U.S. Department of Energy’s Vehicle Technologies Program

White House, DOE, DOT, SAE - Vehicle Data Jam

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Vehicle Data Jam
Detroit, Michigan
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This presentation does not contain any proprietary or sensitive information
Idaho National Laboratory

- U.S. Department of Energy (DOE) laboratory
- 890 square mile site with 4,000 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
  - Homeland Security and Cyber Security
AVTA Participants

- DOE’s Advanced Vehicle Testing Activity (AVTA), part of the Vehicle Technologies Program (VTP) conducts field-, test track-, and laboratory-based testing of light-duty vehicle systems and subsystems
  - Idaho National Laboratory manages the AVTA for VTP
  - ECOtality provides testing support via a competitively bid NETL (National Energy Testing Laboratory) contract
- For the EV Project, ECOtality is the project lead and INL provides data collection, analysis and dissemination support
- Test partners include electric utilities, Federal, state and local government agencies, private companies, and individual vehicle owners
AVTA Goals

• The AVTA goals
  – Petroleum reduction and energy security
  – Benchmark technologies that are developed via DOE research investments

• Provide benchmark data to DOE, National Laboratories (ANL, NREL, ORNL, PNNL), Federal Agencies (DOD, DOI, DOT, EPA, USPS), technology modelers, R&D programs, vehicle manufacturers (via USCAR’s VSATT, EESTT, GITT), and target and goal setters

• Assist fleet managers, via Clean Cities, FEMP and industry gatherings, in making informed vehicle and infrastructure deployment and operating decisions
Vehicle / Infrastructure Testing Experience

- 93 million test miles accumulated on 12,202 electric drive vehicles representing 119 models. 1 million miles / week
- EV Project: 8,715 Leafs, Volts and Smart EVs, 11,208 EVSE and DC Fast Chargers (DCFC), 74 million test miles
- ChargePoint: 3,908 EVSE reporting 761,000 charge events
- PHEVs: 15 models, 434 PHEVs, 4 million test miles
- EREVs: 2 model, 156 EREVs, 2 million test miles
- HEVs: 24 models, 58 HEVs, 6.4 million test miles
- Micro hybrid (stop/start) vehicles: 3 models, 7 MHVs, 608,000 test miles
- NEVs: 24 models, 372 NEVs, 200,000 test miles
- BEVs: 48 models, 2,000 BEVs, 5 million test miles
- UEVs: 3 models, 460 UEVs, 1 million test miles
- Other testing includes hydrogen ICE vehicle and infrastructure testing
INL Vehicle/EVSE Data Management Process

- **Process Driven by Disclosure Agreements**
- **Data quality reports**
- **INL Vehicle Data Management System**
  - **File server**
  - **SQL Server data warehouse**
  - **Report generator**

- **HICEVs**
- **HEVs**
- **PHEVs**
- **BEVs & EREVs**
- **EVSE & Chargers**

- **Individual vehicle reports**
- **Fleet summary Reports - Public**
- **Focused technical analyses and custom reports**
- **Modeling and simulation input**

- Parameters range check
- Lame data check
- Missing/empty parameter check
- Conservation of energy check
- SOC continuity

- **BEVs & EREVs Reports - Public**
  - Focused technical analyses and custom reports
Data Collection, Security and Protection

- All vehicle, EVSE, and PII raw data is legally protected by NDAs (Non Disclosure Agreements) or CRADAs (Cooperative Research and Development Agreements)
  - Limitations on how proprietary and personally identifiable information can be stored and distributed
  - Raw data, in both electronic and printed formats, is not shared with DOE in order to avoid exposure to FOIA
  - Vehicle and EVSE data collection would not occur unless testing partners trust INL would strictly adhere to NDAs and CRADAs
  - Raw data cannot be legally distributed by INL
• **Goal:** Build and study mature charging infrastructures and take the lessons learned to support the future streamlined deployment of grid-connected electric drive vehicles

• ECOtality is the EV Project lead, with INL, Nissan and Onstar/GM as the prime partners, with more than 40 other partners such as electric utilities

