McCullough Research

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To: McCullough Research Clients

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Subject: Critiquing the CBO's Electric Vehicle Report

On September 20, the Congressional Budget Office released a detailed analysis entitled, "Effects of Federal Tax Credits for the Purchase of Electric Vehicles." The basic conclusion is that the current economics of the majority of plug-in hybrids and electric vehicles are not cost effective even considering the current tax credit of as much as $7,500 per vehicle.

This is daunting news for the US electric industry. The rapid growth of renewables – primarily wind – has stressed off-peak operations in many parts of the US. Since wind generation is often off-peak, it is difficult to reduce traditional generation elsewhere on the system sufficiently to avoid over-generation. Since we have few storage alternatives for electricity, a rapid growth of electric vehicles would offset the emerging problem of off-peak generation.

According to the CBO, even after the tax credit, most plug-in hybrids and all-electric vehicles fail the cost effectiveness test at levels as high as $20,000 per vehicle. These results seem counterintuitive. The report makes no attempt to minimize the importance of the assumptions underlying its results, but it does not state the case that would seem closer to current market realities. Replacing the assumptions with values

closer to current market values changes the results dramatically. The CBO's assumptions are:

1. The report assumes a 10% real discount rate and conducts sensitivities at 5% and 20%, whereas current financing for a new car stands at 1% to 2% real.
2. The report assumes the cost of electricity at $.12/kWh. The implicit assumption is that vehicles will be fueled primarily during peak periods. This is an odd assumption, given the significant on-peak/off-peak differentials in the electric industry. This assumption also requires a refueling scenario where drivers are willing to wait for long periods during daytime refueling.
3. The report assumes gasoline at $3.60/gallon. This is possible, although current prices are significantly higher in most parts of the U.S.
4. The report assumes a reduction in the lifetime travel miles of electric vehicles due to refueling requirements. Logically, however, buyers will tend to select the most efficient electric vehicle for their needs. Urban dwellers will likely accept the lower range, but a rancher in Montana will likely choose another type of vehicle. The assumption in the CBO's study seems considerably higher than the data in the 2009 National Household Survey.[1]
5. The report assumes battery prices that are considerably higher than current offers from Tesla.[2]

The most important assumption in many economic studies is the discount rate. Currently, the cost of capital to a car-buying consumer is approximately 1.2% for a six-

[1] http://www.solarjourneyusa.com/EVdistanceAnalysis7.php
[2] http://www.teslamotors.com/models/options

year financing.[3] Thus, the assumption in the CBO study is eight to nine times the current market. In defense of this high value, the CBO cites several studies estimating high consumer discount rates from the last decade.[4] There are many reasons to question the assumption and the studies cited. Suffice it to say that they depend on data before the current recession, when interest rates and consumer opportunity costs were very different.

The basic arithmetic is straightforward. The CBO compares the capital cost for the electric motor plus a 4 kWh battery with the differential in fuel costs between gasoline at $3.60/gallon and 25 miles per gallon – 26.4 cents per mile – and the cost of electricity at 4 cents per mile. A 4 kWh battery provides 11 miles of range on electricity yielding about $2.50 savings per day and $900 savings per year. The battery is estimated to cost $3,800.00. Clearly, most consumers would prefer to purchase a battery with a 4-year payback.

Unfortunately, the CBO glosses over a series of consumer decisions which must be taken in a specific sequence. (It is also worth considering whether consumer perceptions of the viability of new energy efficient vehicles are affected by recent positive experience with hybrids.) First, does the consumer want a hybrid? The answer tests whether the savings of moving from a petroleum engine to a hybrid are cost effective. For the normal driver, halving yearly gasoline costs rapidly offsets the vehicle's higher purchase price.

