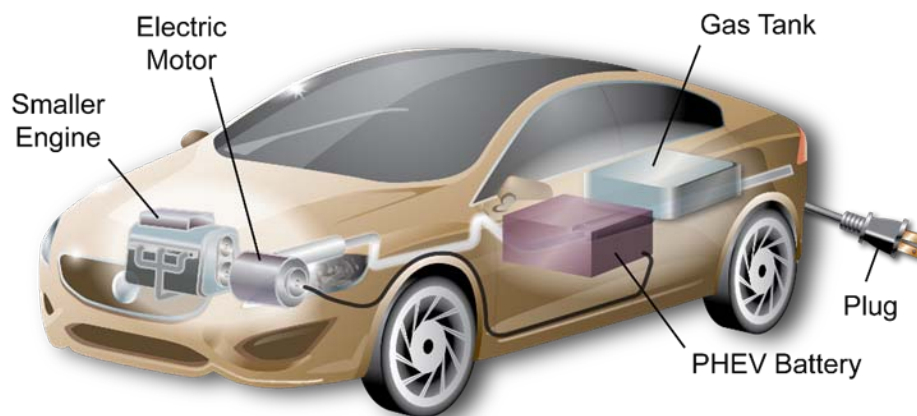


Vehicle and Infrastructure Demonstration Projects

Data Management, Analysis & Reporting

Tim Murphy & Jim Francfort
Idaho National Laboratory
Beyond Oil Conference
Oct. 23-24, 2009, Redmond WA



www.inl.gov

DOE/EERE Vehicle Technologies Program

- **Advanced Vehicle Testing and Demonstration Activities, INL supporting data analysis activities**
 - **American Recovery & Reinvestment Act – “Recovery Act”**
 - Electric Drive Vehicle Battery & Component Manufacturing Initiative, approx. 30 separate awards
 - **Transportation Electrification, approx. 18 separate awards**
 - **eTec/Nissan EV Infrastructure Project**
 - Clean Cities program, approx. 25 separate awards
 - **Technology Acceleration & Deployment Activity awards**
 - **Advanced Vehicle Testing Activity – Light Vehicles**
 - INL manages baseline, fleet & accelerated performance tests
 - This is where the test procedures, data management and analysis processes are developed
 - Other National Laboratories participate in testing projects and focused data analysis/modeling activities (ANL, ORNL, NREL)

Advanced Vehicle Testing Activity (AVTA)

Provide benchmark data for DOE technology modeling, simulations, research and development activities, as well as to fleet managers and other vehicle purchasers for informed purchase, operations, and infrastructure decisions.

- Develop cost-shared partnerships with public, private, and regional groups to test, deploy and demonstrate advanced vehicle and infrastructure technology.

AVTA Testing by Technology

- Plug-in hybrid electric vehicles (PHEV)
 - 12 models, 218 vehicles, 1.1 million test miles
- Hybrid electric vehicles (HEV)
 - 17 models, 45 vehicles, 4.5 million test miles
- Neighborhood electric vehicles
 - 23 models, 200,000 test miles
- Hydrogen ICE (internal combustion engine) vehicles
 - 7 models, 500,000 test miles
- Full-size battery electric vehicles (BEVs)
 - 40 EV models, 5+ million test miles
- Urban electric vehicles
 - 3 models, 1 million test miles



