DOE Data Summit: INL's Ongoing PEV Information Strategies

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This presentation does not contain any proprietary, confidential, or otherwise restricted information

Content

- INL PEV & EVSE Information Management Process & Security
- PEV & Charging Infrastructure Information Focused Projects
- PEV-Focused Benchmarking & Information Collection
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- Future Information Analysis
- Information Collection & Protection, & Presentation Summary

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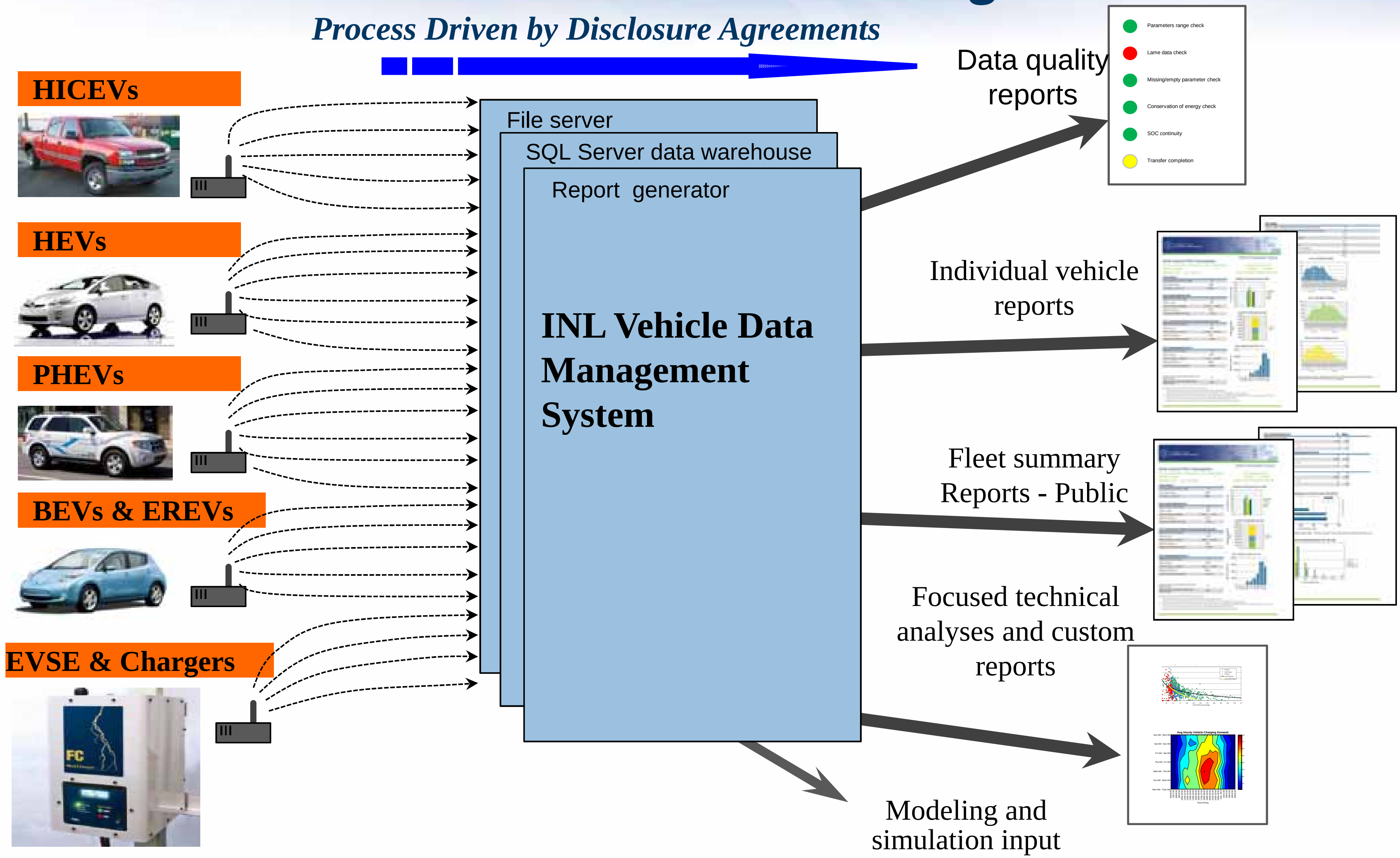
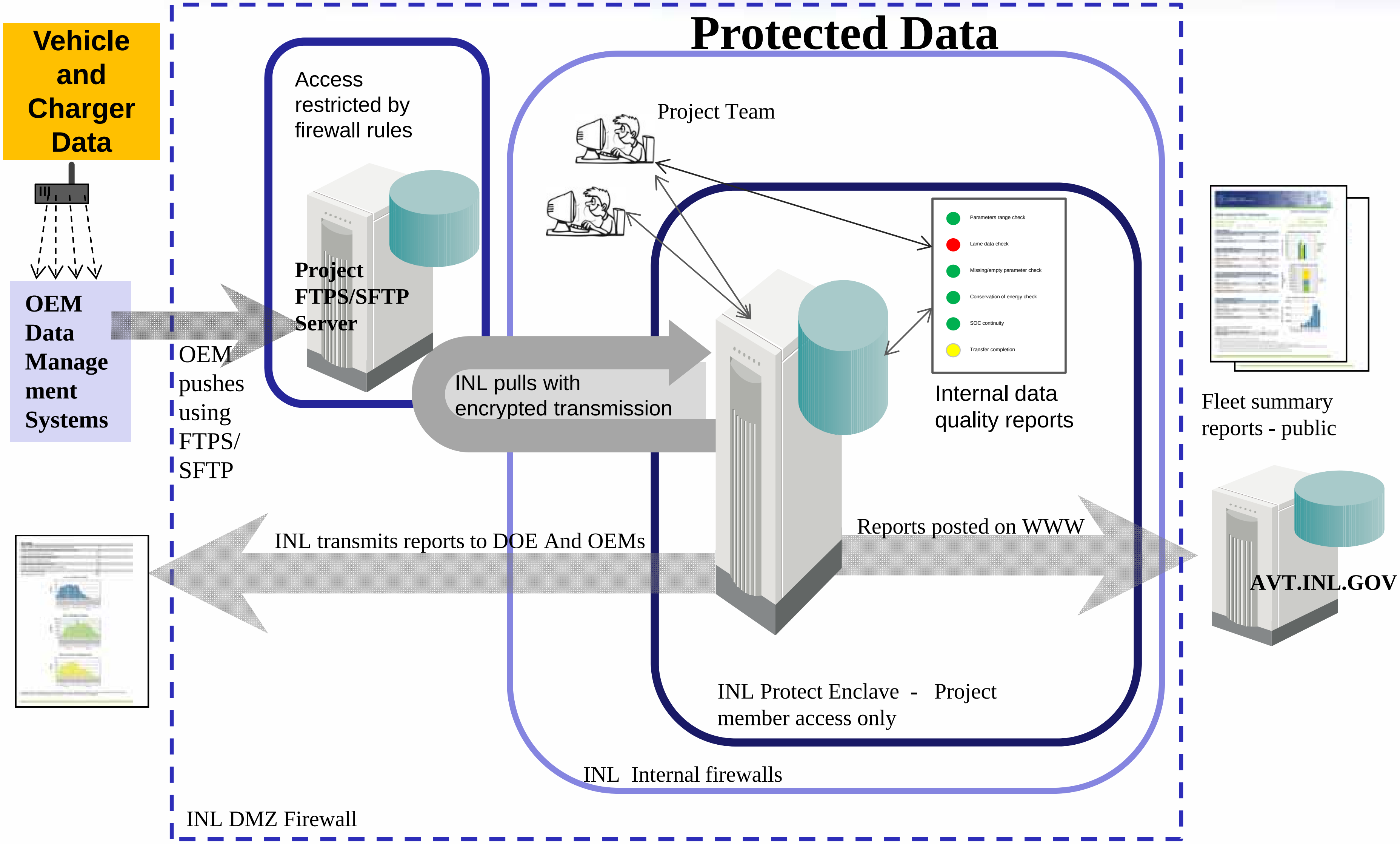
INL PEV & EVSE Information Management Process & Security

