



CHEVY VOLT: CAR OF THE FUTURE?

AVIOS

AUTO

ENTHUSIAST

Rivals

Driven by **Competition**

SPECIAL SECTIONS

CORVETTE & CHEVY

- Barrett-Jackson Big Brake
- 600 HP Through Six States
- CV Joint Rebuild

MOPAR

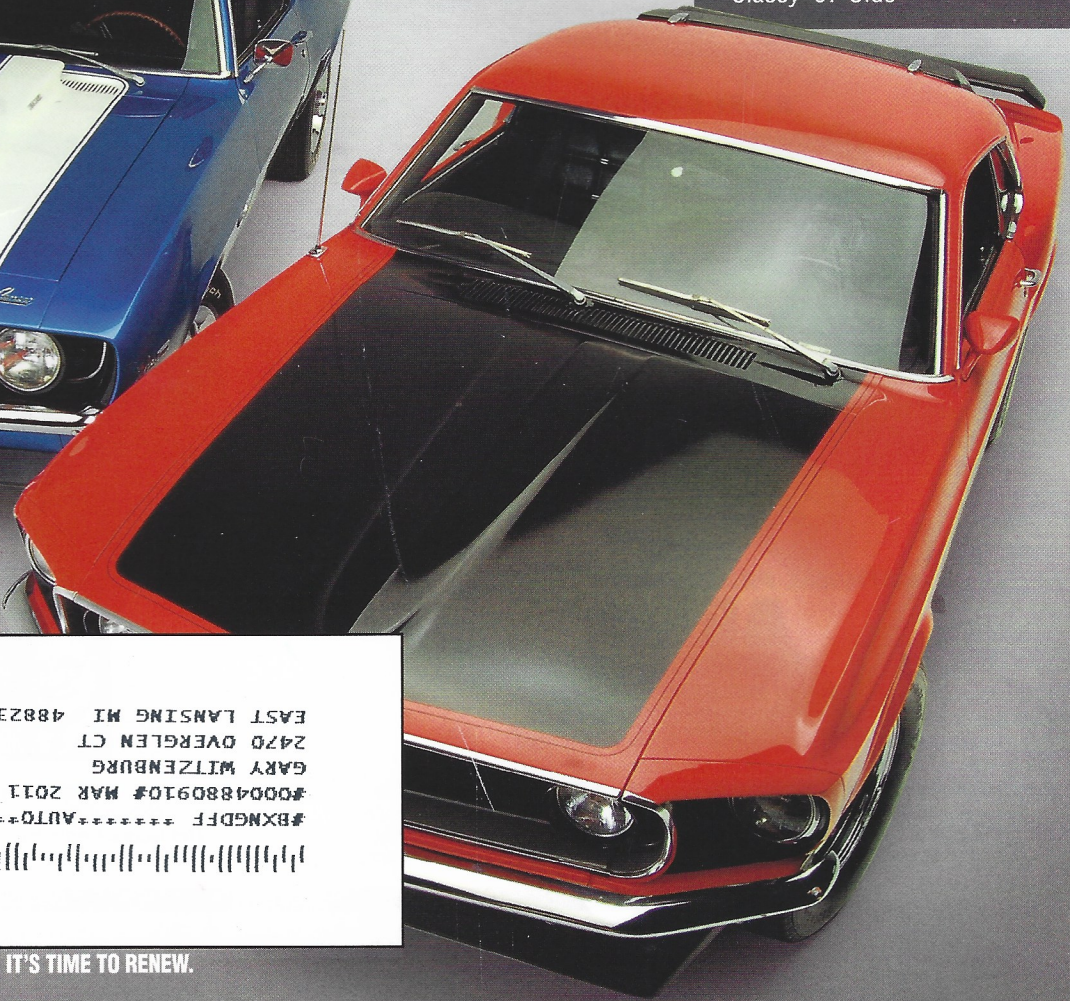
- XP Hemi Charger Rebuild
- Shootout – Ladies Night
- Twin TBI EFI

MUSTANG

- 5.0 Bolt-on Power Parts
- Vintage Steering Rack
- Personal Powdercoat

CLASSICS

- Brake Line Flaring
- Classy '57 Olds



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READY TO EXPIRE?