• 40 different EV Project reports are generated quarterly for the general public, DOE, ECOtality, project participants, industry, regulatory organizations, as well as per special requests
EVSE Data Parameters Collected per Charge Event – EV Project & ChargePoint

- Data from ECOtality’s Blink & other EVSE networks
- Connect and Disconnect Times
- Start and End Charge Times
- Maximum Instantaneous Peak Power
- Average Power
- Total energy (kWh) per charging event
- Rolling 15 Minute Average Peak Power
- Date/Time Stamp
- Unique ID for Charging Event
- Unique ID Identifying the EVSE
- And other non-dynamic EVSE information (GPS, ID, type, contact info, etc.)
EV Project – Vehicle Data Parameters Collected per Start/Stop Event

- Data is received via telematics providers from Chevrolet Volts and Nissan Leafs
- **Odometer**
- **Battery state of charge**
- **Date/Time Stamp**
- **Vehicle ID**
- **Event type (key on / key off)**
- **GPS (longitude and latitude)**
- Recorded for each key-on and key-off event

- Additional data is received monthly from Car2go for the Smart EVs
EV Project Data Complexity

• The EV Project has 44 Databases (DB)
  – Nissan Leaf & GM/OnStar Volt
  – ECOTality Blink, Aerovironment & EPRI EVSE
  – Admin (look up tables, territories, zips codes, QA parameters, etc.)
  • Each of the above six DBs has three versions (process, stage & production) = 18 DBs
  – Four GIS DBs for the Leafs, Volts, Blink EVSEs, and Base (streets, utility service territory areas, etc.)
  – Above 22 (18 + 4) DBs exist on two systems = 44 DBs

• Hundreds of algorithms and thousands of lines of code are required to generate 56,000 data parameters for populating 132 pages of public quarterly reports
• INL must blend multiple data streams, from multiple sources, all on different delivery schedules
• This is not a flat file, spreadsheet experience and this is NOT a simple task
EV Project Vehicles / Miles, 3/17/13

• 8,715 vehicles reporting data
  – 6,329 Leaf. 73%
  – 1,255 Volts. 24%
  – 330 Smart EVs. 4%

• 73.8 million total miles
  – Leaf. 81%
  – Volts 18%
  – Smart EVs 2%

• 173,000 test miles per day = 1 million miles every 5.8 days
EV Project EVSE Deployed / Use, 3/17/13

- **11,208 total EVSE**
  - 8,083 (72%) Residential EVSE
  - 3,049 (27%) non-residential EVSE
  - 76 (1%) DCFC

- **2.2 million charge events**
  - 2,025,000 (91%) Residential EVSE
  - 173,000 (8%) non-residential EVSE
  - 20,000 (1%) DCFC
# EV Project – National Data

**4th quarter 2012 Data Only**

<table>
<thead>
<tr>
<th></th>
<th>Leafs</th>
<th>Volts</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of vehicles</td>
<td>3,762</td>
<td>1,021</td>
</tr>
<tr>
<td>Number of Trips</td>
<td>969,853</td>
<td>369,118</td>
</tr>
<tr>
<td>Distance (million miles)</td>
<td>6.7</td>
<td>3.0</td>
</tr>
<tr>
<td>Average (Ave) trip distance</td>
<td>6.9 mi</td>
<td>8.1 mi</td>
</tr>
<tr>
<td>Ave distance per day</td>
<td>29.2 mi</td>
<td>40.5 mi</td>
</tr>
<tr>
<td>Ave number (#) trips between charging events</td>
<td>3.8</td>
<td>3.5</td>
</tr>
<tr>
<td>Ave distance between charging events</td>
<td>26.3 mi</td>
<td>28.2 mi</td>
</tr>
<tr>
<td>Ave # charging events per day</td>
<td>1.1</td>
<td>1.4</td>
</tr>
</tbody>
</table>

* Note that per day data is only for days a vehicle is driven
### EV Project – EVSE Infra. Summary Report

