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The Energy-Climate Crisis is Your Business

Part V: A Vehicle Revolution Is Part of the Solution-Hybrids Cars[1]

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"He [Santiago] never realized that people are capable, at any time in their lives, of doing what they dream of."
"The Alchemist" by Paulo Coelho

AUTHOR'S NOTE

Nations of the world are experiencing a global financial crisis, the end of which is unlikely to occur for some time. When Part IV of this article went to press, oil was selling at $147 per barrel. Today, the price is fluctuating around $70 per barrel. It fell to this level in a matter of days. However, don't be fooled by this; the oil price will rise again, probably sooner rather than later. In the end, there may be a silver lining to this crisis – it appears to be a catalyst for nations to work together to address a common problem. This kind of global cooperation has never occurred before.

However, there is a caution to recognize, based on Bill Clinton's famous sound bite – "It's the economy, stupid!" With few exceptions, nations of the world, whether socialist, communist or otherwise, practice some form of capitalism. That being the case, the Clinton sound bite will 'bite' even deeper during the current financial crisis. This could influence political leaders and people in general to retract commitments to address the evolving energy security and climate change crises, especially the latter. This would be a serious mistake, as both have the potential for greater negative impact than our current financial challenge.

Even with slower economic growth, the increasing thirst for oil by China and India alone will more than dwarf any decrease in demand in the developed world as a consequence of inflation, recession, or stagflation. As soon as the world's financial markets catch their breath, oil will resume its rapid triple-digit increase in price.

As for climate change, it is like killing a frog in boiling water. You can do it instantly by dropping him into boiling water, or you can place him in cool water and heat it up slowly. Long before the boiling point is reached, the frog will have fallen fast asleep and passed on to his 'hereafter' with a comforting smile on his face. America, the European Union and Asia will face enormous pressures to relax their efforts to address climate change. It would be a big mistake to do so. As with the proverbial 'smiling frog,' it would bring unfortunate consequences in the not-too-distant future.

THE ROLE OF VEHICLES

Let's look at the role of vehicles and energy security and climate change in the United States and the European Union.

The U.S. uses 20.7 million barrels per day (MBD) of oil, and imports 50% of this, or ~10 MBD, at an annual cost of ~$500 billion. About 60 % of these imports, or $300 billion worth, comes from OPEC nations. Automobiles, SUVs and light trucks burn 8.7 MBD or 42 % of the total oil use[2].

The EU uses 14.6 MBD, at an annual cost of ~ € 365 billion, and imports about 79 % of this, or 11.8 MBD, for which it pays ~288 billion. About 1/3 of the EU's imported oil comes from OPEC nations and another 1/3 from Russia. In 2007, the EU imported 4 times more oil than it did in 2003. EU automobiles burn 4.4 MBD, or 37% of its imported oil, which costs ~140 billion per year, i.e. more than the value of the entire EU car industry production for 1 year[3].

As for climate change, consider just the U.S. With 5 % of the world's population and 30 % of the world's automobiles, it contributes 45% of the world's automotive emissions. In 2004, the amount of CO_2 emitted to the atmosphere was equivalent to the carbon contained in a coal train stretching 55,000 miles, i.e. twice around the globe and carrying 314 million tons of carbon[4].

Clearly, improvements in vehicular efficiency are needed to address both energy security and climate change. The fundamental challenge is that in addressing energy security, which is visible because of its economic impact that we not forget climate change, where the socioeconomic impact could be even greater, but created over a longer period of time.

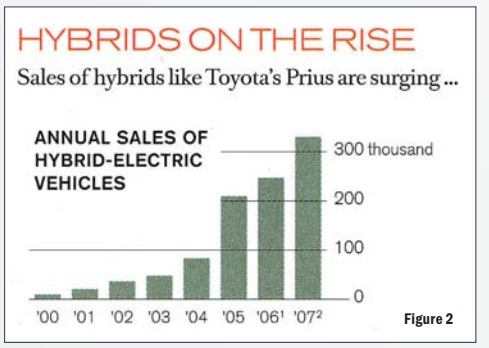


Figure 2

THE "CHINDIA" EFFECT

First, we must recognize the supply challenge. Crude oil supply from the Persian Gulf has been essentially flat for 30 years at about 20 MBD. The minimal growth that did occur came primarily from outside the Middle East. It is also increasingly questionable whether Saudi Arabia, with the largest global oil reserves, in fact has the level of reserves publicly reported.