INL PEV & EVSE Information Management Process



Information Security



PEV & Charging Infrastructure Information Focused Projects

EV Project

- **Data from 8,228 Leafs, Volts and Smarts, 12,363 EVSE & DCFC**

Vehicle data	EVSE & DCFC data
Odometer	Connect and Disconnect Times
Battery state of charge	Start and End Charge Times
Date/Time Stamp	Maximum Instantaneous Peak Power
Vehicle ID	Average Power
Event type (key on / key off)	Total energy (kWh) per charging event
GPS (longitude and latitude)	Rolling 15 Minute Average Peak Power
Recorded for each key-on and key-off event	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

Goal – develop a laboratory of EVSE & PEVs to understand how, where, when EVSE are used in order to support the design of future EVSE deployments. Supports PEV sales, & reduces the costs & risks of EVSE/DCFC installations

- **4.2 million charge events & 124 million test miles**
- **1 million test miles & 9,000 charge events every 5 days**
- ***Data collection was just completed September 2014***
- ***Original & redone NDAs with OnStar, Nissan, ECOtality , & Car Charging. 11,000 use agreements with vehicle owners & site hosts***

654 White papers; technical & quarterly reports; & presentations generated for governments, universities, air quality management districts, miscellaneous requests, & utility groups

All raw data is NDA protected

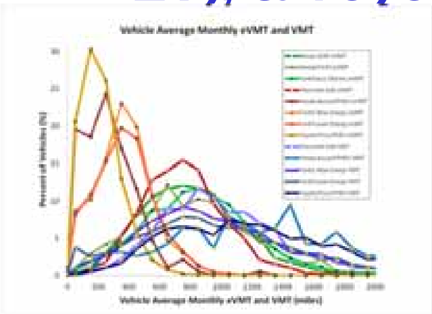
eVMT Project

Goal – benchmark electric vehicle miles traveled of EVs & PHEVs. Supports CARB & OEM, ZEV Credits decisions, & accelerate PEV sales

Vehicle data
Varies by OEM (Ford, Honda & Toyota) Includes EV Project type of trip data Includes second-by-second data Also used EV Project Volt & Leaf data

OEMs requested INL perform the analysis due to prior work, independence & data security

- **15,721 new vehicles & 109 new million miles of data**
- **Analysis totaled 21,627 PEVs & 158 million miles**
- ***First phase of data collection completed September 2014***
- ***NDAs with Ford (Focus EV, C-Max Energi, Fusion Energi), Honda (Fit EV), & Toyota (Prius PHEV)***



2 public presentations given to date

All raw data is NDA protected

ChargePoint Project

Goal – develop a laboratory of EVSE to understand how, where, when EVSE are used in order to support future EVSE deployments, lower costs & reduce risk

- **4,647 EVSE & 1.8 million charge events**
- ***Data collection completed March 2014***
- ***NDA with ChargePoint***

EVSE data
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.)

11 quarterly reports generated. Most ChargePoint presentations , reports, etc., were combined with EV Project data, so they will not be double counted

All raw data is NDA protected

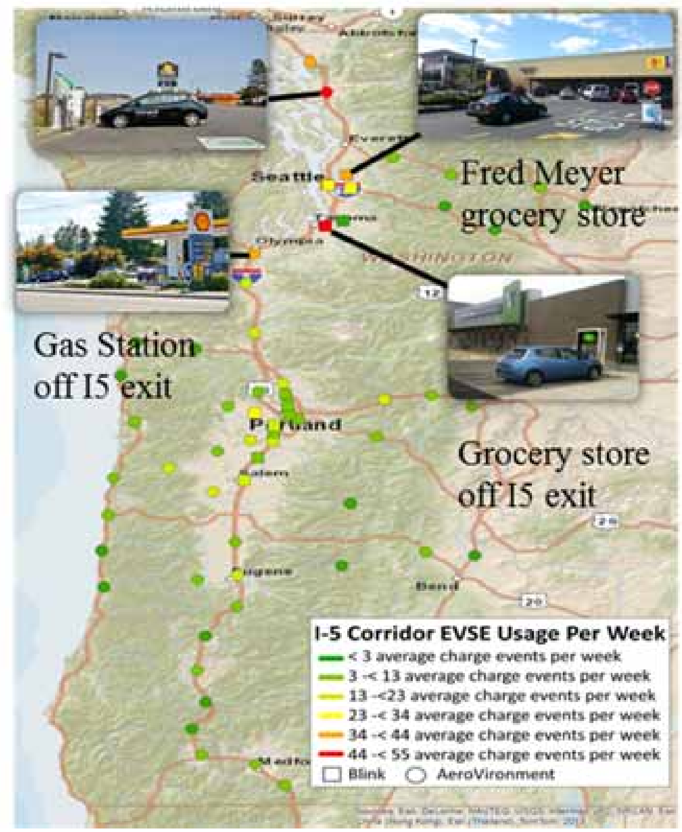
PEV Charging on Interstate Travel Routes

Goal – Identify best types EVSE and location venues to site EVSE. Reduce costs while siting high value EVSE & DCFC along travel corridors. Reduces site selection uncertainties & accel-erate electric vehicle miles traveled.

Vehicle, EVSE & DCFC data

- Same data sets as the EV Project
- EVSE data from Aerovironment, Blink & ChargePoint
- Volt & Leaf data from OEMs

- **Approximately 100 EVSE & DCFC in Oregon and Washington**
- ***Data collection is complete but analysis continues***
- ***Required uniform venue definitions***
- ***NDAs with all partners***



4 public presentations generated to date

All raw data is NDA protected

NYSERDA EVSE Project

Goal – evaluate EVSE use to benchmark how, where, when EVSE are used in order to support future EVSE deployments, lower costs & reduce deployment risk

- **274 Level 2 EVSE, 16,000 charge events, working to 900 EVSE**
- ***Data collection ongoing***
- ***NDA with NYSERDA***
- **Similar to ChargePoint reports but greater venue, local, and fee information reporting**

EVSE data
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.)