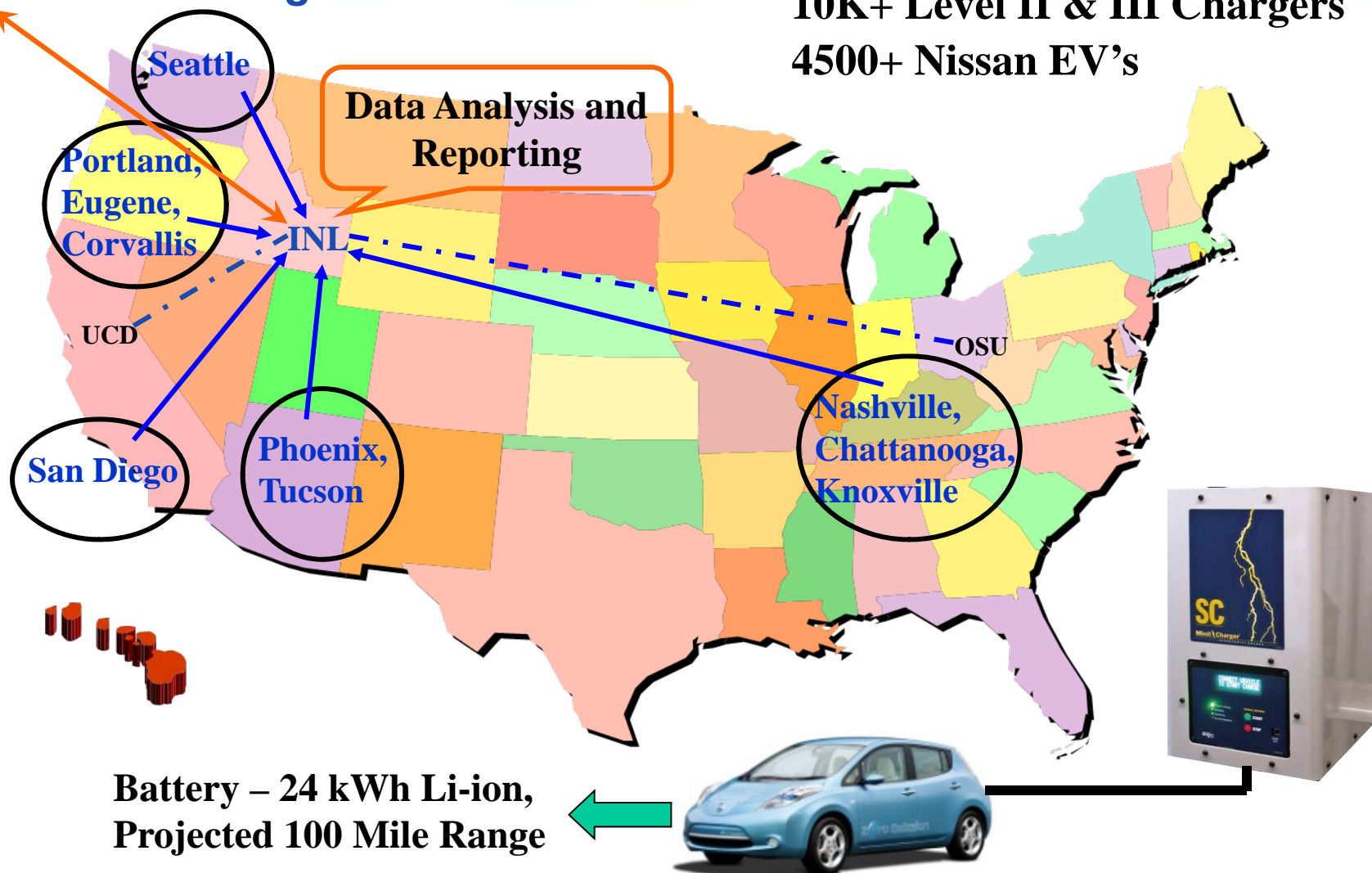


Electric Vehicle Infrastructure Demonstration

eTec/Nissan/Regional Partners

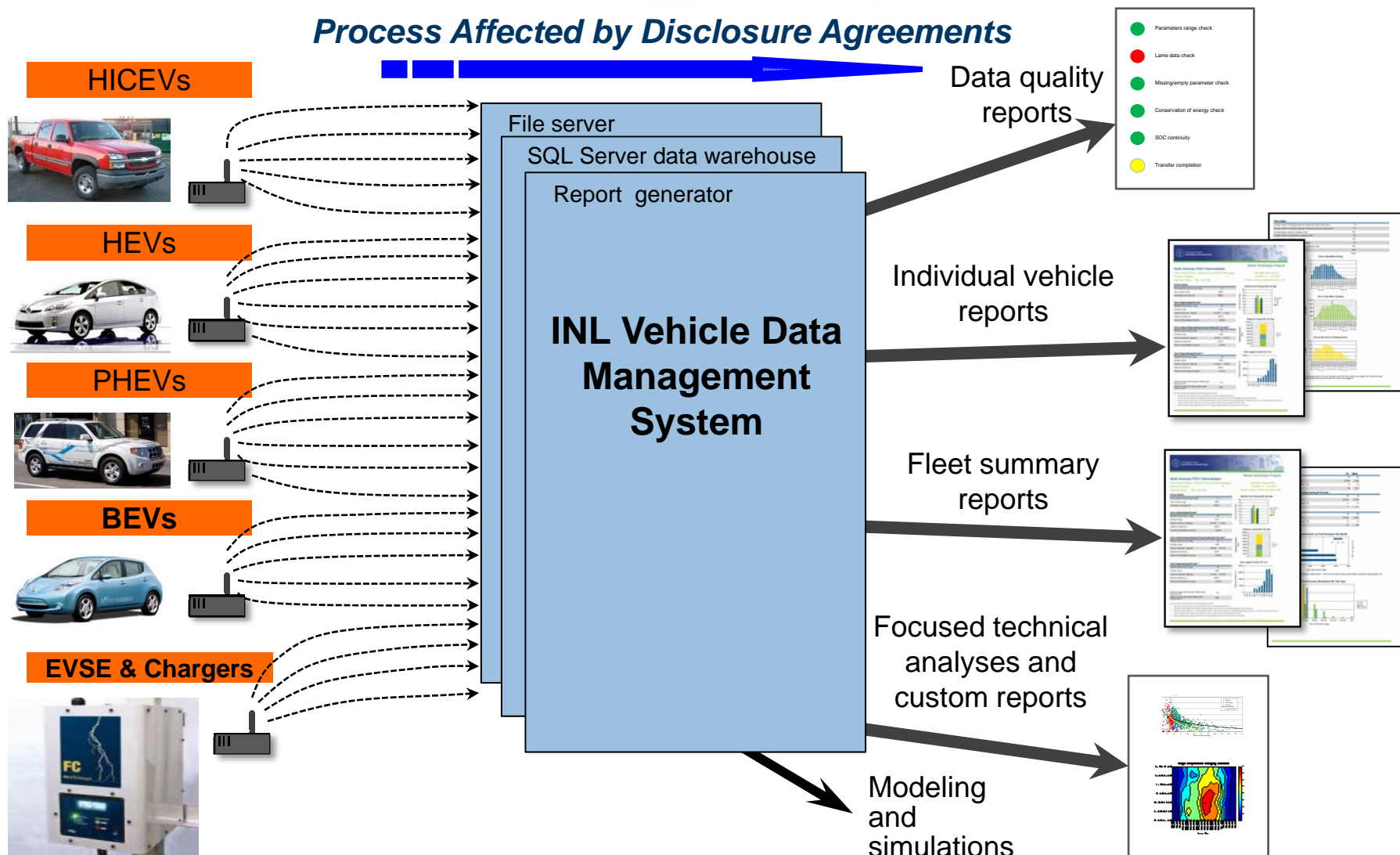
10K+ Level II & III Chargers

