

## **Ferguson: Energy Matters**

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### **Plug-in Hybrids – Where's the Juice?**

I've been doing a lot of thinking lately about what we are going to do if, as I expect, global supplies of crude oil begin to decline in the near future. Converting more food into ethanol doesn't seem like a good solution. Nor does making liquid fuel from coal or natural gas. We would only deplete these resources and warm the planet faster. But with less oil to make gasoline and diesel, what will provide energy for transportation?

The remaining feasible energy source is electricity generated from nuclear or solar power plants. There is no theoretical reason why our transportation systems could not be powered with electricity. There are basically two ways to do this.

The first is to use electricity to make fuel—hydrogen, for example—that could be used in vehicles more or less like those we have today. A few years ago Governor Schwarzenegger was touting his "hydrogen highway" to do just that. Carrying around enough hydrogen in your car to get you to Disneyland isn't easy, but hey, we're talking about the future here. My personal guess is that it would be better to use the electricity to make a liquid fuel like ethanol from spare carbon dioxide and water. But I'm not the governor.

The second option is to transmit the electricity into cities to run our cars. Plug-in hybrids are a step in that direction. These things have batteries that can store enough juice to take the auto 50 miles or so, enough perhaps for a typical commute without having to use the back-up gasoline engine. For longer trips, plug-in hybrids must rely on gasoline for energy. But, in a future transportation system, batteries could improve to the point at which 100 percent electric vehicles are practical.

In my musings, I wondered just how much electricity it would take to replace a significant amount of gasoline with electricity. The answer is a lot. California burns about 16 billion gallons of gasoline a year. The average rate of flow of energy from 16 billion gallons per year of gasoline into our cars is almost 60,000 megawatts (MW). [You recall from science class that power = energy ÷ time, right?]

Electric motors, however, are much more efficient than internal combustion engines. As a rough estimate, let's suppose we need only 30,000 MW of electricity to replace the 60,000 MW of gasoline power. As it turns out, that's about the amount of electricity we already use today.

The implications of this result are not surprising. To decrease gasoline consumption by 10 percent, we would have to increase electricity consumption by about 10 percent to operate electric vehicles. Totally replacing gasoline with electric energy would require an electricity system approximately twice as big as the one we have. (Using electricity to produce hydrogen to be burned in internal combustion engines would require much more.)

Plug-in hybrids are all the rage these days, but if they are to make much of a dent in gasoline consumption, we need to start planning to provide additional electric energy. Current planning by utilities accommodates population growth, but no one yet is talking about additional electricity for transportation.

Plug-in hybrids seem like a good idea; 100 percent electric vehicles seem even better. But the energy they need isn't going to appear by magic. If electric vehicles are in our future, we need to build an energy supply for them.

The world continues to muddle along burning up the remaining oil without any real plans for the future. Governments continue to hope that Saudi Arabia will increase crude oil production indefinitely without any plans for what to do if they can't or won't.

There are fantasies of replacing the energy we obtain from oil with corn ethanol, biodiesel, liquid fuel from coal, hydrogen, electricity, and so on, but no real plans for doing so. Perhaps it is expecting too much of governments to make such plans. It is certainly easier for politicians to rely on the 'magic of the marketplace' than to execute a good plan.

Our current transportation energy system took a century to develop. We don't have that much time to develop what comes next. We'll need all the magic the market can provide and then some.

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