Outline

- Overview of INL and The EV Project
- Purpose of the paper
- Results: Chevrolet Volt driving and charging behavior from October 2011 to October 2012
Idaho National Laboratory (INL)

- Eastern Idaho based U.S. Department of Energy Federal laboratory
- 890 square mile site with 3,600 staff
- Support DOE’s strategic goal:
  - Increase U.S. energy security and reduce the nation’s dependence on foreign oil
- Multi-program DOE laboratory
  - Nuclear Energy
  - Fossil, Biomass, Wind, Geothermal and Hydropower Energy
  - Advanced Vehicles and Battery Development
  - Energy Critical Infrastructure Protection
The world’s largest EV infrastructure deployment project

Objectives:

- Build mature EV charging infrastructure in 16 US regions
- Study
  - Infrastructure deployment process
  - Customer driving and charging behavior
  - Impact on electric grid
- Create a learning laboratory to understand the infrastructure deployment requirements for the first 1 million grid-connected electric drive vehicles
The EV Project

- Deploy >13,000 residential and public Blink brand EVSE units
- Enroll >8,000 privately owned Nissan LEAF battery electric vehicles and Chevrolet Volt extended range electric vehicles
- Deployment from Oct 2010 – Dec 2013
- INL data collection phase from Jan 2011 – Dec 2013
The EV Project Locations

Nissan Leafs and Chevrolet Volts Reporting Data in The EV Project
Project to Date through December 2012

Legend
- Project Regions

- Washington State: 893 Leafs, 98 Volts
- Oregon: 549 Leafs, 94 Volts, 30 Smart Electric Drives
- San Francisco: 1730 Leafs
- Los Angeles: 497 Leafs, 165 Volts
- Phoenix: 285 Leafs, 92 Volts
- Dallas/FW: 18 Leafs, 146 Volts
- Nashville: 605 Leafs, 40 Volts
- Memphis: 54 Leafs, 22 Volts
- Knoxville: 93 Leafs, 24 Volts
- Chattanooga: 61 Leafs, 11 Volts
- Chicago: 29 Leafs, 47 Volts
- Philadelphia: 23 Leafs, 27 Volts
- DC: 38 Leafs, 198 Volts
- Atlanta: 120 Leafs, 28 Volts
- San Diego: 711 Leafs, 176 Volts, 300 Smart Electric Drives
- Tucson: 86 Leafs, 7 Volts
- Houston: 5 Leafs, 74 Volts

Idaho National Laboratory
2/0/2013
INL/MIS-12-26075
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The purpose of this paper is to identify the potential for Chevrolet Volts enrolled in The EV Project to drive in EV-only mode, based on driver behavior and the available charging infrastructure.

This paper also presents distributions of driving and charging behavior to expand on averages previously reported.
Results

- Metrics and distributions to quantify driving and charging behavior were calculated from in-use electronic data logged by:
  - 923 Chevrolet Volts
  - From October 2011 to October 2012
- Vehicles privately owned and operated
- Located in all project regions
- Logged
  - 4,757,672 miles
  - 579,828 trips
  - 170,311 charging events
• Distribution of Trip Distance

- Mean: 8.2
- Median: 4.3
- Max: 382.8
53% of vehicles averaged 40 mi per day or less

62% of vehicle driving days had 40 mi or less
Distributions of maximum, 95th percentile, and median distance per day driven

- 23% of vehicles never drove more than 100 mi in one day

- 35% of vehicles had a 95th percentile driving day over 100 mi, meaning they drove >100 mi on 5% or more of their driving days
80% of vehicles averaged > 1.0 charging events per day driven

62% of vehicle driving days had 0 or 1 charging event
• Distribution of charging events per vehicle day for vehicles with different average charging frequency
• Distribution of vehicle average “driving segment” distance driven between charging events

- 81% of vehicles averaged 40 mi or less between consecutive charging events

• Distribution of “driving segment” distance between charging events

- 82% of vehicle driving days had less than 40 mi between charging events
Miles per Charge Yields Percent of EV Miles

- Miles-weighted distribution of driving segment distance between charging events

- Potential for up to 73% of miles in EV mode
Charging Completeness

- Distribution of battery pack SOC at the start of charging by charging location
- Distribution of battery pack SOC at the end of charging by charging location
Conclusion

- Percentage of EV mode driving determined by total distance driven beyond vehicle’s all-electric range

- 35 miles of each segment would be driven in EV mode if:
  - All charging events end with a full battery
  - Vehicle’s EV mode range is exactly 35 miles

- Resulting in estimated EV mode operation for 73% of all miles driven in data set

- Of course EV mode operation varies based on
  - Charging duration, power level, battery state of charge at beginning of charge, driving style, conditions, etc.
Acknowledgements

This work is funded in part by the US Department of Energy’s Vehicle Technologies Program

For more results from The EV Project:

www.theevproject.com
avt.inl.gov/evproject.shtml
Influences on Behavior

- Early adopters, early market
- Limited public charging opportunities
- Drivers new to Chevrolet Volt, probably new to electric vehicles

Distribution of vehicle miles-in-service