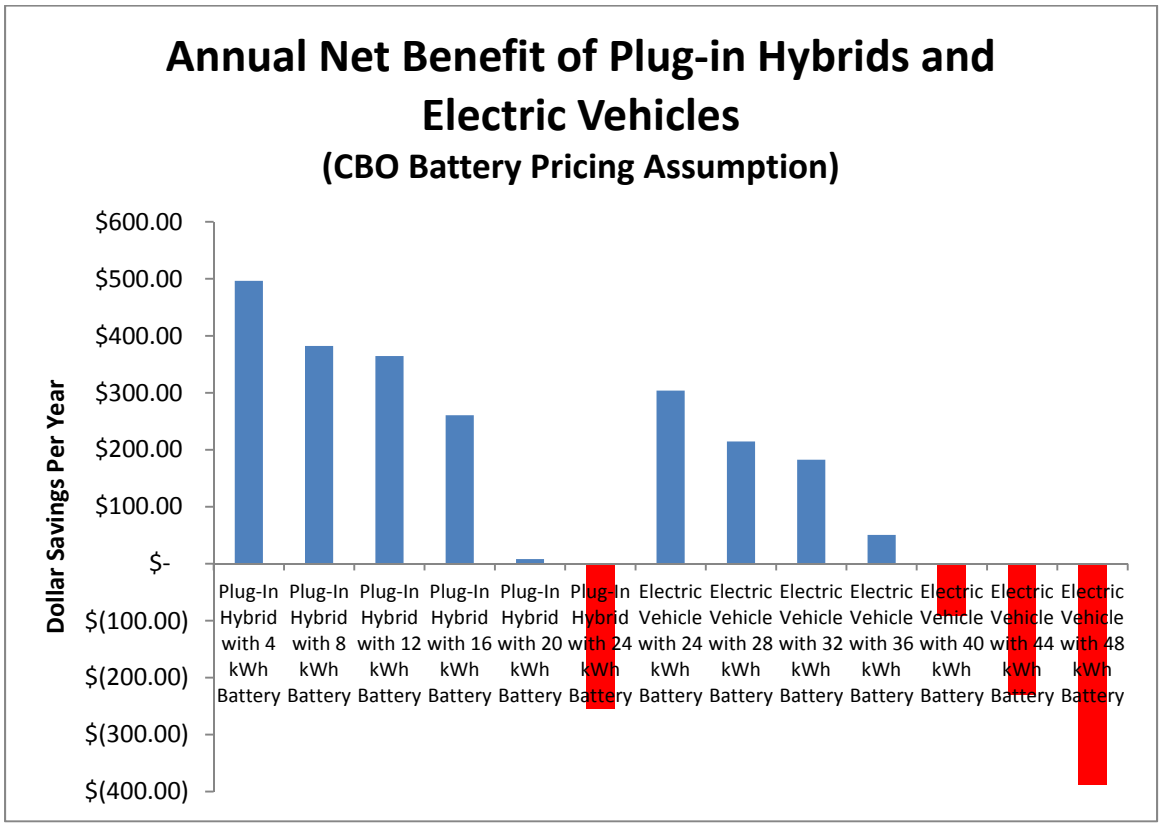
[3] Advantis Credit Union, Portland, Oregon, September 28, 2012, quoted 3% for a new car loan.
[4] See, for example, David L. Greene, John German, and Mark A. Delucchi, "Fuel Economy: The Case for Market Failure," in Daniel Sperling and James S. Cannon, eds., Reducing Climate Impacts in the Transportation Sector (Springer, 2009).

The impact of the battery on gasoline purchases is halved since the purchase of gasoline is halved by the presence of the hybrid itself. The savings from adding the battery falls from $900/year to $400/year. At $3,800.00 for a 4 kWh battery, the decision is marginal at a 10% real discount rate. Thus, the decision on the purchase of a battery is almost entirely driven by the discount rate. Below 10%, the consumer should opt for additional batteries. Above 10%, the consumer should avoid buying a plug-in hybrid.

The benefits of additional battery capacity decline since the battery is a fixed cost that may not be used as often at higher capacities. Increasing the range of all-electric travel may not be cost effective if the vehicle is seldom driven that far on many occasions.