4500+ Nissan EV's



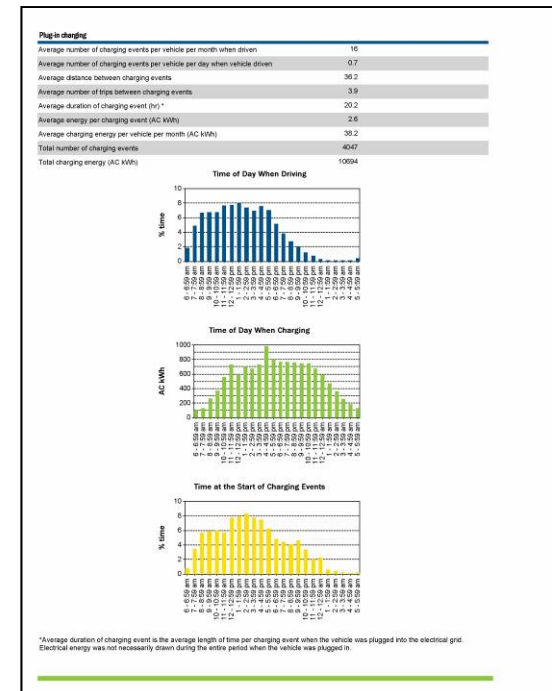
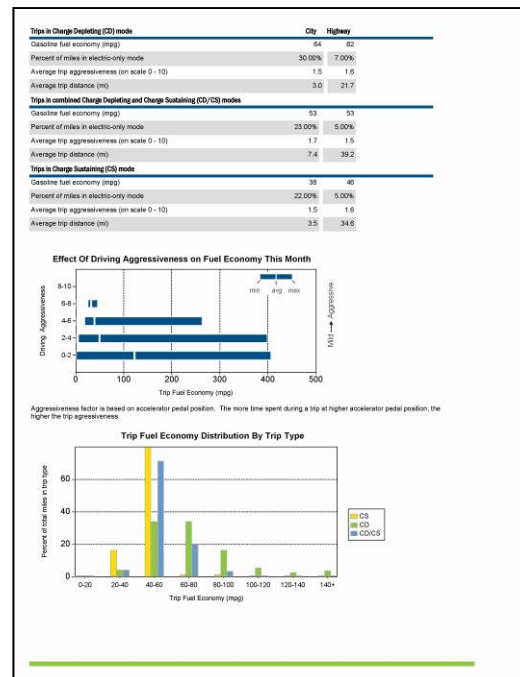
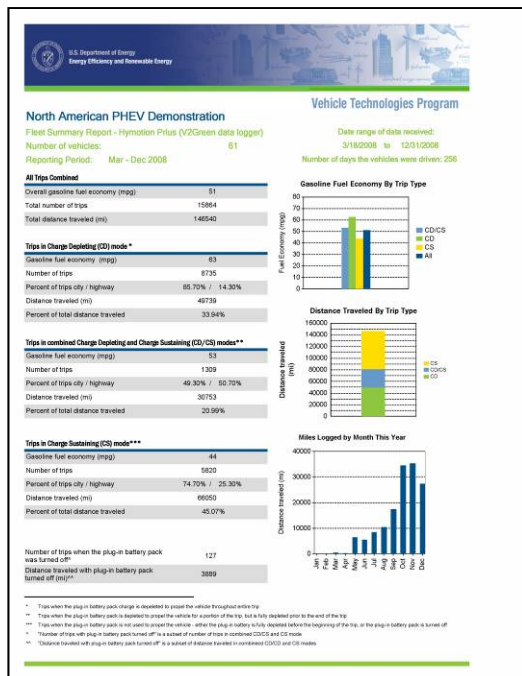
Vehicle Data Management Process

