US – China Electric Vehicle and Battery Technology Workshop

U.S. Department of Energy's Advanced Vehicle Testing Activity

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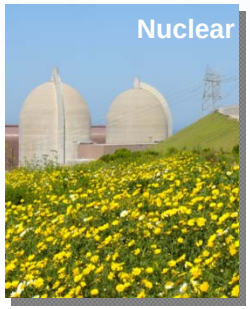
This presentation does not contain any proprietary or sensitive information

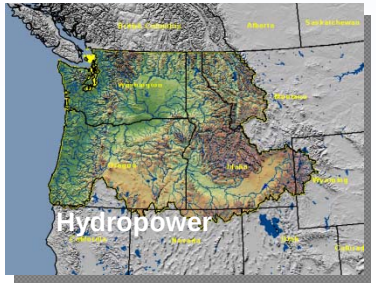
Presentation Outline

- INL / AVTA background, description and testing approach
- Vehicle technologies tested
  - Plug-in hybrid electric vehicles
  - Hybrid electric vehicles
  - Neighborhood electric vehicles
  - Hydrogen internal combustion engine vehicles
  - Full-size battery electric vehicles
  - Urban electric vehicles
- Other data collection / testing activities
- WWW site address

Idaho National Laboratory

- Eastern Idaho based U.S. Department of Energy (DOE) 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





AVTA Description

- Advanced Vehicle Testing Activity (AVTA) is part of DOE's Vehicle Technologies Program. Conducted by:
  - Idaho National Laboratory (INL)
    - Program execution in support of DOE goals. Conducts engineering, data analysis, and reporting / presentations
  - Electric Transportation Engineering Corporation (eTec)
    - Conducts vehicle operations and testing, engineering. Access to numerous testing facilities / test tracks
  - National Energy Technology Laboratory (NETL)
    - Executes eTec contract

AVTA Description – cont'd

- AVTA tests light-duty whole vehicle systems and fueling infrastructures that employ / support:
  - 100% Electric and dual-fuel electric drive systems
  - Advanced energy storage systems
  - Some ICE 100% Hydrogen and HCNG blended fuels
  - Advanced control systems (i.e., start/stop HEVs)
- Provide benchmarked vehicle and infrastructure testing results to R&D programs, modelers, OEMs, battery manufacturers, and target/goal setters (DOE)
- Assist early adaptor fleet managers and the general public in making informed vehicle purchase, deployment and operating decisions. Presentations to industry groups, including via DOE's Clean Cities

AVTA Vehicle Testing Approach

- Depending on vehicle technology and capabilities, vehicles are tested via:
  - Closed test tracks
  - Dynamometer testing
  - Laboratory testing (batteries)
  - Accelerated testing, using dedicated drivers and other methods to accumulate miles and cycles
  - Fleet testing, uses unstructured vehicle utilization
  - Different testing methods are used to balance testing control/repeatability, sample size, and costs
- Publish testing results in relevant ways to accurately
  - Document real-world petroleum reduction potentials
  - Document fuel and infrastructure use
  - Document life-cycle risks and costs

AVTA Testing by Technology

- Plug-in hybrid electric vehicles (PHEVs)
  - 12 models, 259 vehicles, 2 million test miles
- Hybrid electric vehicles (HEVs)
  - 18 models, 47 vehicles, 5 million test miles
- Neighborhood electric vehicles (NEVs)
  - 23 models, 200,000 test miles

- Hydrogen internal combustion engine (HICE) vehicles
  - 7 models, 500,000 test miles

- Full-size battery electric vehicles (BEVs)
  - 41 EV models, 5+ million test miles
- Urban electric vehicles (UEVs)
  - 3 models, 1 million test miles
- 14 million test miles have been accumulated on 1,600 electric drive vehicles representing 99 different electric drive models

PHEV Testing

- 12 PHEV models tested to date
  - Hymotion Prius (A123 Systems)
  - Hymotion Escape (A123 Systems)
  - Ford E85 Escape (Johnson Controls/Saft)
  - EnergyCS Prius, 2 models (Valance and Altair Nano)
  - Electrovaya Escape (Electrovaya) - done
  - Hybrids Plus Escape, 2 models (Hybrids Plus and K2 Energy Solutions)
  - Hybrids Plus Prius (Hybrids Plus)
  - Manzanita Prius (lead acid and Thunder Sky)
  - Renault Kangoo (Saft NiCad) - done

