Characterizing Energy Usage of Chevrolet Volt Versus

Speed

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Introduction

- Range is a key performance metric in EVs → Energy usage and battery capacity determine range.
- Various algorithms determine remaining range to inform consumer.
- Many factors affect energy usage of given vehicle.
 - Terrain
 - Temperature
 - Acceleration
 - Speed
- Specific energy usage over range of speeds has been determined for 2012 Chevrolet Volt.



Volt Specifications



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Powertrain

Traction Motor – 111 kW (149 hp)

- Torque of 370 Nm (273 lb-ft)
- Induction motor
- "Generator" 55 kW
 - Permanent Magnet machine
- ICE 63 kW (84 hp)



Battery Pack

• 16 kWh Capacity (10.4 kWh useable)

- Typically discharges to 20% SOC
- Typically charges to 84.71% SOC
- Total Range of ~ 65%
 - (3.2 kWh 13.6 kWh)
- Lithium manganese spinel chemistry (LG Chem)
- Battery pack consists of 288 Cells (3 parallel sets of 96)
- "Fully" Charged Voltage ~386
- 197 kg (435 lb)



Variability in Energy Usage



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Instantaneous Power



Instantaneous Power at various Speeds



Cumulative Energy Use [kWh]



Experimental Design

- Large quantity of data available through OBD2 (battery voltage, SOC, motor currents, motor RPMs, motor voltages, etc).
- Individual trips were logged at sample rate of ~1kHz with speed kept constant.
- Test segment was 3.48 mile stretch of road with low elevation change.
- Compromise between low elevation change, reasonable access to charging station, and capability to travel at wide range of speeds.
- Energy efficiency measured for repeated trips in both directions to reduce elevation effect.
- Energy usage calculated based on instantaneous power measurements.

Elevation profile of tested road segment



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Results: Average Power [kW]



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Results: Energy Use [Wh / mile]



Results: Energy Use [Wh / mile]

- Minimum energy usage of 169 Wh/mile at 30 mph
- Maximum energy usage of 369 Wh/mile at 75 mph
- 65 mph to 60 mph reduces energy consumption by ~8%
- 65 mph to 70 mph increases energy consumption by ~7%
- 65 mph to 75 mph increases energy consumption by ~22%



Results: Efficiency [miles / kWh]



Results: Efficiency [miles / kWh]

- Minimum efficiency of 2.71 miles/kWh at 75 mph
- Maximum efficiency of 5.98 miles/kWh at 30 mph
- Typical range of 35 40 miles would be seen for a constant speed trip of ~ 55mph



Conclusions

- Energy efficiency is a key performance factor in EVs and major contributor to accurate range calculations
- For 2012 Chevy Volt, energy usage on flat terrain ranges from 169 Wh/mile at 30 mph to 369 Wh/mile at 75 mph
- Energy usage equates to total range expectations from 28 miles to 61 miles, depending on speed travelled (demanding terrain would decrease range)