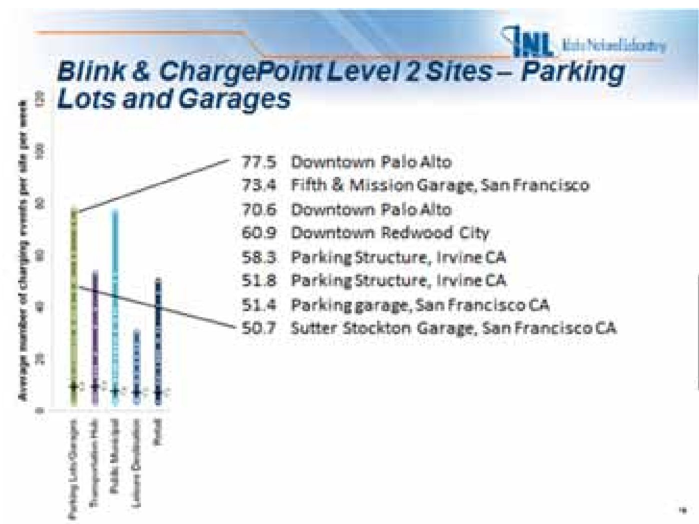
3 quarterly reports generated to date

All raw data is NDA protected

Combining EVSE/DCFC Data from Several Projects

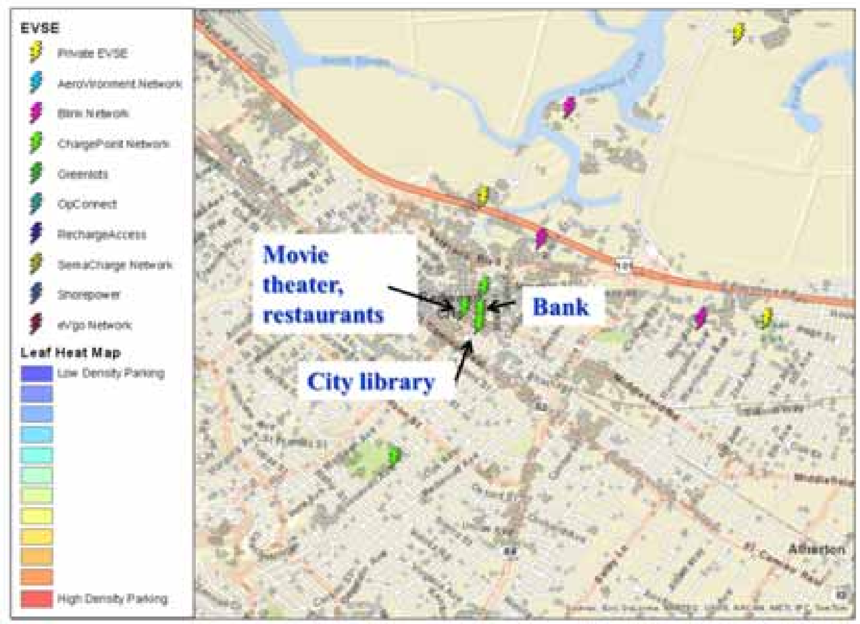
Goal – Go beyond the sum of individual projects to identify locations of high vehicle concentration & sparse EVSE environments, & high EVSE use. Allows the identification of missing EVSE installations & high use EVSE

- ***Data collection is complete but analysis continues***



Vehicle, EVSE & DCFC data

Combing vehicle and EVSE data from multiple projects produces heat maps of missing EVSE



Included in numerous EV Project presentations

All raw data is NDA protected

ARRA Volts Project

Goal – benchmark DOE investment in extended range electric vehicle technology (EREV). Reduce technology risk & accelerate PEV deployments

- **150 Chevrolet Volts**
- **3.8 million test miles**
- ***Data collection completed March 2014***
- ***Several NDAs with OnStar***

Vehicle data
Percent miles electric
kWh data
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

15 public quarterly reports generated. Many more generated for use internally by General Motors. Data used in many EV Project presentations, so they will not be double counted

All raw data is NDA protected

ARRA Chrysler Ram Project

Goal – benchmark DOE investment in plug-in hybrid electric vehicle technology (EREV). Reduce technology risk & accelerate PEV deployments

- **111 Chrysler Ram PHEVs**
- **1.2 million test miles**
- ***Data collection will end December 2014***
- ***NDA with Chrysler***

