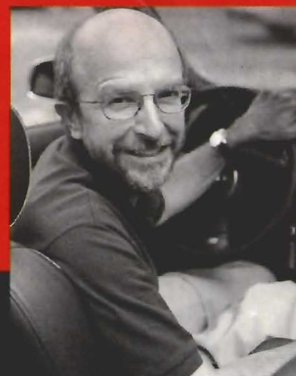


# THE STEERING COLUMN

## GENERAL MOTORS' CONCEPT CAR GIVES A MAJOR ENDORSEMENT TO THE PLUG-IN HYBRID IDEA.



**S**ince I first wrote about plug-in hybrids in this column in November 2005, not a great deal has happened. The concept basically adds extra batteries to a hybrid car so that it can drive the first part of any journey exclusively on electric power, greatly improving fuel economy on short trips. Plug-in proponents, who range from *New York Times* columnists to a former CIA chief, still maintain that the cars provide the solution to America's energy problems, however one chooses to define them. Those of us with more knowledge about cars understand the theory but find it hard to muster enthusiasm for a concept that in the complete absence of any realistic prototypes to drive and evaluate remains a laboratory experiment.

Now General Motors has jumped into the plug-in fray. At the L.A. auto show last December, CEO Rick Wagoner announced that GM was going to pursue the plug-in concept by taking advantage of GM's expertise in electric cars and fuel-cell vehicles. At the Detroit show in January, GM would substantiate Wagoner's announcement by showing the Chevy Volt, a car designed to be a plug-in hybrid from the get-go. As this is written in late December, I haven't seen the Volt, but GM has shared the car's details, and they are more than interesting. The Volt's underpinnings are roughly based on the next-generation Delta platform, which means a car about the size of a Chevy Cobalt, weighing 3200 pounds. But the powertrain is unusual, even for a hybrid.

Tony Posawatz, the project's vehicle line director, describes it as an electric car with an onboard "range extender." I'd say it's a "series hybrid" with a big battery. All the hybrid cars currently on the market are "parallel hybrids," which means the wheels are powered by the gasoline engine or the electric motor or both. In a series hybrid, the wheels are powered solely by the electric motor; the internal-combustion engine only drives a generator to produce the electricity to power the motor. Diesel-electric locomotives have worked this way for decades.

In the Volt, the front wheels are driven by a 160-hp electric motor with 236 pound-feet of torque. This motor, in turn, draws its power from a 16-kilowatt-hour (a kWh is a measure of how much energy a battery can store, sort of like the size of a gas tank) lithium-ion battery pack weighing about 400 pounds and mounted in the central tunnel of the car. To put this into perspective, the lead-acid starting battery in a Chevy Cobalt has a capacity of 0.75 kWh, and the nickel-metal hydride battery in a Toyota Prius can store 1.3 kWh.

This is a seriously powerful battery, and Posawatz says it can propel the Volt for 40 miles, even when using only half the energy in it—charging to only 80-percent capacity and not discharging below 30 percent—to make sure it lives a long and happy life. That's enough to cover the distance that most Americans commute to work—both ways for many of us.

When you park the Volt, you plug it into a conventional 120-volt outlet, from which the battery will charge in six to seven hours. At

prevailing electric rates here in Ann Arbor, Michigan, that charge would cost about a dollar. That puts the cost of those 40 electrical miles at about 2.5 cents per mile. Even a car that gets 30 mpg costs three times as much to fuel per mile at today's gas prices.

If your trip is longer than 40 miles, the Volt's generator fires up. In its front compartment, the Volt has a three-cylinder turbocharged 1.0-liter engine that develops about 85 horsepower, coupled to a 53-kW generator. At an optimized 1800 rpm, this unit can provide enough juice to keep the car running while recharging the onboard battery in about half an hour.

In fact, the generator is powerful enough to provide enough electricity for the car to cruise at 100 mph until the 12 gallons of fuel run out. With a good charge in the battery, the Volt could hit 120 mph and accelerate to 60 mph in eight seconds, so it would have no trouble keeping up with traffic. In normal driving, it would achieve roughly 50 mpg for an overall range of about 640 miles.

The Volt can also run on ethanol, and GM is even thinking about other alternatives, such as replacing the engine-driven generator with a fuel cell to supply electricity when the battery is exhausted. GM calls this versatility "E-flex," because the Volt's supplementary power could come from a variety of sources depending on local needs and technology.



CHEVY VOLT

The idea is promising and the technology is sound, but cost issues stand in the way of production. The major one is the cost of the battery. The Li-ion battery in my IBM ThinkPad holds 0.065 kWh of electrical energy and costs \$159. At that

rate, 16 kWh of battery would cost about \$40,000. Even allowing for retail markup and quantity discounts, the battery in the Volt would probably cost \$10,000 if purchased today. Keep in mind that Li-ion batteries need careful temperature control, as the recent round of laptop fires has demonstrated, and that adds cost. The Tesla electric sports car, which also uses a lithium-ion battery, has a separate air-conditioning system just for the battery!

If the Volt were to retail for about \$25,000, I reckon all the parts and labor needed to manufacture each vehicle would have to cost no more than \$10,000 for GM to recover its development and tooling costs while turning a profit. Achieving that cost probably means getting the battery cost under \$2000.

The electronics needed to intelligently modulate the large electrical flows in a car like the Volt aren't inexpensive, either. There's also plenty of development needed to make the powertrain behave with the seamless refinement we have all come to expect. But if progress is achieved in reducing battery costs, a vehicle such as the Volt could conceivably hit the market in five or so years. ●