  (Lithium unless noted)
- Testing focus has been on the PHEV technology concept and batteries, and driver and environmental impacts on fuel efficiencies and charging rates

HEV Testing

- 5 million total HEV testing miles
- 18 HEV models and 47 HEVs tested to date:
  - 6, 2001 Honda Insight
  - 6, 2002 Gen I Toyota Prius
  - 4, 2003 Gen I Honda Civic
  - 2, 2004 Chevrolet Silverado
  - 2, 2004 Gen II Toyota Prius
  - 2, 2005 Ford Escape
  - 2, 2005 Honda Accord
  - 3, 2006 Lexus RX 400h
  - 2, 2006 Toyota Highlander
  - 2, 2006 Gen II Honda Civic
  - 2, 2007 Saturn Vue
  - 2, 2007 Toyota Camry
  - 2, 2008 Nissan Altima
  - 2, 2008 GM 2-mode Tahoe
  - 2, 2010 Ford Fusion
  - 2, 2010 Toyota Prius
  - 2, 2010 Honda Insight
  - 2, 2010 Mercedes Benz S400
- Published 12 HEV battery testing reports during FY09, with 24 published to date
- Conducted 15 HEV battery pack tests during FY09

Hydrogen ICE Fact Sheet

- Twelve 2005 Chevrolet Silverado 1500HD pickups
- Operating in Canada and the U.S.
- Onboard data logger generated results
- 10.5 GGE ~100% H_2 onboard storage
- cost data monitoring activity

U.S. Department of Energy
Energy Efficiency and Renewable Energy
Bringing you a prosperous future where energy is clean, abundant, reliable, and affordable

Vehicle Technologies Program

HICE Fleet Testing

Advanced Vehicle Testing Activity

2005 Chevrolet Silverado 1500HD Hydrogen ICE[1] Conversion

North American Fleet Testing Results to Date June, 2009

A Strong Energy Portfolio for a Strong America
Energy efficiency and clean, renewable energy will mean a stronger economy, a cleaner environment, and greater energy independence for America. Working with a wide array of state, community, industry, and university partners, the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy invests in a diverse portfolio of energy technologies.

Fleet Performance

Operating Statistics[2]:
Vehicles in Fleet: 12
Total Miles: 55,255
Total Number of Trips: 9271
Average Trip Distance (miles): 6.0
Percent Idle Time: 16%[3]
Percent Air Conditioner Run Time: 8.5%[3]

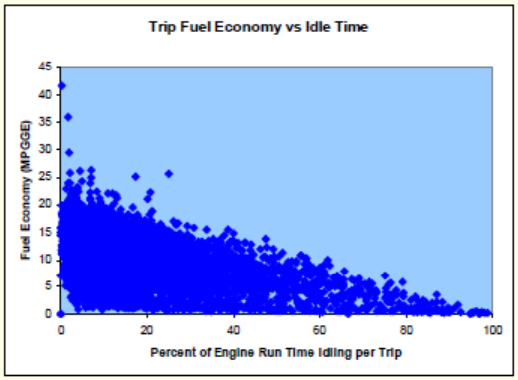
Operating Performance[2]:
Cumulative MPGGE[4]: 13.2
Total Fuel Consumed (kg H_2): 4229
Total Engine Run Time (hours): 2339
Total Engine Idle Time (hours): 385

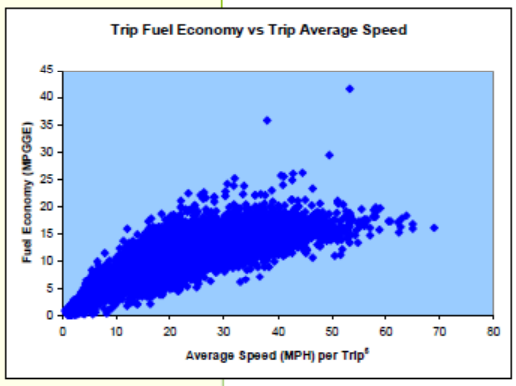
Vehicle Specifications

Engine: 6.0L V8
Fuel Capacity: 10.5 GGE
Nominal Tank Pressure: 5000 psi
Seatbelt Positions: Five
Payload: 2775 lbs
Features: 4 Speed Automatic Transmission

See HICEV America Baseline Performance Fact Sheet for more information.