On the demand side, consider just China and India. Today, China has 50 million vehicles on the road, about 40 per 1,000 people. This compares with 250 million vehicles in the U.S., or about 800 per 1,000 people. If China were to reach 50 % of the per capita vehicle ownership in the U.S., it would have about 500 million vehicles on the road, a 10-fold increase, and twice the number currently on the road in the U.S.[5].

Low-cost vehicles such as India's recently introduced Tata Nano, which sells for $2,500 will increase car ownership within hundreds of millions of newly middle class households around the world over the next few decades.

Today, there are about 900 million vehicles on the road, globally. By 2020, China and India alone, could easily add 25–30 million cars per year, and another 600 million cars within 30 years. These numbers are mind-boggling and there is just no way that our current energy structure could deal with even a fraction of these projections, and do so in a manner that addresses climate change as well. So how do we meet this challenge?

A WORKABLE STRATEGY

A workable strategy encompasses two complementary approaches: 1. Increased vehicular efficiency, and 2. Introduction of low- and non-carbon-emitting fuels, primarily electricity, biofuels, and hydrogen. These two approaches overlap and encompass hybrid, electric, and fuel-cell-powered vehicles. Figure 1 presents a summary of the total energy used by vehicles that could make a significant impact over the next few years. The most promi-

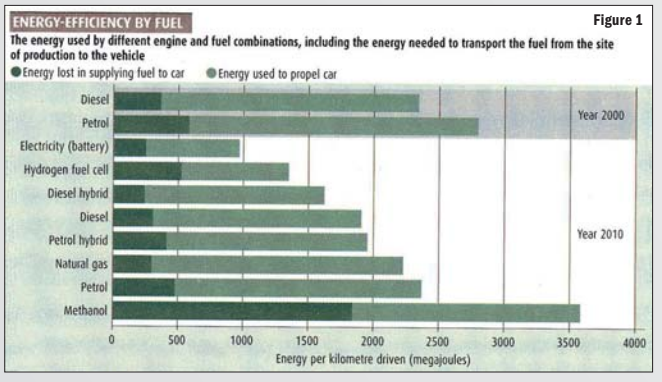
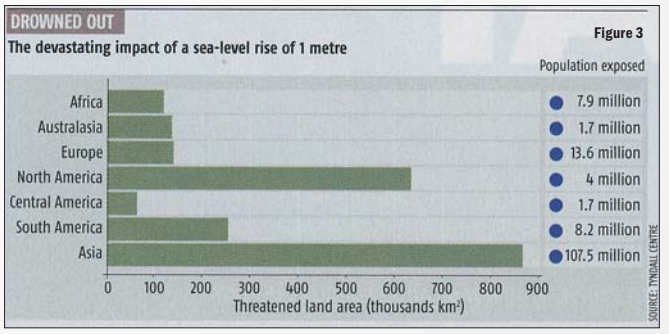


Figure 1



sing options are hybrid vehicles, electric vehicles, and ultimately, vehicles powered by a hydrogen fuel cell. In this issue we consider hybrid vehicles, and in the next issue, electric and fuel-cell powered vehicles.

HYBRID VEHICLES

A hybrid vehicle is powered by battery-generated electricity, the batteries being recharged by a small internal combustion engine. Plug-in hybrids, which will appear on the market in 2009, also permit recharging of the batteries by plugging into a standard wall socket, either at home or at numerous power points that are increasingly being distributed throughout forward thinking communities.

Initially ridiculed by a number of western auto manufactures as a vehicle with no market, hybrid vehicles sales have surpassed all expectations (see Figure 2). Toyota, a pioneer in this market sold its millionth hybrid in 2008.