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IF THE DATE ON YOUR LABEL IS APR 11, IT'S TIME TO RENEW.

TODAY'S SCAR OF TOMORROW

STORY GARY WITZENBURG

IT WAS DECEMBER, 2006 - ALMOST EXACTLY A DECADE SINCE GENERAL MOTORS SHIPPED THE FIRST PRODUCTION EV1 ELECTRIC CARS TO DEALERS IN CALIFORNIA - WHEN GM SUMMONED AUTO WRITERS TO A PRE-DETROIT AUTO SHOW "TECHNOLOGY" PRESS BRIEFING.

On my way, I wondered what it would be about. We were surprised to find then-GM Product Development Vice Chairman Bob Lutz opening the presentation. Must be important, I thought. And it was.

It was the 2007 Chevy Volt concept electric car and its revolutionary "E-Flex" propulsion system, which would be unveiled to the public a few weeks later at the January show. Unlike any other electric vehicle (EV) or hybrid, its electric drive motor would be powered by a battery until that was depleted, then by electricity from a generator driven by a small gas engine.

Because the Volt would run on



inexpensive electricity off the grid for the first 40 or so miles, then as far as needed on electricity generated by the engine, it would be a non-fuel-burning, tailpipe-emissions-free EV for the first part of each day's drive, then a fuel-efficient compact sedan the rest of the way. Most importantly, it would eliminate EV "range anxiety" ... that

sweaty-palm fear of running out of volts before you run out of trip.

Lutz admitted that GM made a mistake, after EV1 had proven to be a marketplace failure, by skipping past volume gas/electric hybrids to full-scale fuel-cell EV (FCEV) development, while Toyota had placed its bet on a torque-blend "parallel" hybrid system that first emerged in the original Prius and won big-time in the image arena. GM Advanced Technology Vehicles (ATV) had explored various types of hybrids in the late 1990s (I know; I was there) and later developed a more fuel efficient (but more complex and expensive) two-

THE NEW 2011 CHEVROLET VOLT DEFINITELY
HAS GAME-CHANGING POTENTIAL

BROW!



mode hybrid system for trucks and buses, but decided that the cost of a Toyota-type system would be too high to justify its fuel-efficiency benefit.

But while GM's parallel hybrid business case didn't compute, it underestimated the PR value of building and selling fuel-efficient hybrids in volume, even at a loss. No amount of money spent on advertising, Lutz asserted, would have bought the company as much image benefit. So now, he said, GM was committed to developing this unique "Extended Range" EV (EREV) technology for production as soon as possible. Then followed

an impressive technical presentation explaining in great detail how the Volt's E-Flex propulsion system would work.

SERIES HYBRID

It would essentially be a "pure" battery EV (BEV) until its battery was depleted to a pre-determined level, then a "series" hybrid, like a diesel locomotive, which is always electrically driven but carries a heat engine to power a generator that provides the electricity. As such, it would be the industry's first EREV.

By contrast, a parallel hybrid – like Toyota's Prius, Ford's Fusion Hybrid, Honda's Insight and the rest – cleverly blends torque from an electric motor

(ICE) to power the vehicle, always in the most efficient way possible. Either one is capable of propelling the vehicle by itself, but such a hybrid can't go fast or far on electric power alone, because its relatively small battery pack doesn't hold all that much energy.

Today's parallel hybrids are never plugged in; their batteries are charged on the fly by the gas engine and by "regenerative" braking, which morphs the drive motor into a generator during deceleration. Coming soon will be Prius (and other) "plug-in" parallel hybrids, which will carry larger (and therefore more expensive) batteries that can be topped off from the electric grid then driven on electricity alone for maybe 12



Based on the same platform as Chevy's all-new 2011 Cruze sedan, it's about the same size and looks a little Cruze-like, though it's a five-door hatchback, not a sedan, with an aero-optimized body. There's a big, bold, black slash along its beltline, its Chevy-signature twin grille ports are covered by aluminum-look bars, its interior is completely unique, and its two-passenger back seat is less roomy due to its centrally-located battery pack.