For more information contact:
EERE Information Center
1-877-EERE-INF (1-877-337-3463)
www.eere.energy.gov





EV Project - Overview

- $230 million total project
  - US Department of Energy grant
  - Partner Cost share match
  - Lead by ECOtality North America (ECOtality NA)
  - Funded via the American Recovery and Reinvestment Act (ARRA) - $115 million
- Purpose: <u>To build and study</u> mature electric vehicle charging infrastructure in eight regions – 16 cities
- Product: Take the lessons learned from the deployment of these first 8,300 EVs, and the charging infrastructure supporting them, to <u>enable the streamlined deployment of the next 5,000,000 EVs</u>

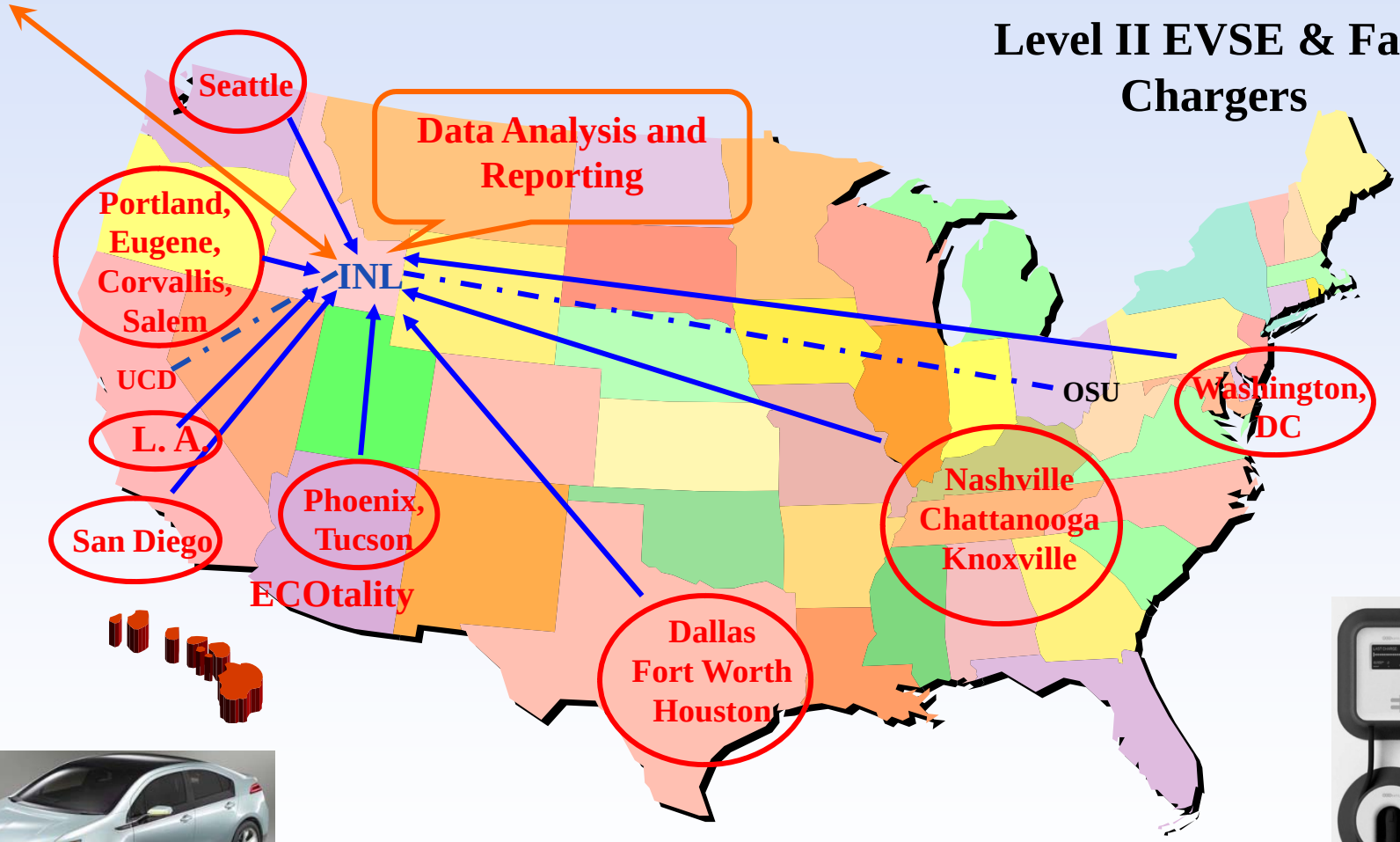
EV Project - Infrastructure Demonstration

