Battery Electric Vehicle Driving and Charging Behavior Observed Early in The EV Project

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2012-01-0199

Outline

- Overview of the EV Project
  - Project objectives
  - Product specs
  - Current status
- Purpose of the paper
- Results: Nissan LEAF driving and charging behavior in 2011

The EV Project

World's largest EV infrastructure deployment project

- Build mature EV charging infrastructure in 14 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 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

Project Partners

Sponsor

U.S. DEPARTMENT OF ENERGY

Primary Partners

ECOtality North America

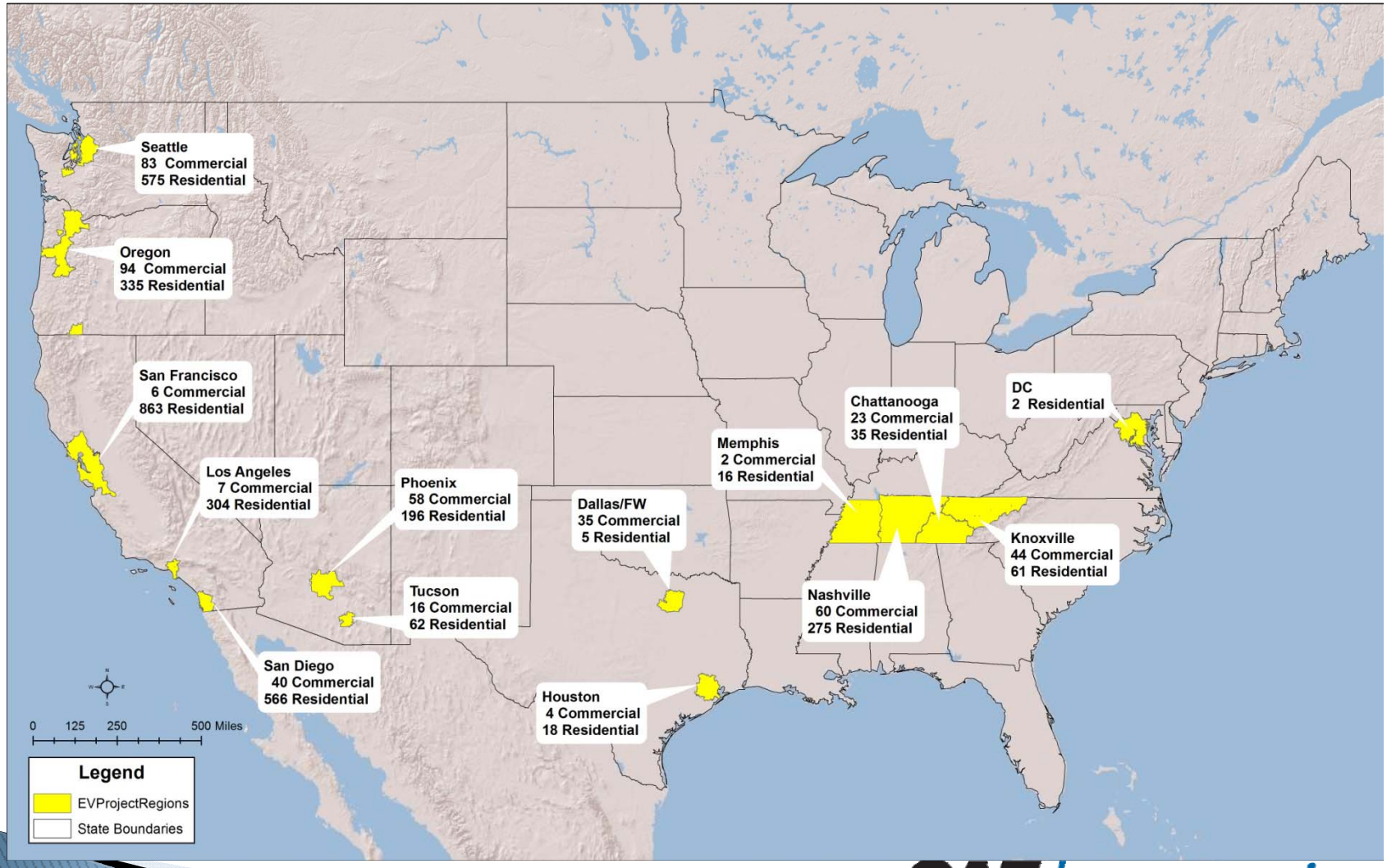
Nissan North America

Chevrolet

Idaho National Laboratory

The EV Project Locations

Blink AC Level 2 EVSE Enrolled in The EV Project through December 2011