That interior is a mix of conventional (a nice Cruze-like steering wheel with convenient audio and cruise controls, turn signal and wiper stalks, comfy seats and PRNDL shifter) and EV-tech. The iPod-like shiny plastic vertical console (which I think looks better in gray than in white) offers touch buttons for audio, climate and navigation, an electric park brake and propulsion system on/off. Fits and materials in the early cars we drove were quite good, with soft upper dash and door-panel pads and



to 15 miles. That will make them more like Volt for those first few miles, though their propulsion systems will still be very different.

As the former manager of vehicle test and development for GM Advanced Technology Vehicles – the dedicated team of engineering miracle workers who made that raindrop-shaped two-seat EV1 the most energy-efficient practical production vehicle ever to roll down the road) from 1991 to 2000 – I was skeptical at first. How well would this system work? Would GM have the commitment and resources to get it done? If so, could it be sold profitably at an affordable price ... and would people want to buy one?

HITTING THE ROAD

Now, four years down GM's long and (of late) incredibly torturous road, here it is, a very nice car that is surprisingly pleasant to drive. "I think we're at an inflection point in the history of our industry," said GM Product Development Vice Chairman Tom Stephens, who rose to that job when Lutz retired at the production Volt's October, 2010 media launch.

"The Chevrolet Volt is an electric vehicle that is capable of being your only car," added Marketing Director Tony Disalle. "You have the freedom to 'fuel up' at home, yet you're not tethered to a charge station. You can't always plan your day around charge opportunities."



nicely-grained plastic elsewhere. Only the contrasting "high-tech wallpaper" pattern on the doors struck a jarring note to my eyes.

A "coin stack" graph on the left of the instrument cluster indicates EV range, while a graphic rotating wheel on the right zips up and down to show power flow out of the battery and regeneration back to it. In between is a compass over a large digital speedo, plus readouts for trip miles, range (EV and gas), fuel used and average fuel economy. A knob

“GM CLAIMS A TOTAL RANGE OF ‘UP TO’ 350 MILES ON FULL BATTERY AND (9.3-GAL.) GAS TANK, AND THAT’S HOW WE STARTED OUR TEST DRIVE.”

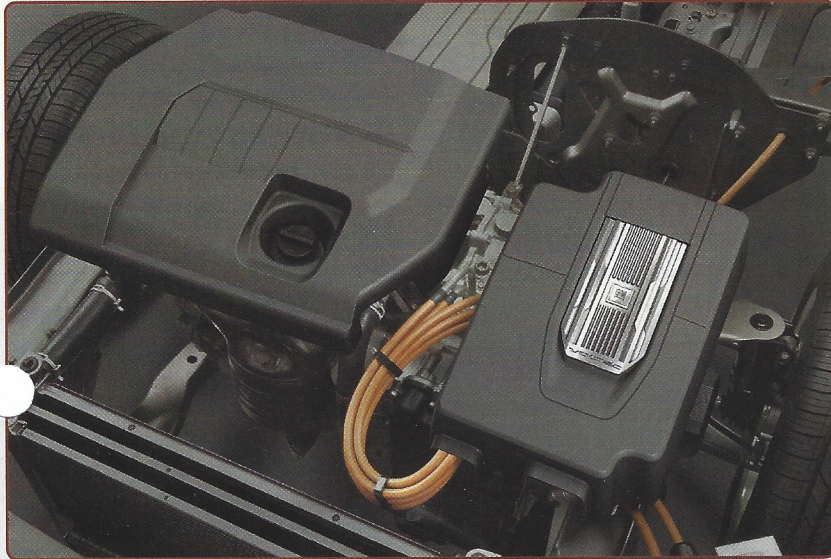
on the left rotates through displays for tire pressures, engine oil life, two trip odometers and a "Tutorial" mode.