Process Affected by Disclosure Agreements



Example Standard Test Reports – from PHEV demo

- Summary reports posted on web
- Individual vehicle reports go to the respective vehicle owners each month, 1,340+ reports to date (October, 2009)
- 157 Hymotion Prius PHEVs, 981,000 miles, 108,297 trips, 26,000 charging events, 58,400 kWh used. **Gridpoint (V2Green) and Kvaser data logger systems**



Focused Analysis/Reports

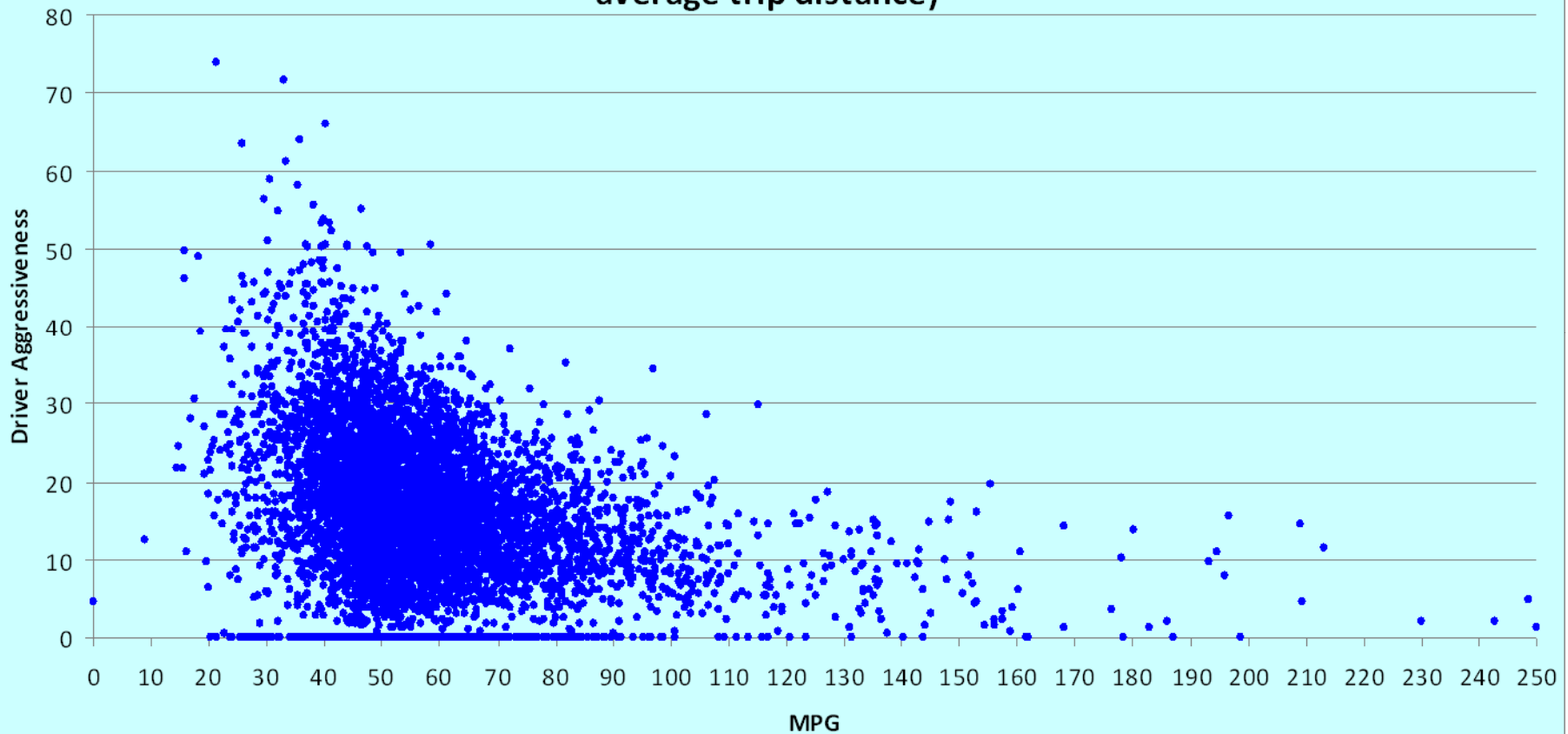
- **Data from a variety of additional test types into database:**
 - Baseline performance testing: closed test tracks and dynamometers
 - Accelerated testing: dedicated drivers on defined onroad loops
 - Fleet testing: everyday unstructured \ non-directed fleet and public use, with onboard data loggers
 - Laboratory testing of vehicle batteries

- **Specialized analysis and custom output reports:**
 - Battery life, charging patterns and profiles
 - Vehicle operations, fuel use (electricity and gasoline) and infrastructure requirements
 - Driver influences on fuel use
 - Affect of climate/location on fuel use
 - Individual PHEV/BEV models and PHEV/BEV concepts
 - PHEV/BEV life-cycle costs
 - Vehicle charging studies