Nissan LEAF™ Specs

- Battery electric vehicle
- 24 kWh Li-ion battery pack
- AC level 2 (3.3 kW) charge rate via J1772 connector
- DC level 2 (50 kW) charge rate via CHAdeMO connector
- Navigation screen interface and website for charge start/end scheduling
- Data acquisition via vehicle telematics

Chevrolet Volt Specs

- All-electric capable EREV
- 16 kWh Li-ion battery pack
- AC level 2 (3.3 kW) charge rate via J1772 connector
- Navigation screen interface, website, and smart phone app for charge start/end scheduling
- Data acquisition via vehicle telematics

Blink EVSE Specs

AC level 2 residential and commercial EVSE

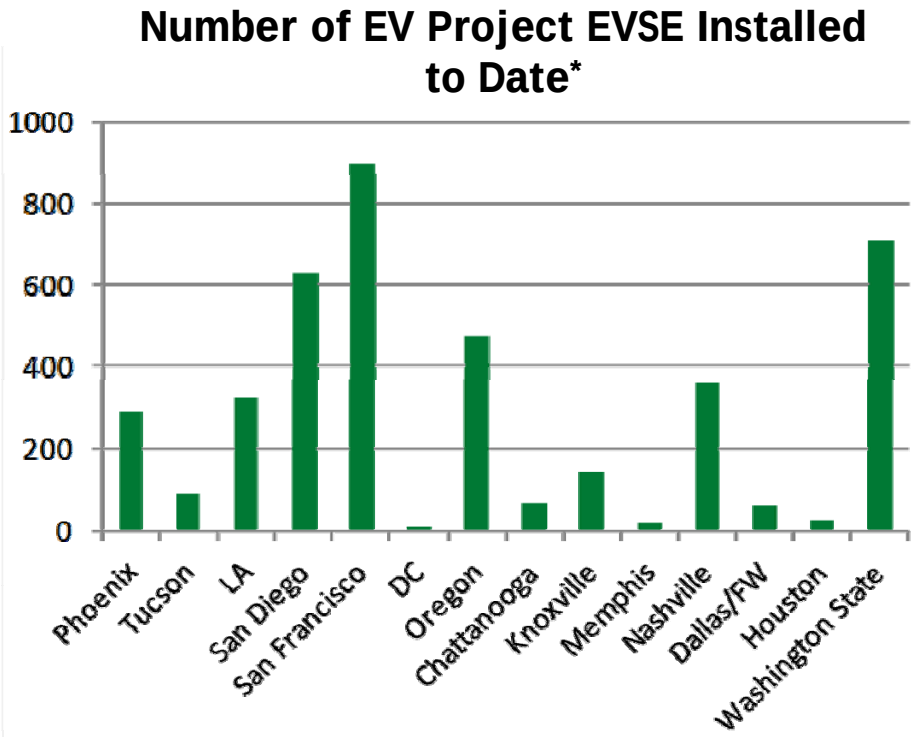
- 240 VAC single phase, 7.2 kW
- Single J1772 connector per EVSE
- Networked with data collection
- Touch screen and website charge scheduling
- RFID authentication

