reasonable expectation. BAU will stop for whatever reason it stops-perhaps financial reasons. It will stop, whether we have used our electric vehicles for their full lifetimes or not. Not everyone will see things this way, however, and the people who believe differently will want to purchase what they think will help for the long term.

Allow politicians to look like they are doing something. I think this is a big part of the push for plug-in automobiles. Whether or not the vehicles are really scalable, will save CO_2, or will help Detroit automakers, I think this is a major reason for plug-in electric vehicles.

Concluding Thoughts

There is a common belief that if there are two options, Option A and Option B, buyers will choose Option A if the cost of Option A is less than that of Option B. This is true up to a point. People won't buy either Option A or Option B, if neither is affordable, or if the option won't fit with their current lifestyle.

The cost of a Nissan Leaf over a lifetime of 20 years (200,000 miles) is the cost of the vehicle, plus the cost of a second battery, for a total cost of $50,800, or a cost of 25.4 cents per mile. The lifetime cost of a Chevy Volt is similar, if we include the cost of an extra battery. The total cost is $50,280, or 25.1 cents per mile.

In addition, the Nissan Leaf will need to buy electricity over the life of the car, currently estimated to cost 2 cents per mile–probably more than this in the future, if electricity prices rise, in response to higher fossil fuel prices. If plug-in vehicles get to be any reasonable share of the total vehicles, governments will need to find a way to tax the owners to collect fees for road construction and maintenance. These costs, according to my calculations, amount to about 3 cents a mile. So total costs (ignoring maintenance and other costs) are about 30 cents a mile, plus interest payments on debt. These costs will be shared very unequally among owners, with the early owners paying a disproportionate share of the costs.

If a vehicle owner buys a 30 mile a gallon car for $15,000, and it also lasts for 200,000 miles, the cost of vehicle ownership will be 7.5 cents per mile. The cost of fuel will be 12.1 cents per mile, at today's price of $3.63 gallon, making the total cost (excluding interest on loans and vehicle maintenance) 19.6 cents per mile.

If debt were completely interest free, and buyers valued a dollar today the same as a dollar 20 years from now, theoretically an average fuel cost of $6.75 over the life of the vehicle would balance costs out (since this would imply a gasoline cost of 22.5 cents per mile). But in the real world, this is not the case. If one needs to account for interest issues, the average cost per gallon would need to be much higher than $6.75–perhaps be double this amount, depending on the interest rate.

There are huge additional questions:

1. Will there really be enough electricity for plug-in vehicles, 10 or 20 years from now? Japan and German are taking nuclear off line now. Coal transport depends on oil. It may be that electricity supplies are as constrained as oil supplies.

2. How will financing of the high cost vehicles be achieved, and at what interest rates? There are limits as to what governments can do.

3. Will resale markets of plug-in vehicles work out as planned?

At this point, I personally would not make a push for plug-in vehicles, but I can understand why some people might want to do so, especially if they are of the belief that costs can come down substantially in the future.

Source: http://ourfiniteworld.com/2011/09/07/will-plug-in-automobiles-be-a-success/