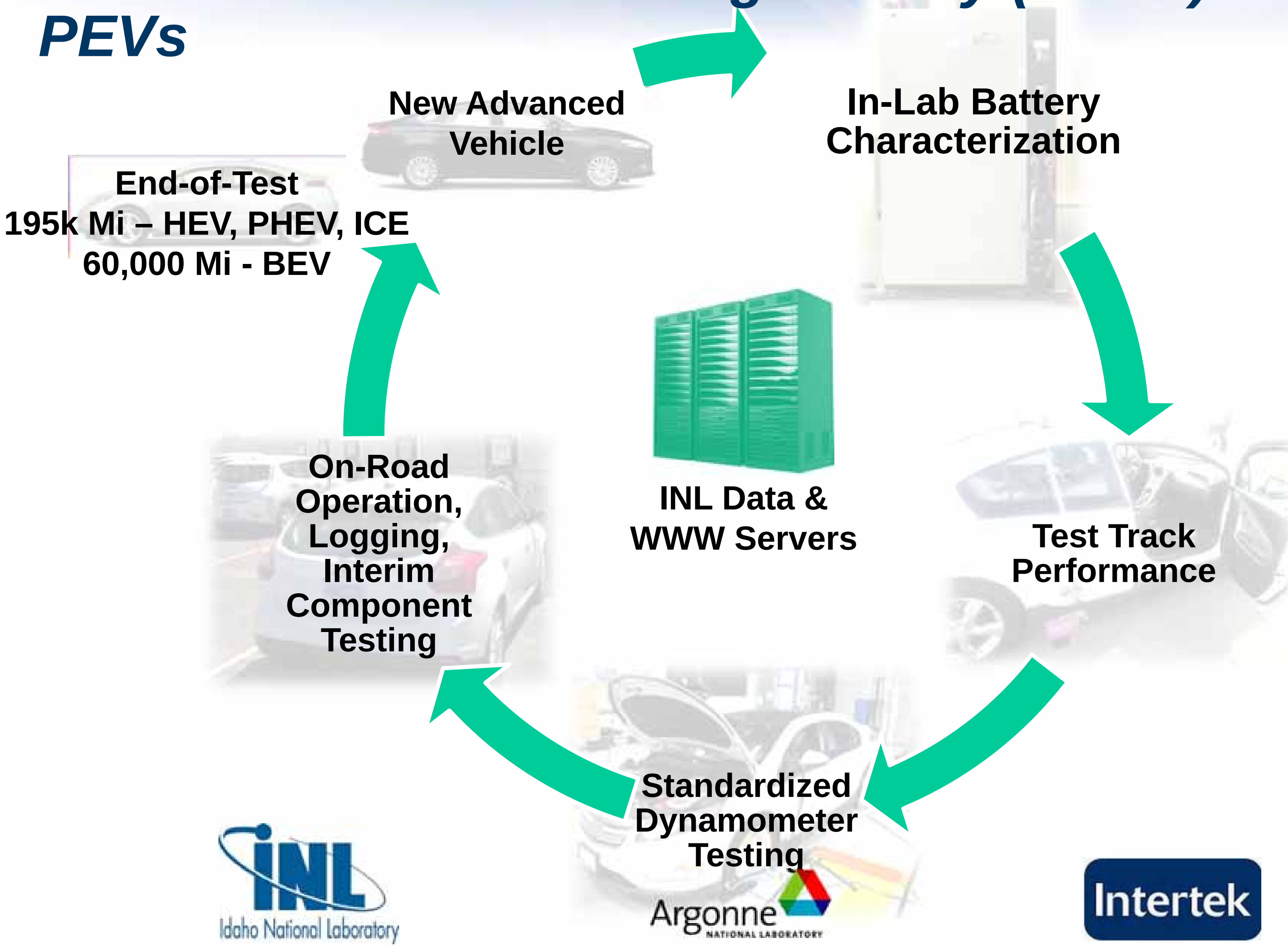
Vehicle data
65 parameters were provided to INL
Data collected and captured 1 second increments
Parameters included everything from speed, rpm, auxiliary use to battery current, voltage and temperature; and ambient temperature, Level 1 & 2 charging

31 public quarterly reports generated. Many more generated for use internally by Chrysler

All raw data is NDA protected

PEV-Focused
Benchmarking & Information Collection

Advanced Vehicle Testing Activity (AVTA) Fleet PEVs



AVTA Owned PHEVs

Goal – benchmark life-cycle costs, maintenance requirements, battery performance, real world mpg & kWh / mile. Inform fleet & public PEV pur-chase decisions. Reduces technology adaption & mission placement risks

Vehicle data – AVTA Data Loggers

16 standard parameters. Most 30 total parameters @ 1 hertz. Allows calculations of Mpg & DC Wh/mi, Total & trip distances, ambient temperatures, AC use, etc. Reported by trip mode: all trips, EV trips, mixed mode trips, charge sustaining trips.



- **5 PHEV models since 2011, 18 PHEVs**
- **956,000 test miles**
- ***Data collection ongoing***

- ***(4) 2013 Ford Fusion Energi, (6) 2013 Ford C-Max Energi, (4) Toyota Prius PHEV, (4) 2013 & (2) 2011 Chevrolet Volts. (4) 2015 Honda Accord PHEV coming.***

70 public quarterly reports generated. Some raw data shared with other national labs and universities

No NDAs

AVTA Fleet PHEVs

Goal – benchmark life-cycle costs, maintenance requirements, battery performance, real world mpg & kWh / mile. Inform fleet & public PHEV purchase decisions. Reduces technology adaption & mission placement risks

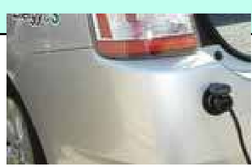
Vehicle data – AVTA Data Loggers

PHEV 16 standard parameters. Most 30 total parameters @ 1 hertz. Allows calculations of Mpg & DC Wh/mi, Total & trip distances, ambient temperatures, AC use, etc., reported by trip mode: all trips, EV trips, mixed mode trips, charge sustaining trips.