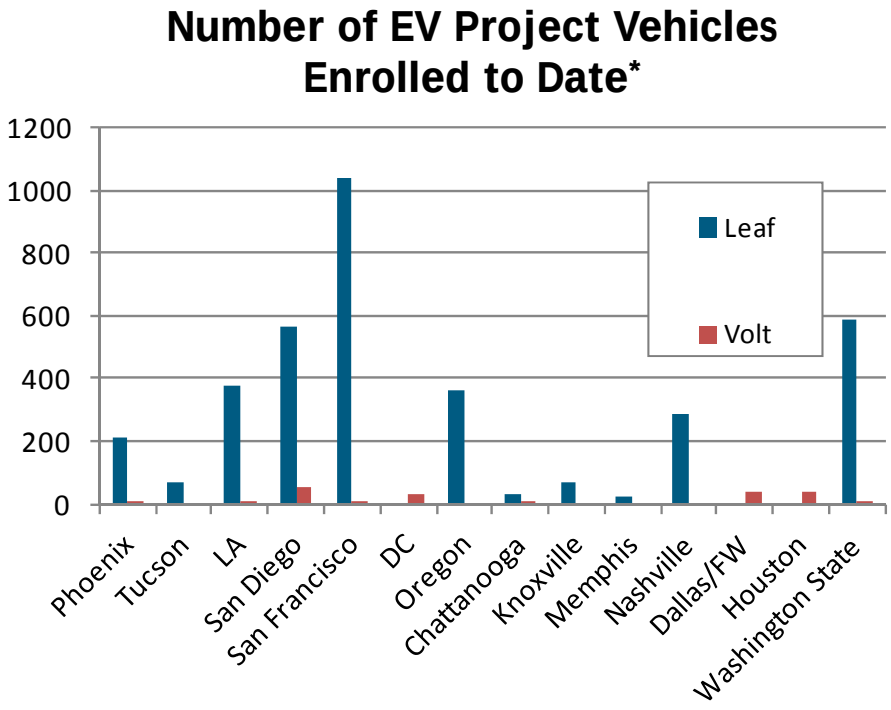
DC level 2 commercial fast charger

- 480 VAC 3 phase, 60 kW
- Two CHAdeMo connectors per charger
- Networked with data collection
- Touch screen user interface, RFID authentication

Deployment at End of 2011

- 3,785 EVSE (467 publically available)*
- 3,629 LEAFs, 218 Volts *





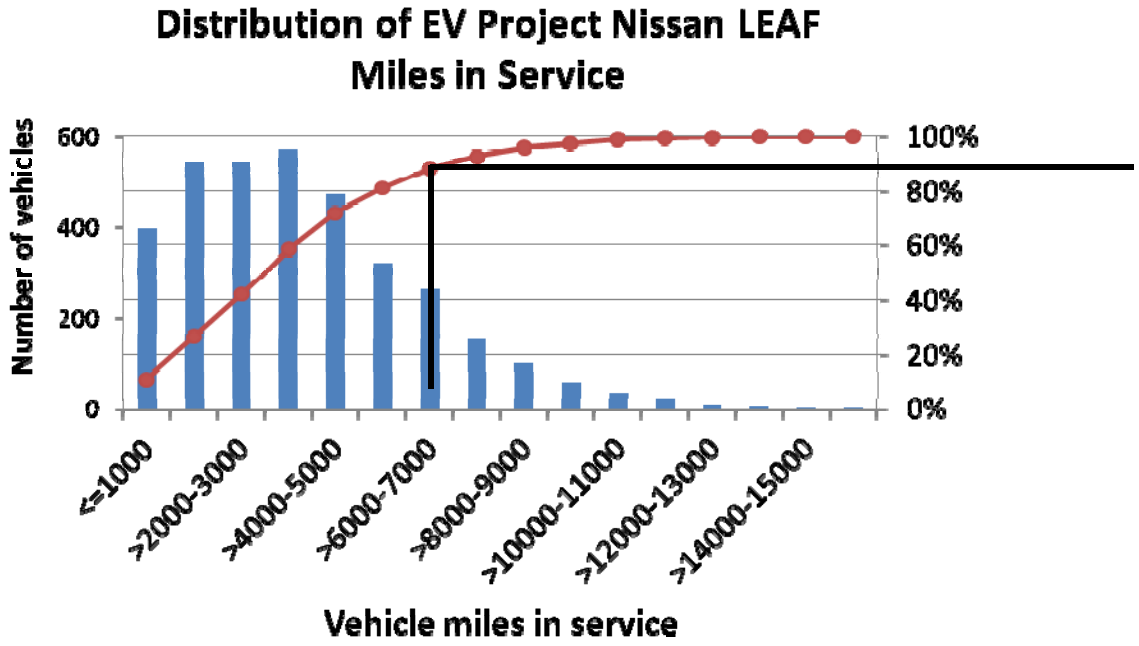
* Varies from manuscript due to refinement of reporting criteria