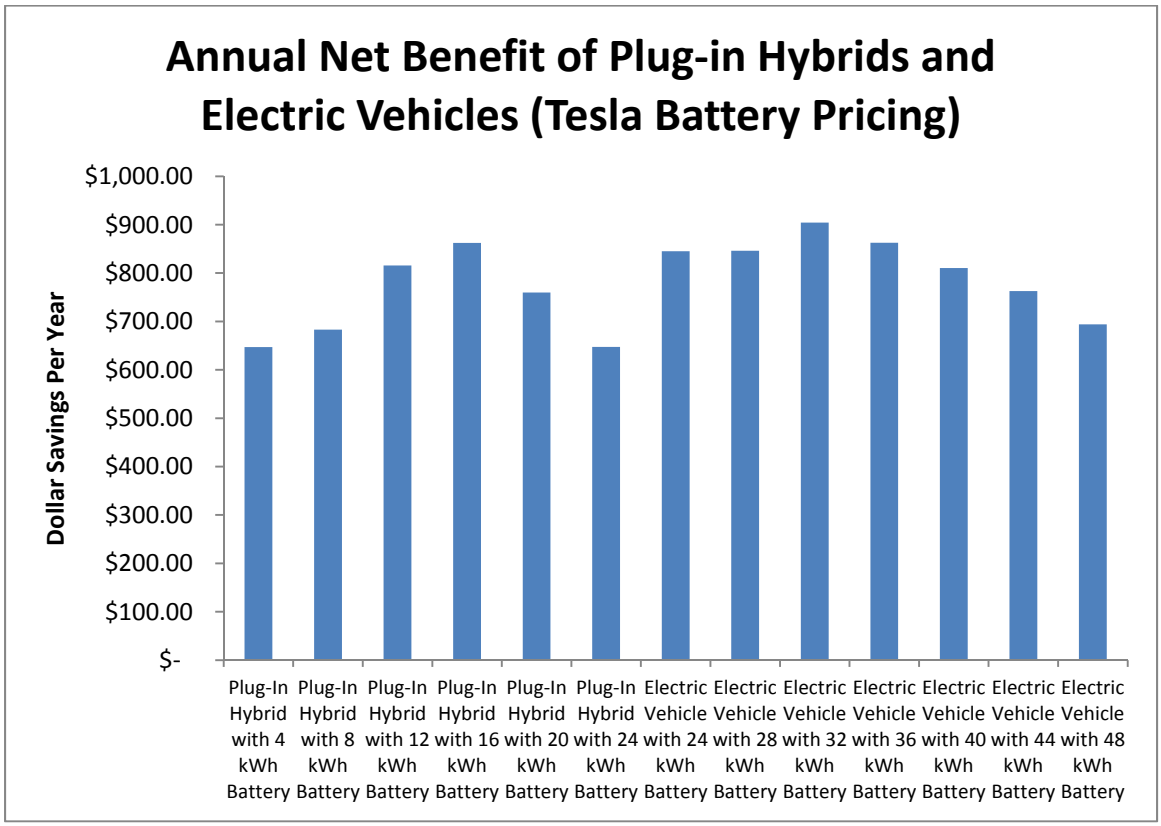
The decision to purchase an all-electric vehicle is relatively easy if the batteries are cost effective. The CBO estimates that eliminating the petroleum engine lowers the cost of installations by 40% across both the fixed cost and the variable cost for batteries. Thus, anyone who would buy a battery for his/her hybrid would move to an all-electric vehicle with sufficient storage to meet the consumer's need for range.

The following table shows the net cost advantage per year for plug-in hybrids and electric vehicles over a range of battery capacities using the current real financing rate, off-peak electric prices, and gasoline prices.



Our results differ sharply from the CBO, primarily due to the use of a more realistic discount rate. Assuming a 10% real discount rate rapidly discounts future fuel savings and eliminates most forecasted savings.

The CBO's battery pricing would also appear to be high compared to the prices offered on the Tesla. Although the Tesla prices are speculative – Tesla deliveries are just starting – they are market prices as opposed to estimates. Tesla offers an upgrade from 40 kWh to 60 kWh for $10,000 – $500/kWh in contrast to the $950/kWh estimate in the CBO report.



Contrary to the CBO report, we conclude that plug-in hybrids and electric vehicles are cost effective across most battery sizes when using the CBO's battery cost estimates and that plug-in hybrid and electric vehicles are cost effective across all battery sizes using battery prices from Tesla.

The policy implication from this exercise in varying the assumptions in the CBO study is that the problem – if there is one – barring the purchase of electric vehicles lies in the perceived cost of financing for consumers and not in the cost of the vehicles themselves. If so, policy should address the area of market failure at its source. Given the availability of inexpensive financing in the current environment, the assumed financing obstacle seems questionable.