**4th quarter 2012**

<table>
<thead>
<tr>
<th>Description</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ave hours V connected R2 WD</td>
<td>12.1 hours</td>
</tr>
<tr>
<td>Ave hours V connected R2 WE</td>
<td>12.2 hours</td>
</tr>
<tr>
<td>Ave hours V drawing power R2 WD</td>
<td>2.4 hours</td>
</tr>
<tr>
<td>Ave hours V drawing power R2 WE</td>
<td>2.1 hours</td>
</tr>
<tr>
<td>Ave AC kWh/charge event R2 WD</td>
<td>8.6 AC kWh</td>
</tr>
<tr>
<td>Ave AC kWh/charge event R2 WE</td>
<td>7.4 AC kWh</td>
</tr>
<tr>
<td>Ave hours V connected P2 WD</td>
<td>5.9 hours</td>
</tr>
<tr>
<td>Ave hours V connected P2 WE</td>
<td>4.1 hours</td>
</tr>
<tr>
<td>Ave hours V drawing power P2 WD</td>
<td>2.5 hours</td>
</tr>
<tr>
<td>Ave hours V drawing power P2 WE</td>
<td>2.5 hours</td>
</tr>
<tr>
<td>Ave AC kWh/charge event P2 WD</td>
<td>8.4 AC kWh</td>
</tr>
<tr>
<td>Ave AC kWh/charge event P2 WE</td>
<td>6.4 AC kWh</td>
</tr>
</tbody>
</table>

- **R:** residential, **P:** public, **WD:** weekday, **WE:** weekend, **2:** Level 2 EVSE, and **V:** vehicle
EV Project – EVSE Infra. Summary Report

• National Residential and Public Level 2 Weekday EVSE 4th Quarter 2012

• Residential and public connect time and energy use are fairly opposite profiles. Note different scales

National Residential Connect Time

National Residential Demand

National Public Connect Time

National Public Demand
EV Project – EVSE Infra. Summary Report

- Residential Level 2 Weekday EVSE 4th Quarter 2012
- San Diego and San Francisco, with residential L2 TOU rates, are similar to national and other regional EVSE connect profiles

San Diego

Los Angeles

San Francisco

Washington State
EV Project – EVSE Infra. Summary Report

• Residential Level 2 Weekday EVSE 4th Quarter 2012
• TOU kWh rates in San Diego and San Francisco clearly impact when vehicle charging start times are set

San Diego

Los Angeles

San Francisco

Washington State
ChargePoint America ARRA Project

- Conducted by Coulomb
- Project to Dec. 2012
- 3,908 EVSE installed and reporting data
  - 1,763 Residential
  - 193 Private / commercial
  - 1,940 Public
  - 12 unknown
- 760,995 charge events
- 5,359 AC MWh
ChargePoint America ARRA Project

- Oct - Dec 2012 data
- 3,541 units
- Percent time vehicle connected
  - Residential 47%
  - Private/com 24%
  - Public 9%
- Percent time drawing power
  - Residential 9%
  - Private/com 5%
  - Public 4%
- EVSE data only

- Public is open access. Commercial are limited access
- Public and commercial reflect at work charging
- Residential reflects end of day return-to-home charging
- Note difference in scales
Summary

• Combined, largest infrastructure and plug-in electric vehicle research in the world with 24,000 data sources

• The data allows researchers to understand both how vehicles are operated and charged
  – Supports studies to understand where future infrastructure should be placed
  – Where infrastructure is and is not used
  – How operators drive different technologies
  – Impacts from public infrastructure revenue models
  – Identify opportunities to incorporate smart charging
  – Identify grip impacts and demand costs
  – Problems with vehicles and infrastructure that both meet the same SAE standard

• There are many legal, PII, proprietary, and investment constraints that restrict the use of vehicle and charging infrastructure data
ChargePoint: The Leader

- 70%+ of the public charging station market
- 1,700+ companies providing charging via ChargePoint
- 11,000+ charging spots
- 937+ Megawatt hours (MWh) dispensed each month
- 2,400,000 gallons of gas avoided (annual equivalent)
- 35 million lbs of CO$_2$ emissions prevented
- 4,500+ times every day drivers plug into a ChargePoint station
- 54,000+ mobile app downloads
- 14 countries
1,700+ ChargePoint Customers