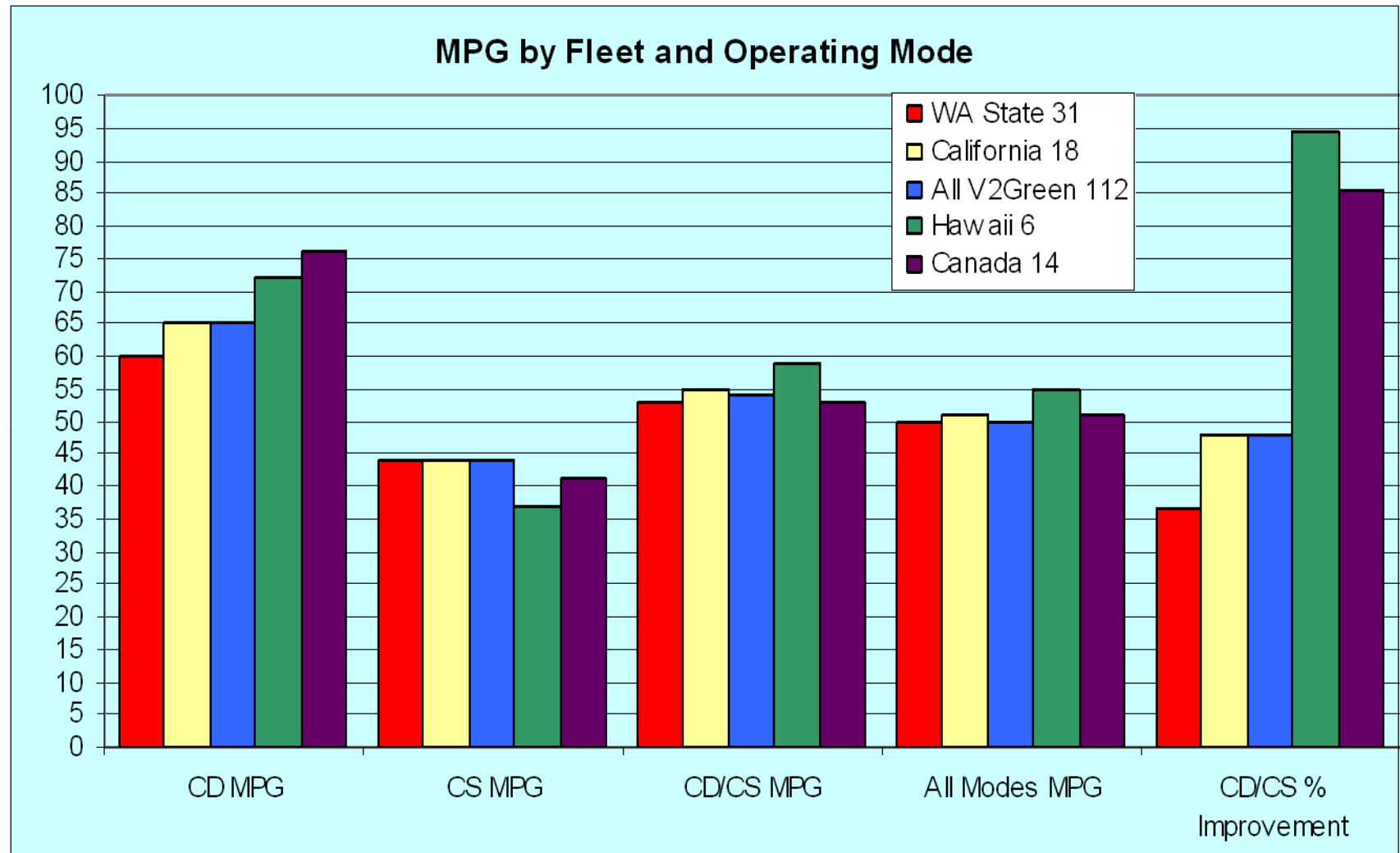
PHEVs – Example Focused Analysis

- Example of MPG versus aggressive driving

MPG & Driver Aggressiveness for 5,900 CD/CS Trips, 149,000 miles (25.3 miles average trip distance)