Whereas the average U.S. car travels about 23 miles on a gallon of gasoline (54 kilometers per liter or 10.3 liters per 100 kilometers), a Toyota Prius Hybrid travels twice as far on the same amount of gasoline. Today, in addition to Japanese hybrid pioneers such as Toyota and Honda, nearly every major automaker currently markets or is about to market a hybrid vehicle. This change of strategy by western automakers has been driven by the demands of energy security and climate change.

Leading models achieve high efficiency by recovering energy that heretofore was lost. For example, modern hybrids recover about 50% of the braking power to recharge the batteries. Another source of increased efficiency is careful blending of electric power with that provided by the combustion engine, which is efficient only in a limited range of operation. Computerized operation smoothly kicks in a burst of energy from the electrical system whenever needed. This means that hybrids are efficient, low carbon emitters and yet have high performance. I drive a Lexus hybrid, which not only achieves excellent gas mileage, but has rapid acceleration, and yet it is a heavy vehicle. To achieve higher fuel efficiency, most hybrids replaced the standard Otto cycle internal combustion engine with a fuel-thrifty Atkinson cycle. The use of electronic controls allows for greater expansion of the fuel/air mixture in the cylinder, thereby providing much lower fuel consumption. But this comes at the expense of power output, which is more than made up for by the electric power of the car. Hybrids can achieve much better fuel efficiency than modern diesel engines. Diesel hybrids, which will be available in the future, will be a significant step forward in both efficiency and power. However, the biggest advance in fuel efficiency, climate change protection, and performance will come with plug-in hybrids, which will be offered commercially in 2009.

PLUG-IN HYBRIDS

Besides fuel efficiency, the great advantage of hybrid cars is their low carbon footprint and this is particularly true for the next generation models-plug-in hybrids. In the U.S., a conventional car costs about 15 cents per mile to operate at current fuel prices. A plug-in hybrid costs 3 cents per mile to operate with an electricity cost of 8 cents per kilowatt-hour, the current residential average price in the U.S. Because Americans travel an average of 25 miles per day, a plug-in hybrid with a battery capable of providing power for 20 miles could cut petroleum consumption in the U.S. by 60%[6].

In 2005, Daimler Chrysler released in limited number, their first plug-in hybrid, the Mercedes-Benz Sprinter Van Hybrid. With its 143-horsepower internal combustion engine and a 120-horsepower electric motor, it can travel 20 miles in all-electric mode and has 40% lower consumption of gasoline, and significantly greater acceleration than the non-hybrid Sprinter Van[7].

By a simple modification of the internal combustion engine, plug-in hybrids also can run on biofuels, e.g. Petrol 85, which is a mixture of 85% ethanol and 15% gasoline. The ethanol should come primarily from cellulose, and in this mode of operation, the plug-in hybrid could travel 500 miles on a single gallon of gasoline blended with 5 gallons of cellulosic ethanol. Even greater advantages for energy security and climate change could be achieved by using bio-diesel in plug-in diesel hybrids, which will appear on the market some time after the launch of the gasoline models[8].

SAVING SCENARIOS

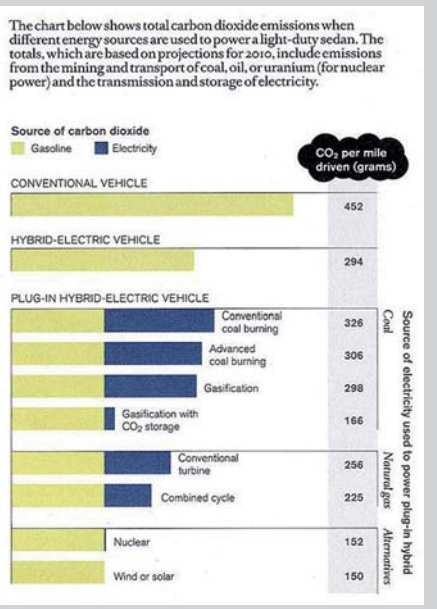
Other creative scenarios provide even greater advantages for plug-in hybrids, especially for combating climate change. Lest we forget the challenge we face in this arena, as discussed in detail in Part II of this series[9], Figure 3 shows the impact of a 1-meter rise in sea-level, a consequence that is increasing in probability as the projected potential global temperature for 2050 rises. Figure 4 shows the level of CO_2 attributed to conventional, hybrid and plug-in hybrid vehicles, when various fuel sources are used to supply electricity. From this chart one could conclude:

- Coal power is too expensive to achieve even a modest advantage. Even coal gasification plus CO_2 deep storage is not an option because gasification plants are hugely expensive and CO_2 deep storage leaves open the possibly for CO_2 to escape in the future[10].
- Natural gas turbine-combined cycle is quite favorable.
- The lowest emissions come from nuclear, wind and solar power. Nuclear is ruled out for economic, health, and nuclear proliferation reasons[11].

These data also provide promising possibilities for power generation. Power plants have excess power capacity at night, because the peak requirements come during the day. Plug-in hybrids could be charged during evening hours, and when not in use during the day, feed power into the grid. This would be a valuable service for which power plants would pay its customers. Studies at the University of Delaware show that a power plant could afford to pay its customers $3,000 per year, which would help subsidize purchase of the vehicle.

Finally, as shown in Figure 4, there is a significant environmental advantage to wind power. Linking modern wind power with plug-in hybrids provides a creative means for essentially running vehicles on wind power. Modern turbines and technology have decreased the price of wind power from 38 cents to 4 cents per kilowatt-hour. A study by the U.S. Department of Energy shows that 3 states (Kansas, North Dakota and Texas) are capable of producing enough wind power to supply the entire U.S. In Europe, wind supplies electricity to 40 million customers and could easily supply power to 195 million consumers by 2020. So wind power is cheap, abundant, inexhaustible, widely distributed, clean and climate-benign. For the interface

Figure 4
PLUG-INS: EMISION COMPARISON



to work on a large scale with plug-in hybrids will require revamping the grid system both in the U.S and in Europe, i.e. creation of a "smart grid" that can efficiently interface with micro-power sources.

In summary, there is no doubt that the world will move with great speed toward plug-in hybrids with flexible fuel capabilities, thereby using increasing levels of zero-carbon electricity and zero-carbon bio-fuels.

In the next issue, we will explore the possibilities for total electric and fuel-cell power vehicles.

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[1] Parts I and II of this series outline the Global Energy Security and Climate Change issues, respectively; Part III provides a summary of a workable solution, and Part IV presents an analysis of nuclear power. See Leaders Magazine, Nos. 1, 2, 3 & 4 2008.
[2] http://tonto.eia.doe.gov/dnav/pet/pet_sum_snd_d_nus_mbblpd_a_cur.htm
[3] European Federation for Transport and Environment–Briefing, June 18, 2008.
[4] http://www.ens-newswire.com/ens/jun2006/2006-06-28-03.asp.
[5] Jeffrey D. Sachs, "Coping with a Persistent Oil Crisis," Scientific American, October 2008, p. 22.
[6] Joseph J. Romm and Andrew A. Frank, "Hybrid Vehicles Gain Traction," Scientific America April 2006, p. 60.
[7] Ibid, P. 62.
[8] Ibid, P. 63.
[9] James A. Cusumano, "The Energy-Climate Crisis is Your Business—Part II: Climate Change & Global Sustainability," Leaders Magazine Volume III, 2008, p. 130.
[10] James A. Cusumano, "The Energy-Climate Crisis is Your Business—Part III: A Workable Solution," Leaders Magazine Volume IV, 2008, p. 110.
[11] James A. Cusumano, "The Energy-Climate Crisis is Your Business—Part IV: Is Nuclear Power a Viable Solution?" Leaders Magazine Volume V, 2008, p. 110.
[12] Joseph J. Romm and Andrew A. Frank, Op. Cit., p. 62.
[13] Lester R. Brown, "The Short Path to Oil Independence—Gas-Electric Hybrids and Wind Power Offer Winning Combination," www.earth-policy.org/Updates/Updates43.htm.
[14] "The Power and the Glory," The Economist, June 21, 2008, pp.12-14.

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