Purpose of Paper

- Paper describes early **driving and charging behavior** of EV Project **Nissan LEAF** drivers
- Serves as baseline for comparison to behavior observed later in the project as driver habits and charging infrastructure mature
- Future works will evaluate of charging infrastructure placement and impact of vehicle charging on the electric grid

Influences on Behavior

- Early adopters, early market
- Limited public charging opportunities
- Drivers new to Nissan LEAF, new to electric vehicles



90% of vehicles had driven 7,000 miles or less by end of 2011

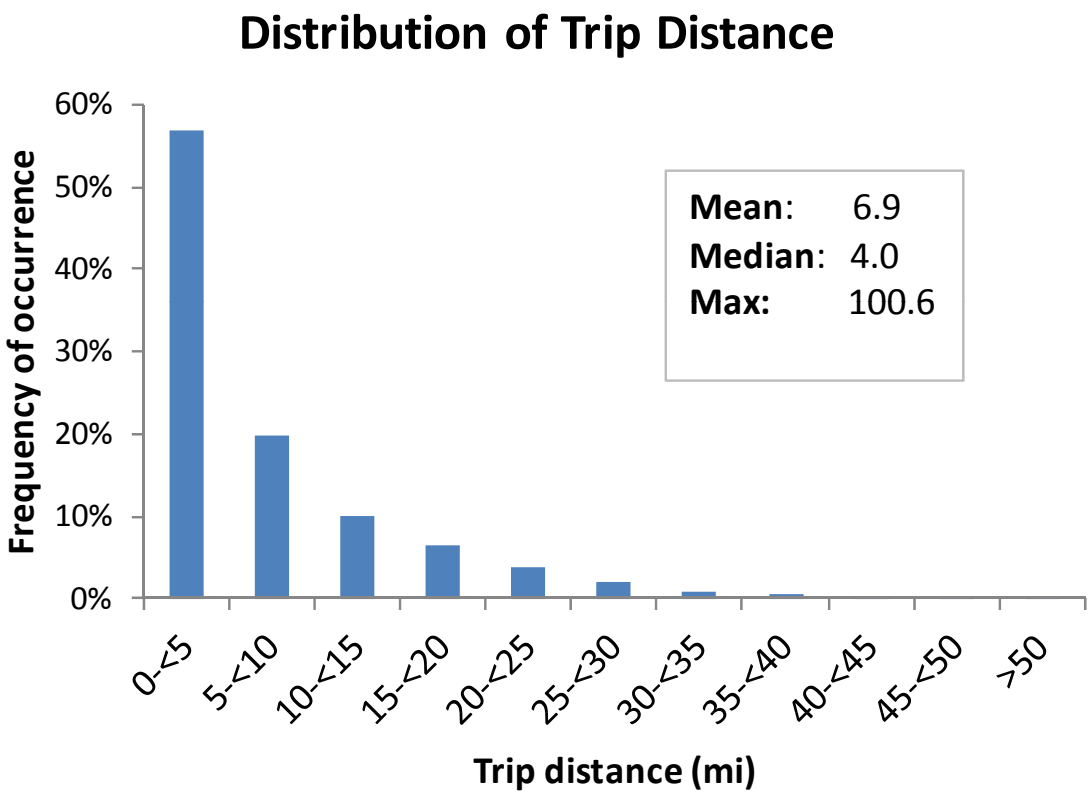
Median: 3,472 mi
Max: 23,298

The EV Project 2011 Results

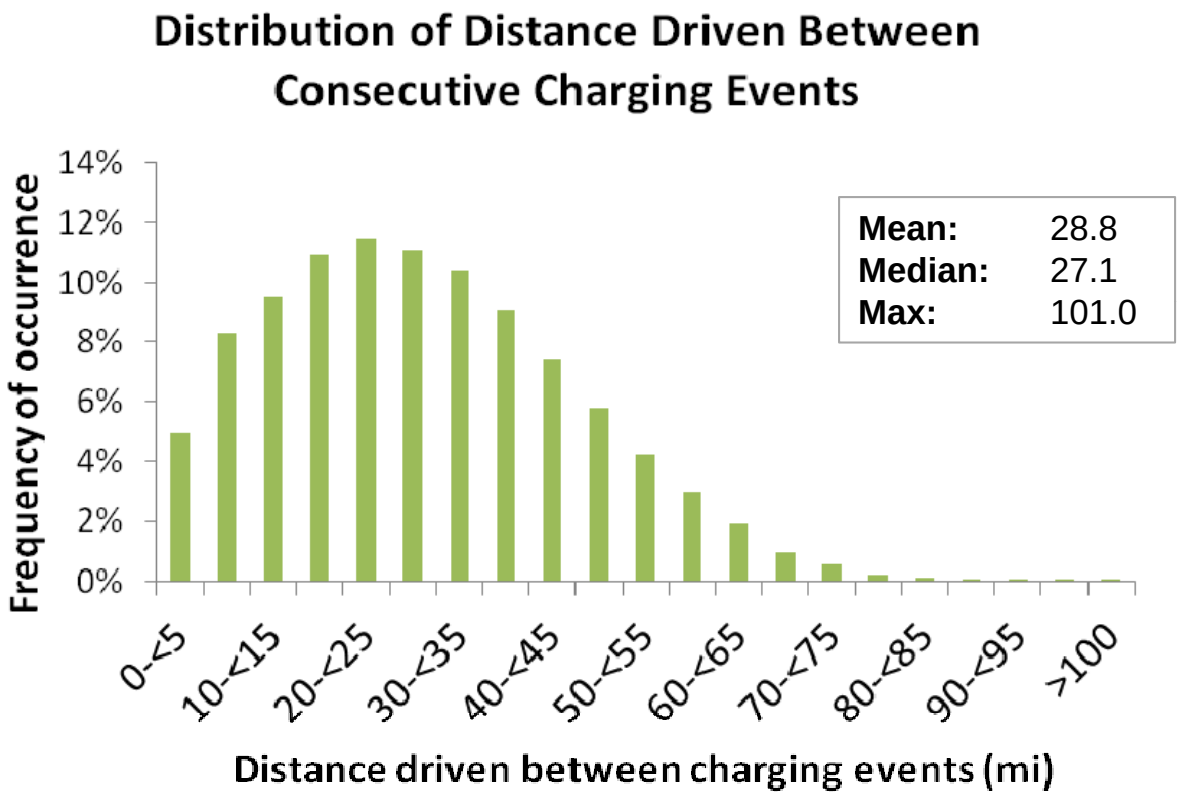
Nissan LEAF Driving Statistics

Number of vehicles with matching residential EVSE	2,903
Number of trips	1,454,220
Total distance driven (mi)	10,000,316
Mean / median trip distance (mi)	6.9 / 4.0
Mean / median distance driven per vehicle day driven (mi)	30.3 / 26.8
Mean / median number of trips between charging events	4.2 / 3.0
Mean /distance driven between charging events (mi)	28.8 / 27.1