Example Testing Results by PHEV Demo Fleets

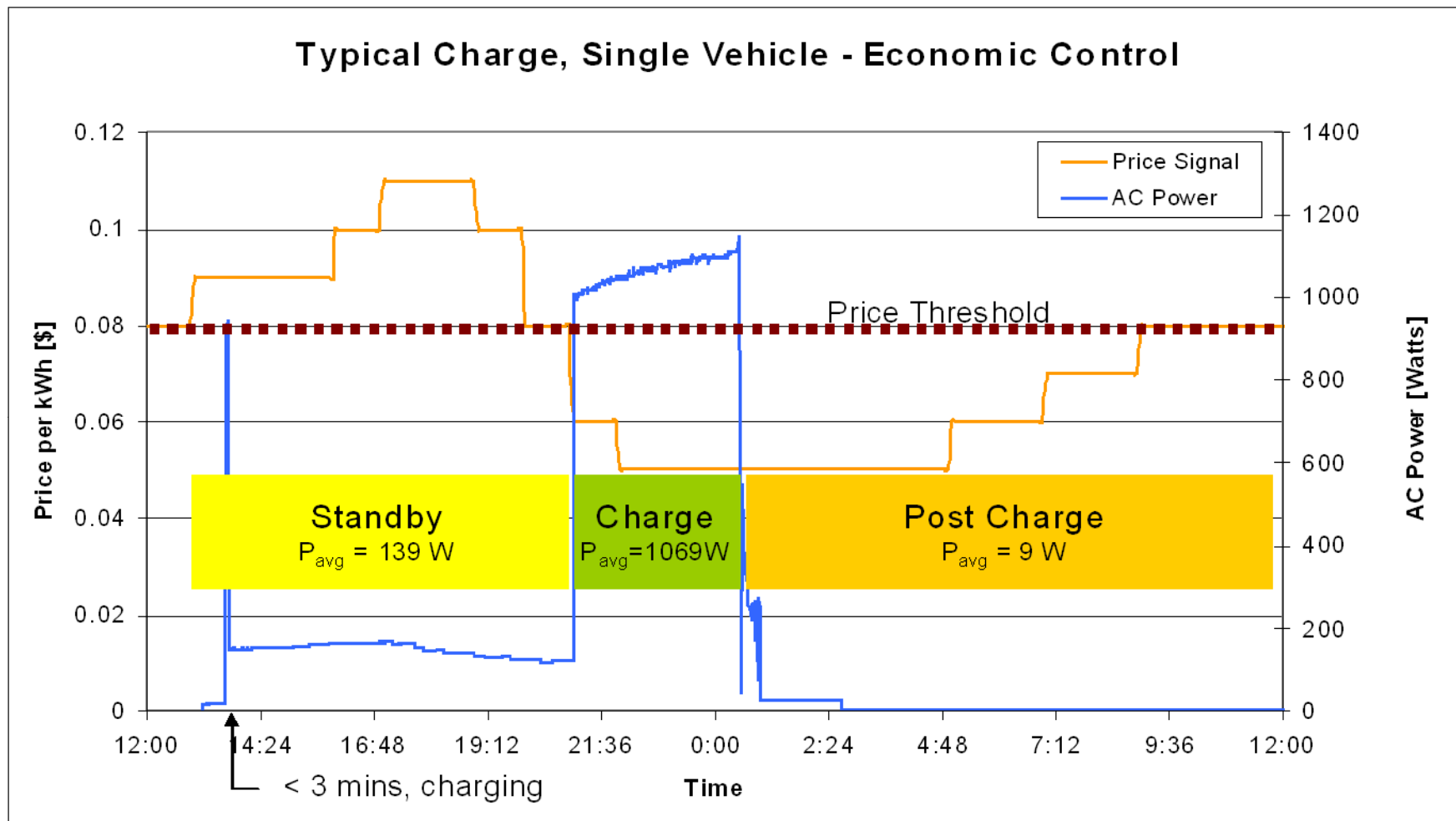


Example Focused Charging Study Puget Sound PHEV Smart Charging Trials

- 13 Seattle PHEV's participated in trials conducted by **Seattle City Light** using **GridPoint's Electric Vehicle Management Solution**
- Types of Trials:
 - Time of Day Charging – Vehicles charging allowed only during certain hours of the day.
 - Goal Based Charging – Normalize power demand for vehicle charging around a goal load.
 - Economic Charging – Allow vehicle charging only when the price of electricity is below a threshold