### Major Employers
Google, Microsoft, 3M, Adobe, Dell, GM, SAP, Netflix, Johnson & Johnson, MasterCard, eBay, and more

### Utilities & EV Service Providers
LA Dept of Water & Power, San Diego Gas & Electric, Austin Energy, Toronto Hydro, Hydro Quebec, and more

### Government & Fleet
New York, San Francisco, LA, Boston, Orlando, Washington DC, Connect by Hertz, Google, and more

### MDUs/Apartments
Equity Residential, The Keller Group, TGI, The Tower Companies, Alliance Residential, and more

### Retail, Hotels & Shopping Centers
Walgreens, Kohl's, Whole Foods, Meijer, Ritz-Carlton, Hyatt, Best Western, Bellevue Square (WA), Fashion Island (CA), and more

### Regional & National Parking Services
Edison Properties, Sylvan Parking, Priority Parking, InterPark, and more
Charging Services

- Charging Stations
- Billing Software
- Reservations
- Smartphone Apps
- Advertising
- Authentication
- Asset Management
- Energy Management
- 24/7 Driver Care
- Station Owner Care
- Monitoring & Statistics
- Remote Maintenance
ChargePoint Open Network Solution

Services for Station Owners

ChargePoint Service Plans
Cloud-based solutions for managing EV charging

Services for Drivers

Driver Applications & Services
Web, mobile, in-car apps from ChargePoint & ecosystem providers

ChargePoint and OnRamp Stations

From ChargePoint or other manufacturer
For Drivers

• Charging Session Info
• Usage History
• Monthly statement
• Notifications
• Finding Charging Stations
• Reservations
• Smartphone Apps
• 24/7 Driver Care
• Monitoring & Statistics
• Remote Maintenance
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- Monitoring & Statistics
- Remote Maintenance
- Charging Session Info
- Usage History
- Monthly statement
- Notifications
For OEM’s

- Charging Stations
- ChargePoint Software
- Database of charging stations
- Reservations
- Smartphone Apps
- 24/7 Driver Care
- Monitoring & Statistics
- Remote Maintenance
ChargePoint Connections
Connecting Drivers with Retailers, Employers, Utilities, and Others

• Drivers declare affiliations via their ChargePoint account
  – Opt-in for rewards, custom benefits
  – Single account for many Connections

• Examples
  – Connect with Employer to access private stations
  – Connect with Retailers for benefits (e.g., charging credits, advertising, discounts, offers)
  – Connect with EVSP/Utility for preferred rates
Thank You

www.chargepoint.com
• Every owner of a blink home-charger that registers with the blink network and agrees to the terms of use, can view their utilization through gauges and dashboards that are available.
Clicking on the ECOtiles provides additional information about how this data is calculated.

The total GHG reduced assumes that an EVSE’s electricity from the U.S. grid emits 1.53 pounds of CO2e per kWh generated, and a comparable, conventional gasoline vehicle achieves 28.6 miles per gallon and emits 20.1 pounds of CO2e per gallon. The CO2 reduction is calculated by the formula:

\[
CO2 \text{ Avoided (Pounds)} = total \text{ kWh used} \times 0.54
\]
My Dashboard

Gallons of fuel saved assumes that 1% of US electricity generation comes from petroleum and can thus be neglected. The number of kWh used to power the EV, 340 Wh/mile electricity consumption of the EV, and the 28.6 mpg fuel economy of the comparable, conventional vehicle are used in the formula for Gallons of Fuel saved:

Gallons of Fuel Saved = \frac{(\text{Total kWh Used} \times 1000)}{340 \times 28.6}

Download CSV of Usage Data

| Total Usage |  
|-------------|---

![Graph showing daily gasoline usage from Feb 26, 2013 to Apr 11, 2013](image-url)
• There are several pre-generated graphs that can be chosen to add to a residential dashboard.
• Exporting charging data can be done through the following:
• Commercial blink owners get the same tiles and are allowed to view or pull data from any charger they own.
Acknowledgement

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

More Information

http://avt.inl.gov

This presentation will be posted in the publications section of the above website, alphabetically as “White House, DOE, DOT, SAE - Vehicle Data Jam”

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