THE VOLTEC SYSTEM

GM claims a total range of "up to" 350 miles on full battery and (9.3-gal.) gas tank, and that's how we started our

test drive. At 10.9 city/suburban miles, driving in "Normal" mode, we noted 38 miles EV range remaining for a projected total of 48.9. (The two other selectable modes are "Sport" and "Mountain" – the former trading some range for performance, the latter reserving some battery energy for long upgrades.) At 19 miles, we stopped at GM's Warren, Michigan, Technical Center for a tech briefing with 27 miles of EV range remaining – a projected total of 46 at that rate of usage.

The "Voltec" (formerly "E-Flex") propulsion system begins with a 111 kW (149-hp) electric drive motor that generates a healthy 273 lbs-ft of torque from zero rpm for strong launch response. There's no shifting or powertrain noise – just smooth, swift, silent acceleration. At higher cruise



speeds, the smaller 55 kW (73-hp) motor/generator joins in to keep the drive motor in its most efficient range for a 10- to 15-percent efficiency gain.

When the battery runs down, the 84-hp DOHC dual-variable-valve-timing (VVT) 1.4-liter engine fires up, almost undetectably, and operates in its most efficient speed range (2,200 to 4,200 rpm), driving the motor/generator to keep electricity flowing to the drive motor. At higher speeds with the battery depleted, both the motor/generator and the ICE assist the drive motor through the complex and clever planetary gearbox for best efficiency, though the engine can't power the car on its own. EV purists find this controversial, but if it increases efficiency, why not do it?

It may also be controversial that this little range-extender engine requires premium fuel. But Volt Powertrain Chief Engineer Pam Fletcher explains that high-octane gas adds five to 10 percent efficiency by enabling a higher compression ratio and more spark advance. Why not have it recharge the battery instead of providing just enough

juice to power the car? "It would be inefficient to charge the battery using gasoline," she says. "We don't want you to pull into your garage with a full battery ... that would defeat the purpose."