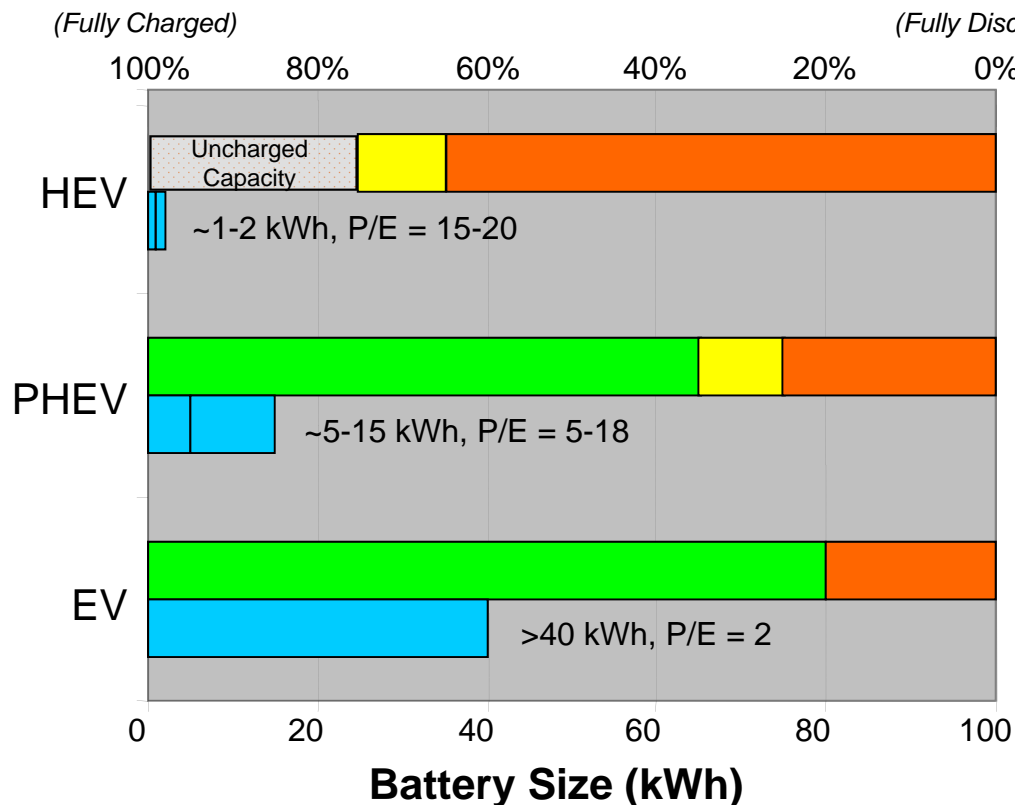
Example Results of Charging Studies

- Control charging cost; vehicles charge when energy price < \$.08/kWh



Vehicle Battery Operation Testing

Battery State of Charge (SOC)



CS only: 300-500 Wh, 25-40 kW (10 sec) @70% SOC, 300,000 cycles

CS: 300-500 Wh, 25-40 kW (10 sec) @30% SOC, 300,000 cycles

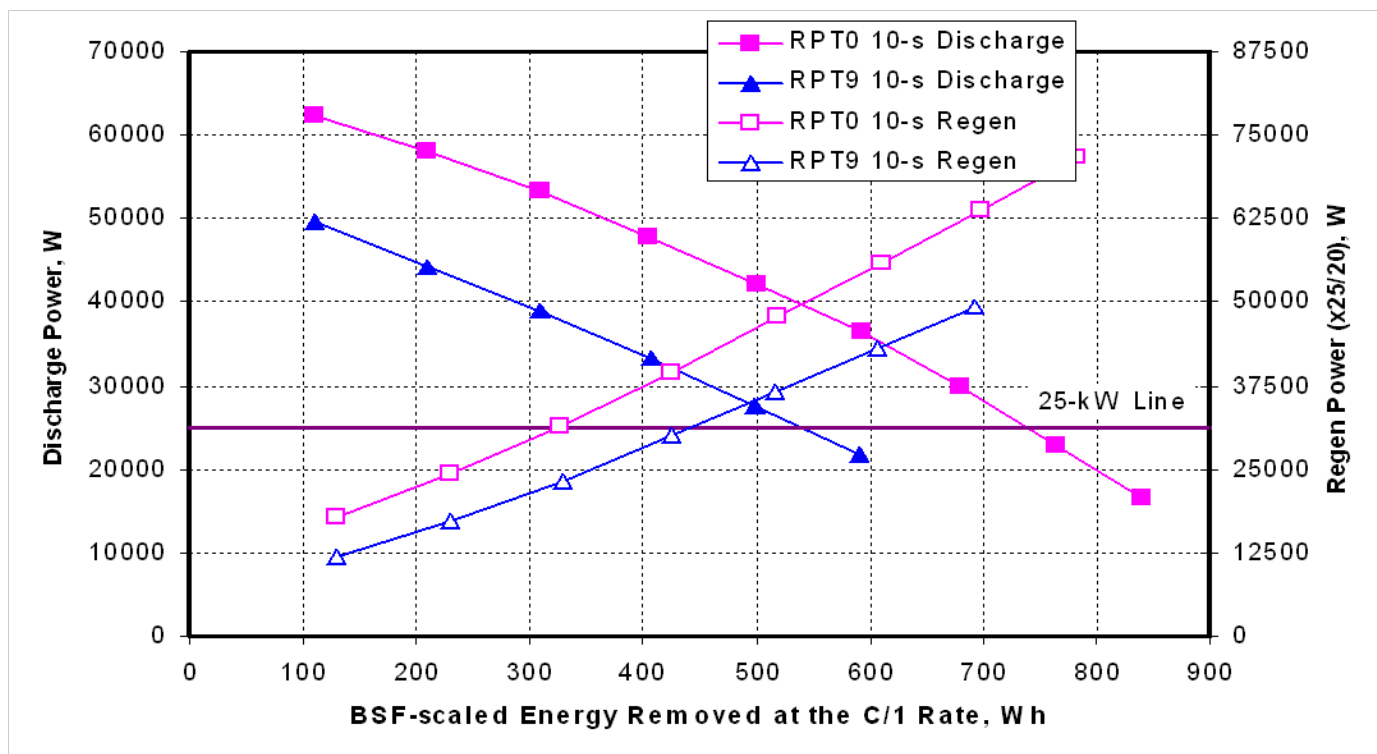
CD: Energy scaled for range (10-40 miles), 5,000 deep discharge cycles