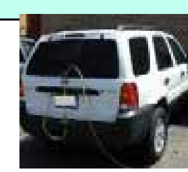
- **10 models, 266 PHEVs**
- **4.1 million test miles**
- ***Data collection completed 2012***

- ***TADA Town & Country, Quantum Escapes, TADA Ford Escapes, Hymotion Escapes, Hymotion Prius, Electrovaya Escapes, Hybrids Plus Escapes, EnergyCS Prius, & Renault Kangoo.***

118 public quarterly reports generated. Some raw data shared with other national labs and universities



Mix of no & expired NDAs, & 1 NDA



AVTA Owned BEVs

Goal – benchmark life-cycle costs, maintenance requirements, battery performance, real world mpg & kWh / mile. Inform fleet & public BEV purchase decisions. Reduces technology adaption & mission placement risks

Vehicle data – AVTA Data Loggers

BEV 12 standard parameters. Most BEVs 30 total parameters @ 1 hertz. Allows calculations of Mpg & DC Wh/mi, total & trip distances, ambient temperatures, charging behavior, AC use, amp-hour through put, etc. .

- **6 models since 2011, 17 BEVs**
- **171,000 test miles**
- ***Data collection ongoing***

- ***(4) 2014 Smart EVs, (4) 2013 Ford Focus, (4) 2013 Nissan Leafs, (2) 2012 Mitsubishi i-MiEVs, (2) 2011 Nissan Leafs, (1) 2015 BMW i3 w/RE. (3) More BMW i3 w/RE, (4) BMW i3, (4) Kia Soul EV, (4) Mercedes B- EV, (4) Chevy Spark coming.***

103 public quarterly reports generated. Some raw data shared with other national labs and universities

No NDAs

AVTA Fleet BEVs

Goal – benchmark life-cycle costs, maintenance requirements, battery performance, real world mpg & kWh / mile. Inform fleet & public BEV purchase decisions. Reduces technology adaption & mission placement risks

Vehicle data – AVTA Data Loggers

BEV 12 standard parameters. Most BEVs 30 total parameters @ 1 hertz. Allows calculations of Mpg & DC Wh/mi, total & trip distances, ambient temperatures, charging behavior, AC use, amp-hour through put, etc.

- **42 models, 2,000 BEVs**
- **5 million test miles**
- ***Data collection completed 2012***

- ***EV1, Rangers, Epics, Mini-Es, RAV4s, S-10s, E-10's, Forces, EV 100 Pickups, Metro's, Caravans, U.S. Electricars, EV Plus's, Altras, etc.***

118 public quarterly reports generated. Some raw data shared with other national labs and universities

Mix of no & expired NDAs

DC Fast Charging Project

Goal – Operate on-road & benchmark two Nissan Leafs charged @ Level 2 & two DCFC charged. Battery tests every 10,000 miles. Two additional Leafs on lab cyclers. Reduce DCFC uncertain-ties & accelerate DCFC use, which in-creases electric vehicle miles traveled.

Vehicle data
~30 parameters captured by AVTA data loggers @ 1 hertz. Parameters included everything from speed, rpm, auxiliary use to battery current, voltage and temperature; ambient temperature, Level 2 & DCFC energy & power, efficiency

- **Six Nissan Leafs**
- **240,000 test miles & 30 battery tests to date.**
- ***Data collection will complete at 70,000 test miles per battery pack***

10 public reports & presentations generated

No NDAs

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Custom Reports & Information Generated

Custom Reports & Information Generated

- **A multitude of universities, other academic institutions, research organizations, countries, & NGOs have requested & been provided with reports to aid their research with PEV design & promotion, & climate change issues. These groups include the following:**
  - **National Academy of Sciences Committee on Overcoming Barriers to EV Adoption**
  - **Center for Climate and Energy Solutions (formerly the Pew Center on Global Climate Change)**
  - **Clinton Foundation - Clinton Climate Initiative**
  - **Union of Concerned Scientists**
  - **Electric Drive Transportation Association**
  - **Argonne National Laboratory**
  - **Oak Ridge National Laboratory**
  - **National Renewable Energy Laboratory**
  - **Lawrence Berkeley National Laboratory**
  - **Portland State University**
  - **U.S. Departments of Defense & Transportation**

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Custom Reports & Information Generated: cont'd

- Electric Power Research Institute
- Washington State Department of Transportation
- State of Oregon Department of Transportation
- California Air Resources Board
- California Energy Commission
- Electric Power Research Institute
- National Rural Electric Cooperative Association
- Collaborative Efficiency
- Commonwealth of Australia
- International Energy Administration
- Washington PEV Working Group (Seattle area)
- Stanford University
- Aalto University in Finland
- SAE committees
- Numerous Clean Cities Collations requests for presentations & information