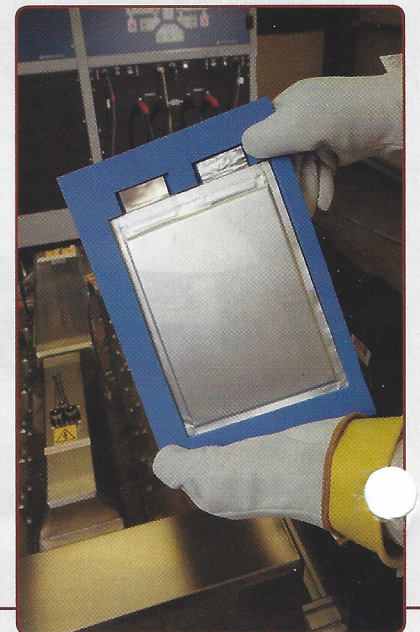
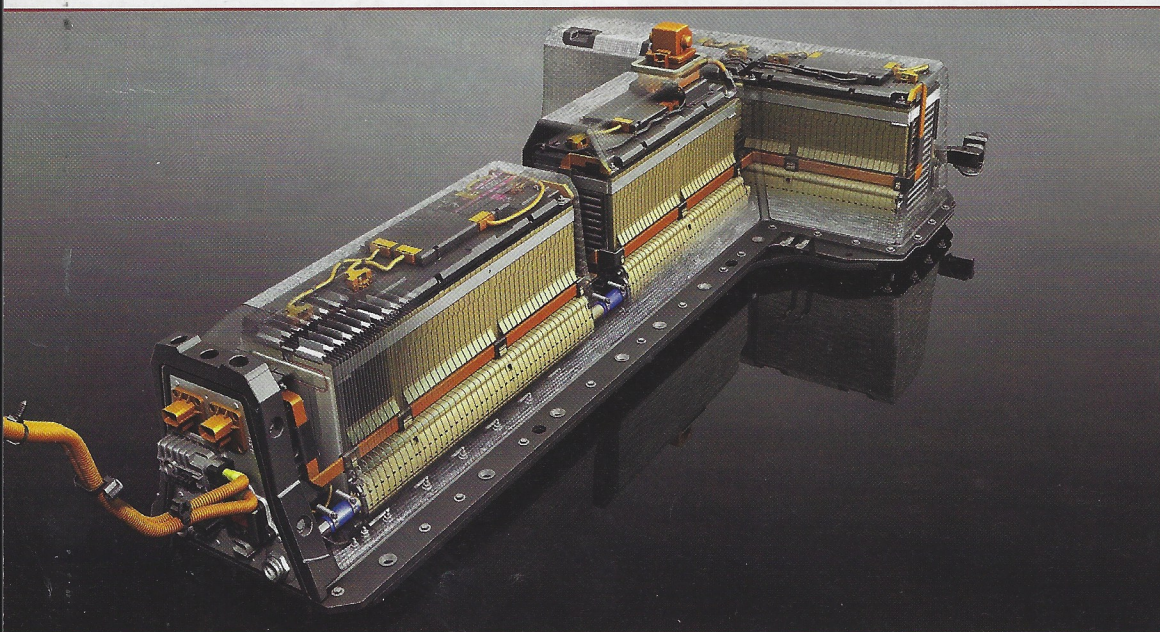
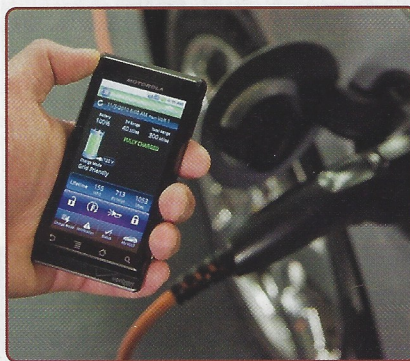
The 435-pound GM-engineered battery pack holds 16 kWh of energy in 288 liquid-cooled lithium-ion-phosphate/manganese cells. Every cell is precisely temperature controlled and micro-balanced by four individual controllers. While the original intent was to use just 50 percent of the pack's energy to extend its life and keep it far away from low and high state-of-charge (SOC) extremes, the engineers now have opened that window to 65 percent – hence the recently revised 25- to 50-mile (vs. the original 40) battery-only range claim. GM says the pack is designed to last 10 years in normal service and warrants it for eight years/100,000 miles. Full-recharge times are about four hours on 240-volt power, 10 to 12 hours on 120-volt house current.

RANGE AND EFFICIENCY

Following the briefing, we drove 16.8 city miles, some in Sport mode with the heater on, before changing drivers. With four miles of EV range remaining, our projected total had slid to (19 + 16.8 + 4 =) 39.8 miles, and the fuel-economy meter still said "250+" mpg – really infinity, since we had consumed no gas at all. Some eight miles later, we noticed that the range-extender engine had started and the gas range meter said 247 miles. Should you run the gas tank dry, by the way, the battery reserve provides about five more miles to find a station.

We arrived at a lunch stop at 34.1 miles (53.1 total) with 240 miles of gas range remaining. We had burned just 0.3 gallons of gas and achieved gas/

SMART PHONE Owners of smart phones can connect to their Volt to give them a whole new world of interactivity with their car. **BATTERIES** GM says the pack is designed to last 10 years in normal service and warrants it for eight years/100,000 miles. Rear seating is reduced to two due to the extra battery space required. **BATTERY CELL** GM-engineered battery pack consists of 288 liquid-cooled lithium-ion-phosphate/manganese cells like this one.



electric composite fuel economy of 112.7 mpg. After lunch (with no battery recharge), we drove 48.1 gas-only city/suburban miles, some of them aggressively, at a still-respectable 33.9 mpg. Our total trip, counting the first roughly 40 on electric, came in at a very impressive 81.5 mpg.