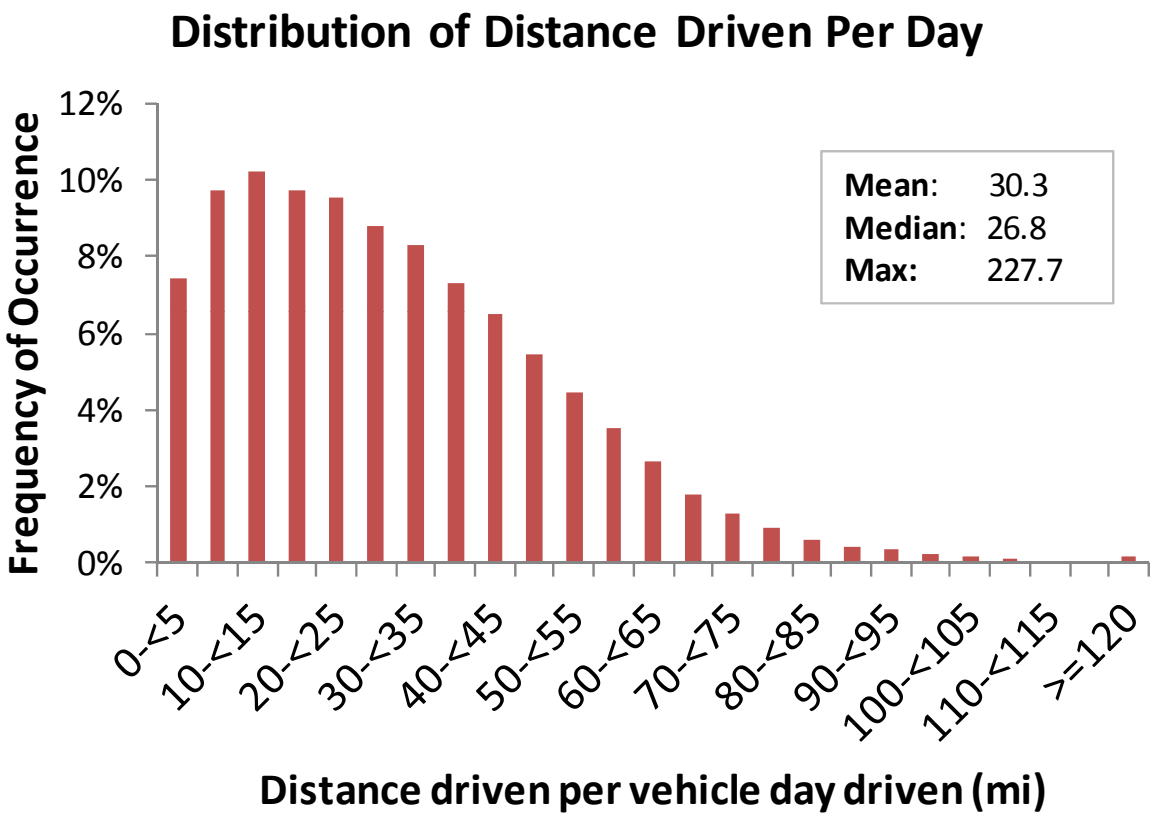
Trip Distance



Driving between charging events



Distance driven per day

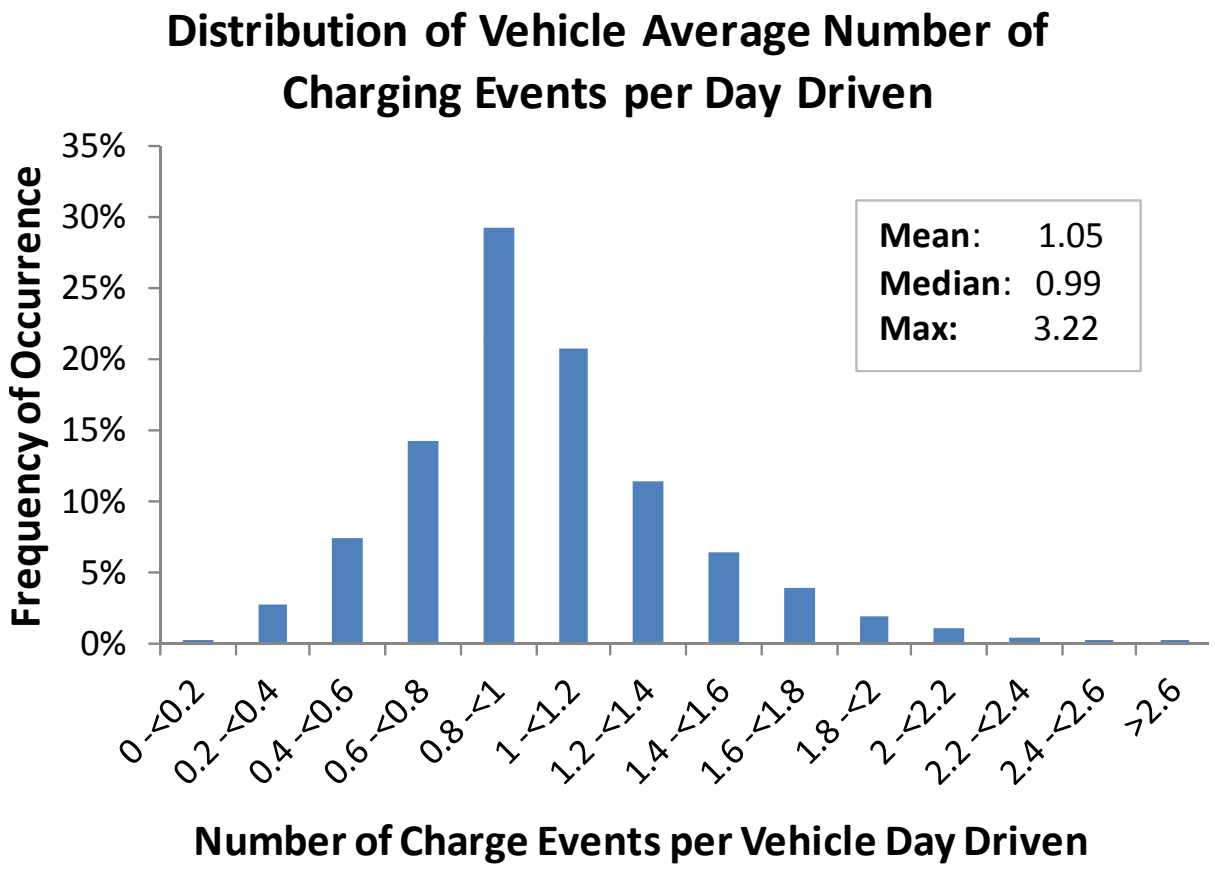


The EV Project Q4 2011 Results