Custom Reports & Information Generated: cont'd

- **Sea Tac Airport (Seattle / Tacoma)**
- **Numerous research and government groups within the People's Republic of China**

- **Charging behavior & demand on the electric grid was requested by 22 electric utilities to inform their assessments on the following:**
  - **The impact of EV charging on the electric grid**
  - **Pricing elasticity & efficacy of time-of-use electricity rates for PEV owners**
- **The EV Project enabled the identification of 140 companies who have installed workplace charging equipment. The list of these companies was provided to DOE for invitation to participate in the Workplace Charging Challenge. Additionally, reports on the use of workplace charging equipment in The EV Project were published and shared with Workplace Charging Challenge participants to promote lessons learned and best practices**

Custom Reports & Information Generated: cont'd

- INL reports on driving & charging behavior observed in national plug-in electric vehicle & charging infrastructure demonstrations have been used by OEMs to make informed decisions such as:
  - Vehicle powertrain architecture design, electric range selection, & battery sizing
  - Onboard charger power level
  - Battery life & warranty cost prediction models
- Representatives from Ford, GM, Chrysler, Honda, Nissan, Toyota, & Mitsubishi have expressed appreciation for information published by INL, because results from real-world demonstrations provide them with rare & valuable feedback on how customers are using their products. Ford, GM, Honda, & Toyota have asked for additional special analysis and reporting
- EV infrastructure installation cost data has been requested by EVSE providers, auto OEMs, and researchers to understand if equipment installation cost may be a barriers to EV adoption

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Future Information Analysis

Information Analysis Tasks for FY15

Leaf and Volt travel studies

- **Leaf and Volt away-from-home infrastructure usage vs. eVMT**
  - **Day-time vs. night-time; home vs. away from home; L1 vs. L2 vs. DCFC**
  - **Update Volt Aug and Sep 2013 papers**
- **Leaf driving range**
  - **How often do they drive beyond single charge range?**
  - **When they do, what infrastructure do they use? How far from home do they drive?**
  - **How important are DCFCs for range extension**?

EVSE usage and PEV travel on inter-city corridors

- **OR/WA I5**
- **San Diego/LA**
- **Nashville/Knoxville (?)**
- **Chattanooga/Atlanta (?)**

Information Analysis Tasks for FY15: cont'd

Workplace charging

- **Longitudinal driving and charging behavior of drivers with access to WP charging**
  - **How many WP charging users "need" it based on commuting patterns?**
  - **Are they off-setting home off-peak charging with WP on-peak charging?**
- **Vehicle charging frequency at small, medium, large companies with WP charging**

EVSE usage by venue

- **Deep dives by venue (airports, retail, leisure, etc.)**

Demand charge impact

- **DCFCs**
- **Banks of Level 2 EVSE**

Upcoming EV Project White Papers

Infrastructure Issues

1. **What makes an L2 commercial site highly utilized - correlation between utilization and three location based factors**
2. **What makes an L2 public site highly utilized - correlation between utilization and three location based factors**
3. **What makes a DCFC site highly utilized - correlation between utilization and three location based factors**
4. **What makes an L2 commercial site highly utilized - correlation between utilization and three host based factors**
5. **What makes an L2 public site highly utilized - correlation between utilization and three host based factors**
6. **What makes a DCFC site highly utilized - correlation between utilization and three host based factors**

User Issues

7. **What makes an L2 commercial site highly utilized - analyze correlation between utilization and three user based factors**
8. **What makes an L2 public site highly utilized - analyze correlation between utilization and three user based factors**

Upcoming EV Project White Papers

User Issues – cont'd

9. What makes a DCFC site highly utilized - analyze correlation between utilization and three user based factors
10. Top mileage accumulators - characterize use patterns, demographics and geographic of top 50 highest mileage accumulators
11. Top residential charging users - characterize use patterns of top 50 users that never (or rarely) charge away from home
12. Top commercial/public charging users - characterize use patterns of top 50 users of commercial/public charging (by percent of their total charging)
13. Top DCFC users - characterize use patterns of top 50 users of DCFC (by percent of their total charging)

Cost Issues

14. What was the cost to add separate utility submeters at the time of EVSE installation
15. What is the impact of utility demand charges on a Level 2 host
16. What is the impact of utility demand charges on a DCFC host
17. What were the implementation challenges associated with workplace charging installation
18. What were the cost drivers for workplace charging installations

