FY 2016 Vehicle Technologies Office's Annual Operating Plan Lab Call, Area of Interest 9B, Vehicle Technology Evaluations – Idaho National Laboratory FY-16

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Task

- **Idaho National Laboratory (INL) was part of a 3 Task, 2 Lab response to remove uncertainties as to how DOE technology investments will:**
  - **Support greenhouse gas emissions reduction of 15% by 2020**
  - **Net oil imports reduction of 50% by 2020**
  - **Achieve CAFÉ standard of 54.5 mpg by the year 2025.**
- **The three tasks are conducted by:**
  - **Idaho National Laboratory**
  - **Argonne National Laboratory**
  - **National Renewable Energy Laboratory**

Task Significance

Publicly accessible data that benchmarks the performance of advanced vehicle and subsystem technologies are rare

Data may exist within the largest industry laboratories; however, these data are considered proprietary and are closely guarded

This project provides access to data from laboratory and on-road testing that is normally too expensive for most research institutions to generate

Four Task Objectives

The much-needed open data serves the following main objectives:

- ***Technology Assessment*: Public test data aids in the creation of appropriate research goals and helps focus research efforts to maximize energy efficiency and petroleum displacement**
- ***Independent Public Data and Knowledge Base*: DOE's investment in creating test data for advanced technology vehicles is leveraged across a wide range of partners:**
  - **Academia**
  - **Startup companies**
  - **National laboratories**
  - **Suppliers**
  - **Original equipment manufacturers**

  Accelerates the market for advanced vehicle technologies

Four Task Objectives – cont'd

- ***Integration with Modeling and Simulation***: **Integrate laboratory and on-road test results with simulation to improve DOE forecasting of technology benefits. This road-to-lab-to-math correlation process is vital to understanding the real-world benefits of advanced vehicle technologies today and in the future**
- ***Codes and Standard Development Support***: **Public laboratory testing and established centers of expertise enable the development of suitable standards and procedures to accurately evaluate performance and efficiency characteristics of vehicles**

1914 Detroit Electric 50 to 85 miles per charge

INL Light-Duty Vehicle Technology Evaluations

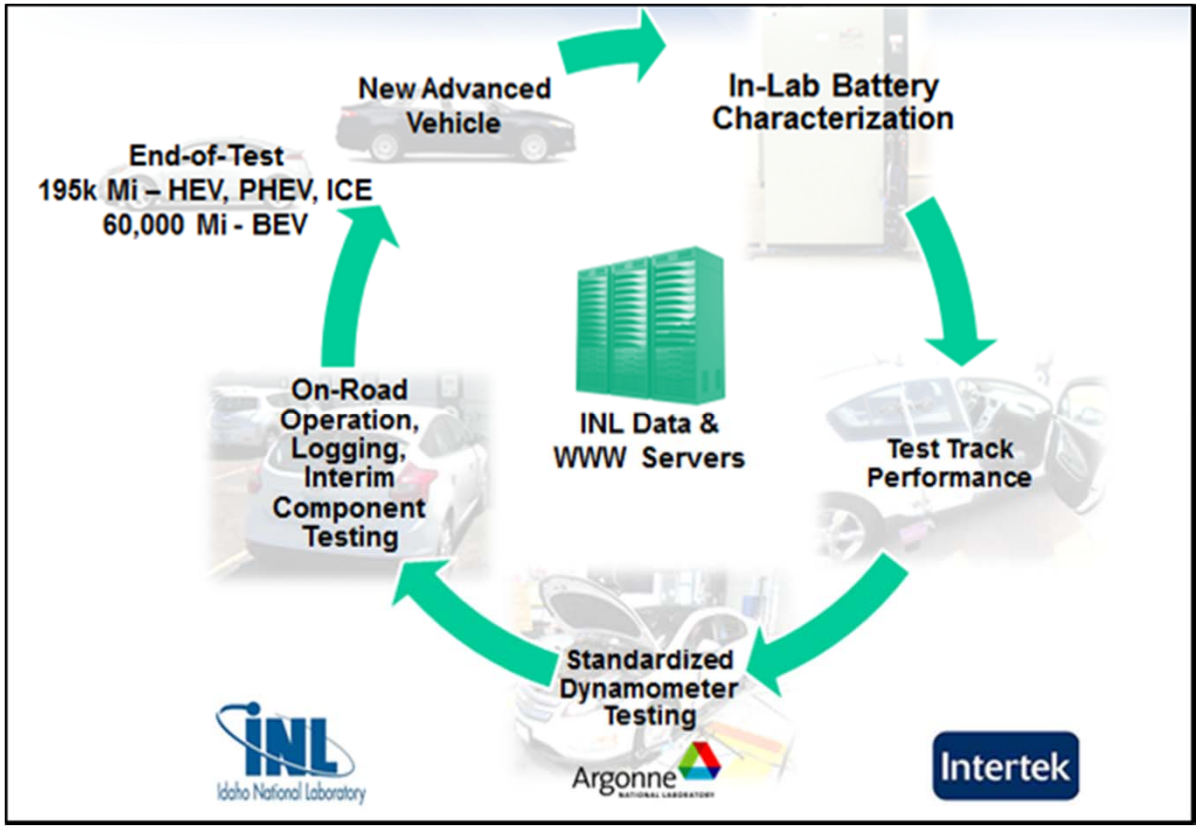
- **INL is responsible for Task 2, including:**
  - **Advanced Vehicle Testing Activity (AVTA) and subcontractor (Intertek) execution of the Advanced Vehicle Testing Extended (AVTE)**
    - **AVTE incorporates track, dynamometer, test cell, and field testing of vehicles and subsystems**
  - **Vehicle selection**
  - **Data collection, analysis, and reporting for the AVTE testing of light-duty vehicles**