- Nissan LEAF Charging Statistics

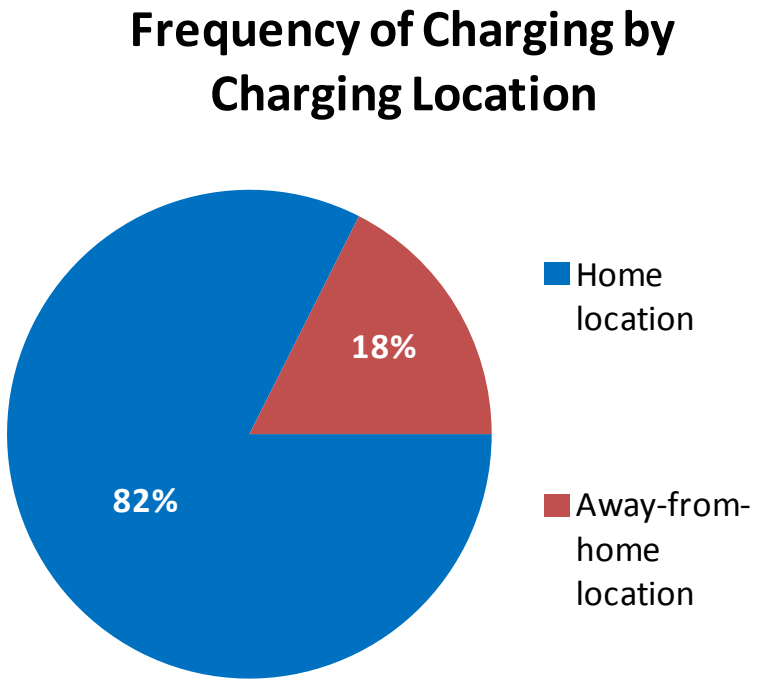
Total number of charging events	347,222
Mean / median number of charging events per vehicle day driven	1.05 / 0.99