Upcoming EV Project White Papers

Cost Issues – cont'd

19. How do non-residential charging infrastructure installation costs vary by geographic location
20. What were the cost drivers for residential charging installations
21. How do residential charging infrastructure installation costs vary by geographic location
22. What were the cost drivers for DCFC installations
23. How do DCFC infrastructure installation costs vary by geographic location
24. What are the business models currently employed for commercial charging
25. What are the business models currently employed for workplace charging and what is the impact of free workplace charging
26. What are the business models currently employed for DCFC
27. How many Low Carbon Fuel Standard credits have been generated by the EV Project and how many gallons of gasoline have been saved in California
28. What are revenue streams and intangible benefits a charging site host can expect to gain from the installation of EVSE units

Grid Impact Issues

29. Characterize the demand and energy characteristics of L2 commercial EVSE

Upcoming EV Project White Papers

Grid Impact Issues – cont'd

30. Characterize the demand and energy characteristics of L2 public EVSE
31. Characterize the demand and energy characteristics of DCFC
32. Characterize the demand and energy characteristics of residential EVSE
33. Characterize clustering of L2 commercial EVSE
34. Characterize clustering of L2 public EVSE
35. Characterize clustering of DCFC
36. Characterize clustering of residential EVSE
37. Characterize global controllable demand from L2 commercial EVSE
38. Characterize global controllable demand from DCFC
39. Characterize global controllable demand from residential EVSE
40. Characterize energy storage required to reduce peak Level 2 commercial charging demand
41. Characterize energy storage required to reduce peak Level 2 public charging demand
42. Characterize energy storage required to reduce peak DCFC charging demand
43. Characterize energy storage required to reduce peak L2 public/commercial charging demand

Upcoming EV Project White Papers

Grid Impact Issues – cont'd

44. Characterize impact of 6.6kW residential charging
45. Characterize impact of 6.6kW Level 2 commercial charging
46. Characterize impact of 6.6kW Level 2 public charging
47. Characterize the capability of L1 residential charging to satisfy Volt charging needs
48. Characterize the capability of L1 residential charging to satisfy Leaf charging needs
49. SDG&E Project description and lessons learned - TOU rates
50. What was the impact of the car sharing on Publically Available charging infrastructure in San Diego
51. What were 'best practices' for residential infrastructure permitting
52. What were 'best practices' for public infrastructure permitting
53. What practices were used for non-residential charger locating (way-finding)
54. What were practices were used for workplace charging use allocation

Planning Issues

55. How does the location of public and commercial infrastructure actually deployed correlate with EV Project Micro-Climate planning locations
56. How does the use of public and commercial infrastructure actually deployed correlate with EV Project Micro-Climate planning locations

Upcoming EV Project White Papers

Planning Issues – cont'd

57. What percent of total charging energy is dispensed at Level 2 vs. DCFC
58. What percent of total charging energy is dispensed at residential vs. workplace vs. commercial vs. public venues
59. What practices were used for parking/charging enforcement issues

First FY-15 EV Project White Papers

- What were the cost drivers for workplace charging installations
- What were the cost drivers for publicly accessible charging installations
- What were the cost drivers for DCFC installations
- How do residential charging infrastructure installation costs vary by geographic location
- How do publicly accessible infrastructure installation costs vary by geographic location
- Characterize clustering of residential EVSE & grid impacts
- Characterize global controllable demand from residential EVSE "smart grid"
- How does the location of public and commercial infrastructure actually deployed correlate with EV Project Micro-Climate planning locations

First FY-15 EV Project White Papers: cont'd

- **What percent of total charging energy is dispensed at residential vs. workplace vs. commercial vs. public venues vs. DCFC locations**
- **What makes a DCFC site highly utilized - correlation between utilization and three location based factors**
- **Top commercial/public charging users - characterize use patterns of top 50 users of commercial/public charging (by percent of their total charging)**

Information Collection & Protection, & Presentation Summary

Information Collection & Protection

- **INL has used data loggers on PEVs & EVSE since 1993 in order to benchmark performance & use profiles**
- **Most PEV, charging infrastructure, & personal information is legally protected by NDAs (Non Disclosure Agreements)**
  - **Limitations on how proprietary information can be distributed, stored, & used**
  - **No raw data, per NDAs, will be distributed by INL**
  - **Raw data, in both electronic & printed formats, is not shared with DOE in order to avoid exposure to FOIA requests**
- **All documents are submitted for export control compliance via the INL Scientific & Technical Information Management System**

Jim before the EV Project

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Summary

INL's Overall Goal – In the most cost effective method possible, INL will use the information discussed today to provide support to DOE's and other organizations' information needs, per NDA limitations

- *INL staff have adhered to NDA requirements while accumulating 248 million PEV test miles & 6 million charge events*
- *From 44,001 PEVs & EVSE information sources*
- *INL staff have generated a total of 1,135 PEV public documents, using 37 information models*

Information collection would not occur unless NDAs are strictly adhered to by INL, and our testing partners were confident that the NDAs would be strictly followed by INL

For all public reports, please visit:

http://avt.inl.gov

INL's funding for this work comes from DOE's Vehicle Technologies Office

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