AVTA and AVTE Execution

- **Light-duty vehicle and subsystems (energy storage devices and accessory subsystems) vehicle testing flow**

End-of-life vehicles are sold to capture life-cycle capital depreciation costs, and sometimes sold to ANL, INL, NREL and the EPA for secondary testing programs, such as:

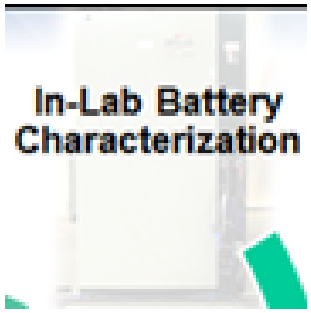
- **Thermal impacts**
- **End-of life mpg and emissions testing**
- **Battery testing**



Main AVTA/AVTE Execution Activities

- **The main activities for conducting the AVTE vehicle testing as seen on the previous slide, are described below. This process restarts every time a new vehicle model is introduced into the test fleet**

***New Advanced Vehicle*: AVTE vehicles are procured by Intertek and INL determines which CAN bus parameters need to be collected when the data logger is installed in a vehicle in order to benchmark operational profiles that support partners' and audiences' needs**

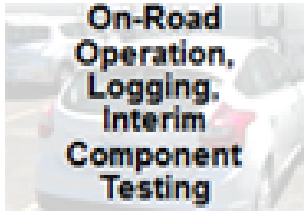


In-Laboratory Battery Characterization: INL engineers establish the proper battery test cycle, ensure proper application of the battery test manual, and establish testing frequency

Main AVTA/AVTE Execution Activities – cont'd

Test Track Performance: INL engineers establish the track tests and conditions that are required for each vehicle. Only one AVTE vehicle per model is track tested

Standardized Dynamometer Testing: ANL conducts dynamometer testing, with INL engineers receiving and analyzing the results for AVTE vehicles