Charging Events per Day



The EV Project 2011 Results

- Nissan LEAF Charging Location

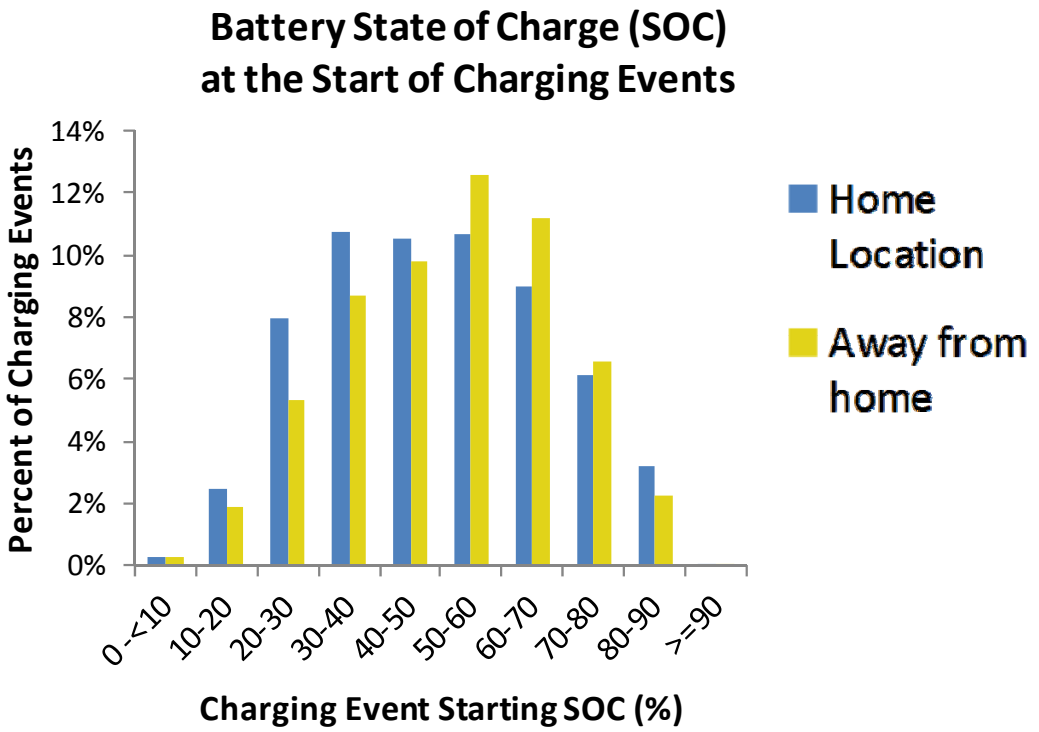


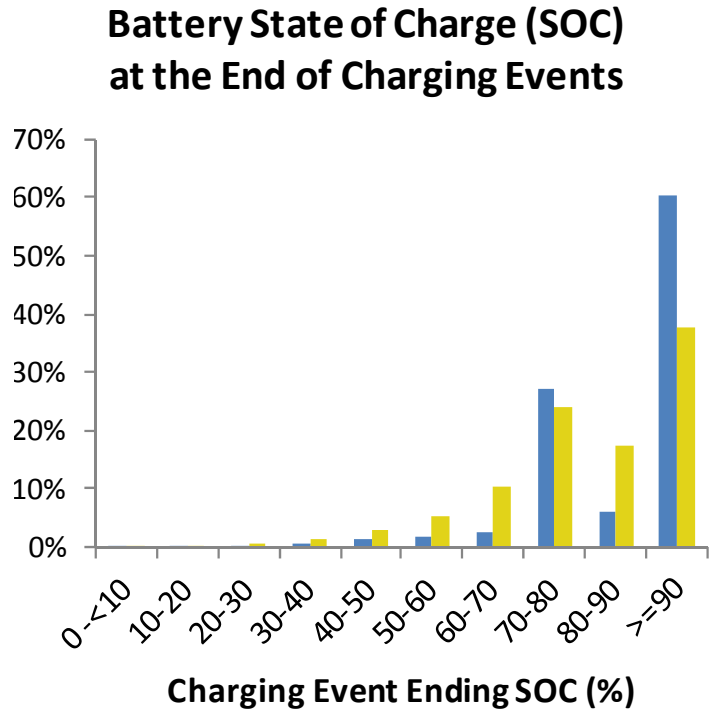
The EV Project 2011 Results

- >70% of vehicles charged at least once away from home
- Most of those vehicles charged at 5 or more distinct locations, such as:
  - Shopping centers
  - Health clubs and spas
  - Bars and restaurants
  - Office buildings
  - Other homes
- Small number of vehicles charged exclusively away from home
- Mix of locations was similar for vehicle with high and low charging frequency

The EV Project 2011 Results

- Nissan LEAF Charging Completeness





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Conclusions

- On average, LEAFs charged frequently with respect to time and range
  - ~1 charge per day
  - ~30 miles between charging events
  - charging started with 20 – 80% SOC in pack
- Most charging done at home but away-from-home charging was explored
- Averages are not enough -- distributions show wide variety of charging and driving behavior from vehicle to vehicle

Remember…

- Vehicle drivers were early in ownership experience
- Limited public charging opportunities in 2011

Additional Information

Quarterly and project-to-date reports and other information available at AVTA website:

http://avt.inl.gov/evproject.shtml

Acknowledgements

This work is supported by the U.S. Department of Energy's EERE Vehicle Technologies Program

INL/CON-10-18967

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