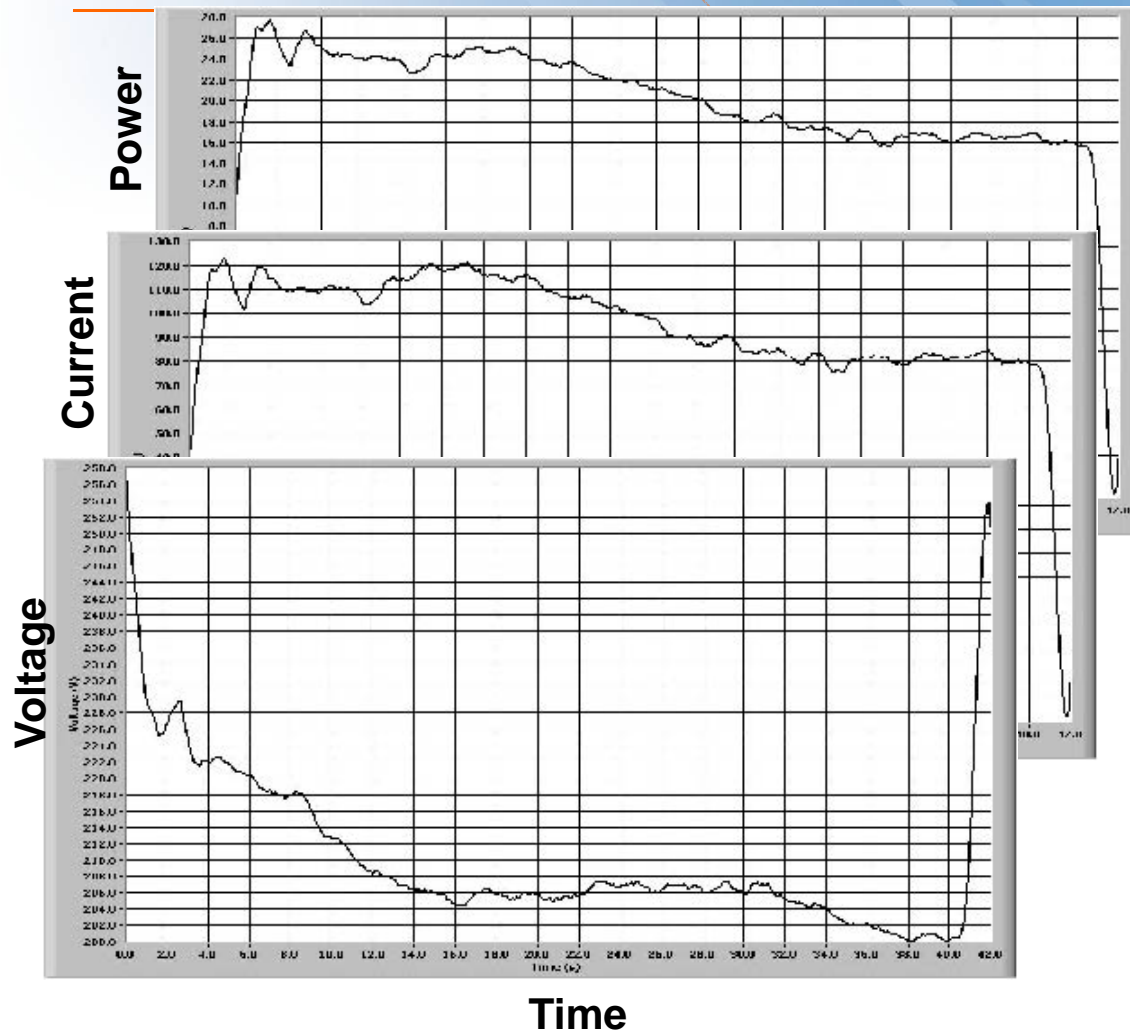
CD only: Energy scaled for 100+ mile range, 1,000+ deep discharge cycles

- Charge Depleting (CD)
- Charge Sustaining (CS)
- Unused Energy
- Battery Size (kWh)

Example Results-Battery Power & Energy Fade

Power level decreases with time
Energy window at constant power decreases with time





Example vehicle battery data from Camry Hybrid

Example Acceleration Test data provides on-road, real-world battery power, current and voltage data which may be compared to the manufacturer's specs, DOE/USABC targets, laboratory test data and used to update vehicle systems analyses models.

The Acceleration Test 10-sec-average discharge power of **23.6 kW is within 10% of the HPPC BOT value of **25.7 kW**.**

Acknowledgement

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

Additional Information

<http://avt.inl.gov>
or

<http://www1.eere.energy.gov/vehiclesandfuels/avta/>