

# Electric Vehicle Basics

**Read this first if you are new to EVs like the Chevy Volt, Nissan Leaf, Tesla Model S, Ford C-Max Energi, BMW i3 ...**



**What is an electric vehicle?** An electric vehicle (EV) provides motion via an electric motor and an electric energy storage system like a battery, instead of an internal combustion engine and a gas tank.

**Why now?** Electric motors have been around for over a century, and indeed there were even some EVs a century ago. But now they can provide useful performance and reasonable convenience, because battery technologies have made huge improvements in recent years, driven by massive growth in portable consumer electronics (cell phones, cameras, laptops) -- big increases in battery power and capacity, with decreases in cost.

**Electric motors are fundamentally more efficient.** Electric motors are FAR more efficient at converting energy into motion than internal combustion engines (ICE) -- 95% thermodynamic efficiency compared to 15-20% for an ICE.

**Electric motors have full torque at zero RPM.** They don't have a *minimum* operating RPM (idle RPM) like ICE engines do. This ultimately means you don't need clutches or multiple gears -- no shifting! So there are less parasitic transmission losses, and there is no such thing as "idling".

**Even with a dirty coal power plant, an EV is cleaner than an ICE.** The most common misconception about EVs is that you are just transferring the point of emissions. But power plants are more efficient at converting fuel to power than a regular car's ICE could ever be -- 33-50% compared to 15-20%. The transmission efficiency of the electric grid is also around 95%. Look into "well to wheels efficiency" analyses. Further, EVs are the only cars that get *cleaner* over time as the power grid gets cleaner with newer technologies.

## **Battery technology:**

- Thermal Management System (TMS) matters!
- Tesla uses off the shelf 18650 cells, rigorous TMS
- big carmakers using prismatic (flat) cells, rigorous TMS (mostly), now achieving decade-plus lifetimes

**Public charging infrastructure:** (like gas stations, but for EVs) Started taking off in 2011; 20,000+ stations nationwide, with dozens more every week. All use the same J1772 connector, shown above. DC Fast Charging coming too. Note that public charging is largely irrelevant to plug-in hybrids like the Chevy Volt and Ford C-Max Energi.

**How to calculate efficiency?** Miles per gallon when no gallons? This is a complicated question, that requires that you look at how you drive your car -- how many miles per day on *average commuting* days? Those miles dominate typical car usage, and are virtually *free* when driving an EV.

**EV creates choice in how you power your car.** Right now you have no choice, it's oil or nothing. Electric power is cleaner, domestically produced, much cheaper than oil and will get cheaper and cleaner as more solar/wind capacity comes online.

**Plug-in hybrids like the Chevy Volt are transitional vehicles between an oil-based transportation sector and an electricity-based sector.** Being based on electricity gives us flexibility of energy sources. Current ICE cars can only be fueled by oil extracted from the ground; electricity can be generated from virtually any energy source.

**We are witnessing the beginning of another technology revolution.** This is like the 1993-1995 Internet wave -- EVs are disruptive technology. Think about the birth of digital photography in the late 90's -- who still uses film? CRT vs. LCD ...

Check out this URL, or Google for "top 11 electric car myths".

<http://www.plugincars.com/top-11-electric-car-myths-86131.html>

# Chevrolet Volt

## Items of interest for EV enthusiasts (i.e. those who already understand EVs in general)

38 miles nominal “All Electric Range” (AER); pure electric vehicle with full performance for first 38 miles. No gas is used for the first 38 miles every day – including at highway speeds.

Transition to gas engine generator is barely noticeable at first, although you can certainly hear it in stop and go traffic; pure EV experience is definitely more fun; gets 37 MPG in gas mode; 300+ mile range between gas station stops.

120V charge takes 10 hours using portable EVSE cordset that comes with car; car is compatible with any J1772 EVSE and can charge as fast as 3.5 hours at 240V (limited by Volt onboard 3.3 kW rectifier)

120V EVSE offers 8 Amp mode for circuits that are already carrying some load; 14 hour charge.

0-60 in 8.5 secs, feels faster due to electric torque; top speed limited to 101 MPH; agile due to low CG

Three techniques to deal with stale gas:

- premium gas required; higher octane goes stale slower (also better gas engine efficiency)
- fuel tank is pressurized
- after one year on same tank of gas, engine will run to burn up remaining gas, forcing you to replace it

Battery is Lithium Ion, 288 prismatic cells, 400 pound package in center of car; 16 kWh capacity of which 10.5 kWh is used (65%), to improve battery life; electrodes are manganese spinel, for durability.

Battery thermal management system (TMS) is quite complex, with both heating and cooling capability, multiple temperature thresholds. Design temperature range is -13 °F to 122 °F; beyond those extremes, the TMS will heat / cool the battery pack before operating. Note these are battery pack core temps, not ambient temps.

Battery has 8 year / 100,000 miles warranty; GM has said they engineered it to last 10-15 years.



Cold weather observations: AER is affected a bit – about 30 miles daily range in winter. Cabin heating is somewhat anemic. Heated car seats are fantastic. Remote start (cabin preconditioning) is addictive.

L mode on shifter adds more regen braking when lifting off accelerator – great for stop and go traffic.

Drive mode = Sport : changes “accelerator pedal mapping” and effectively makes the car much more fun to drive; however the default is off so most test drivers are not aware of how fun the car can be!

Drive mode = Mountain : intended for use on very long uphill grades (like 20 mile climbs!) when in gas mode; increases low SOC threshold from 20% to 40% (est.); commanded *before* you get to the climb, so that when you get there you have the battery to dip into.

Drive mode = Hold : “holds” the battery level, forcing the gas engine on early to preserve some battery for the end of a long gas drive. Useful for electric driving in city at end of long trip.

Options: OnStar includes smartphone remote monitoring and control; most buyers are opting for the leather seats which include seat heaters; nice stereo available, useful for such a quiet car!

Built in Detroit (Hamtramck plant); battery cells supplied by LG Chem (Michigan factory), packs assembled in USA by GM; gas engine built by GM in Flint, Michigan. Detroit factory can produce high volumes, 7,000 units on road by end of 2011, 20,000+ sold annually since then.

Marketed in Europe as Opel Ampera.  
Marketed in Australia as Holden Volt.

See [www.VoltStats.net](http://www.VoltStats.net) for cool usage data!

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**[www.FirstVoltInGeorgia.com](http://www.FirstVoltInGeorgia.com)**

(I don't work for GM – I'm just an EVangelist!)