A few days later (during North American Car of the Year testing), I reset the B trip odometer and flogged a battery-depleted Volt hard in Sport mode on twisty back roads. I found it surprisingly quick, agile and fun to drive despite its low-rolling-resistance tires and 3,781-pound curb weight. I

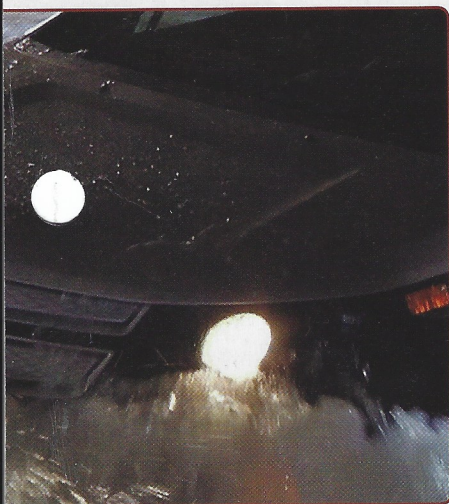
Well, there are a couple of big ones: the engine, the complex gearset and their sophisticated controls add a major cost increment over a battery-only electric; and limited availability of vehicle-size lithium-ion packs will limit Volt production for the first few years, at least ... just 10,000 units for the 2011 model year and maybe 50K the following year.

For \$41,000 (before a \$7,500 federal incentive and any available locally), the 2011 Chevy Volt comes in one well-equipped model with voice-recognition touch-screen navigation, six-speaker Bose audio with XM Satellite radio and five years of OnStar service. There are

14 years ago, it shares little with it except that many of the incredibly hard-working engineers who have made it happen were part of that original 1990s GM ATV team.

Is the extended-range EV the “car of the future?” No one knows. Like a conventional car, its range is unlimited. You can drive it every day on its battery alone and never burn a drop of fuel, then take it on a weekend trip or a long vacation. (You can’t do that with a “pure” BEV, at least not until fast-charge stations are as plentiful as gas stations.) Its fuel economy is essentially infinite until the engine starts, then still very high (composite gas/electric) for short trips,

“I RESET THE B TRIP ODOMETER AND FLOGGED A BATTERY-DEPLETED VOLT HARD IN SPORT MODE ON TWISTY BACK ROADS.”



averaged just 26.1 mpg on that hard drive, but the A trip meter (which factored in other testers’ earlier EV-only and gas-powered driving) said 54.2 mpg overall. Not bad!

CAR OF THE FUTURE?

So, as promised, the Volt is “pure” electric ... to a point. Then it’s a series hybrid ... except at higher cruise speeds, when it morphs temporarily into a uniquely-driven parallel hybrid. But if it enables owners who drive short distances most days to do it on fuel, yet provides fuel-efficient compact-car extended range when needed, what’s the downside?

two option packages: Premium Trim and Rear Camera with Park Assist. And, with a smart phone, you can even communicate with it remotely to check its state of charge, program its charge timing, lock or unlock its doors, and heat or cool its cabin while plugged into grid power.

Much more than a battery-only EV or a parallel hybrid, Chevy’s Volt is a potentially game-changing EREV that should enjoy a rosy future – IF (and it’s a big if) GM can get its cost down and volume up over the next few years. Given that its mission is very different and its engineering and componentry several generations removed from that brilliantly-engineered, but ill-fated, EV1 of

WATER TEST This pre-production Chevrolet Volt drives through a water trough to test reliability and durability. **CHARGING STATIONS** like this one can possibly become more frequented by owners of a Volt than a gas station.

diminishing to compact-car average on long ones. In those conditions, the best parallel hybrids are much more fuel efficient. But once Volt’s battery is recharged, they can’t compete.

In the long run, it offers another very viable choice that many will make despite its high price. Others, depending on their needs and priorities, will opt for parallel hybrids – or simpler, less expensive (but range-limited) battery electric vehicles – or much less expensive (for now) conventional internal combustion engine cars and trucks, which experts agree will continue to dominate the U.S. market for many years.

Meanwhile, Volt production and availability will increase over time, its price should eventually come down (some), and its Voltec technology will proliferate to other GM vehicles around the globe. All that is certain right now is that it will be a very interesting race to watch. **AE**