- 14,650 Level 2 electric vehicle supply equipment (EVSE)
- 310 DC fast chargers
- 8,300 electric drive vehicles
  - 5,700 battery electric Nissan Leaf EVs
  - 2,600 General Motors Volt EREVs
- Charging and vehicle data for the 23,260 EVSE, fast chargers and vehicles will be collected by the Idaho National Laboratory via data streams from ECOtality NA (charging infrastructure), and Nissan and General Motors (vehicle data)

EV Project - Locations

ECOtality NA/INL/Nissan/GM/Regional Partners

Level II EVSE & Fast Chargers



EV Project - Reporting

- EV Project will analyze and report on the charging infrastructure utilization (Level II EVSE units and fast chargers) by the 8,300 Leaf and Volt drivers
- EV Project will report on driver/vehicle charging patterns, and charging infrastructure utilization patterns
- Many of the 42+ EV Project partners are electric utilities with high interest in demand / smart charging controls
  - Smart charging will include multitier time-of-day pricing
  - Micro grid analysis
- Fast charge / grid energy storage test component is also being developed

EV Project - Infrastructure Data Collected per Charge Event

- Date/Time Stamp
- Unique ID for Charging Event
- Unique ID Identifying the EVSE – may not change
- Connect and Disconnect Times
- Start and End Charge Times
- Max Instantaneous Peak Power
- Average Power
- Total energy (kWh) per charging event
- Rolling 15 Minute Average Peak Power
- And other non-dynamic EVSE information (GPS, ID, type, contact info, etc.)

EV Project - Vehicle Data Collected per Start/Stop Event

- Vehicle ID
- Date/Time Stamp
- Event type (key on / key off)
- Odometer
- Battery state of charge
- GPS (longitude and latitude)
- Liquid fuel consumption (some vehicles)
- Recorded for each key-on and key-off event

EV Project - Fact Sheet Reporting

- Driving (by reporting period)
  - Number of trips
  - Distance driven (miles)
  - Average number of trips between charging events
  - Average distance between charging events
- Charging
  - EV Project charging
    - Number of charging events
    - Percent of all charging events
    - Total time plugged in (hours)
    - Percent of all time plugged in
  - Non-EV Project charging events
    - Number of charging events
    - Percent of all charging events

EV Project - Data Collection Summary

- Utilize a systematic process for planning and installing charging infrastructure - ECOtality NA's Micro-Climate© process
  - Document travel patterns
  - Document charging patterns
- Provide feedback on infrastructure deployment decisions
- Successful grid connected electric drive vehicle deployment is dependent on successful infrastructure deployment
- Future charging infrastructure deployments must be based on real-world travel and charging patters
- Replace internal combustion engine vehicles with grid connected, and infrastructure dependant, electric drive vehicles

Other INL Data Collection Projects

- **INL is / will be collecting vehicle data from:**
  - **Ford's PHEV SUVs**
  - **General Motors EREV Volts**
  - **Chrysler's PHEV Pickups**
  - **Other OEM(s)**
  - **United States Post Office electric vehicles**
- **Above are vehicle demonstrations versus infrastructure demonstration**

Acknowledgement

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

Additional Information, Reports, Fact Sheets @

AVTA - http://avt.inl.gov

INL/MIS-10-19648