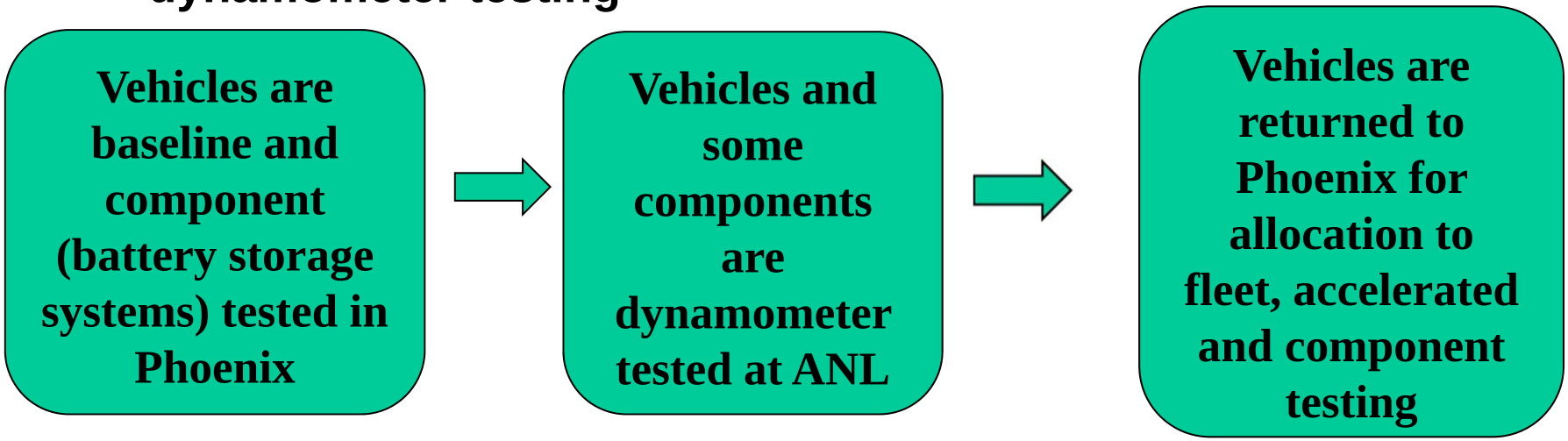
On-Road Operation, Logging, Interim Component Test: INL engineers match vehicles to test fleets, parameters collected, data loggers, analysis methods, and reports. This information is shared with NREL and ANL.

Main AVTA/AVTE Execution Activities – cont'd

<u>End-of-Test 195K Miles:</u> HEVs, PHEV, EREV, ICEV, and BEV: In accordance with INL direction, final laboratory and track testing occurs, vehicles are disposed of, and lifecycle costs are established. Vehicle disposition often includes sending vehicles to other DOE laboratories and sometimes EPA for additional testing

Cooperative Testing

- INL works with both ANL and NREL in various tasks
  - INL takes advantage of ANL's expertise and facilities for dynamometer testing



  - INL coordinates with NREL on data parameters and reporting
  - INL provides analysis results for ANL and NREL modeling and simulation tools
  - INL also provides drive cycles and charging profiles analysis results for ANL and NREL modeling and simulation tools

Vehicle Technologies

- **Of primary interest is the benchmarking of electric drive vehicles and their energy storage subsystems**
  - **Electric drive vehicles have the highest petroleum reduction potentials**
- **Other vehicle technologies to be tested that provide petroleum reduction benefits include:**
  - **Compressed natural gas**
  - **Hydrogen (fuel cell vehicles)**
  - **Diesel vehicles**

- **Historically, electric drive vehicles have been of primary interest. However, other past vehicle technologies tested include:**
  - **Hydrogen internal combustion engine vehicles**
  - **CNG with start / stop technology**
  - **Small classes of electric drive vehicles such as neighborhood electric vehicles**

Infrastructure Testing

- **Vehicle and fueling infrastructure testing includes electric charging infrastructure on the vehicle side of the electric meter, including:**
  - **Efficiency**
  - **Standby power**
  - **Driver use preferences**
  - **Power quality**
  - **Cyber security testing is sometimes conducted beyond the electric meter in order to better understand the impacts of grid-connected vehicles**
- **Testing includes AC Levels 1 and 2, and DC fast chargers**

Fleet (unless noted) Vehicle Testing FY-16

- 36 high impact technology vehicles for testing during BP3
- In order of priority:
  - (4) 2016 Chevrolet Impala CNG Bi-Fuel vehicles

  - (4) 2016 Chevrolet Volt PHEV

  - (4) 2016 Audi A3 e-tron PHEV

  - (4) 2016 Hyundai Sonata PHEV
  - (1) 2016 Toyota Mirai FCEV – Accelerated Reliability out of Irvine
  - 2016 Via VTRUX PHEV – Loaned vehicle from EV Everywhere Grand Challenge, conduct coastdown and ANL fuel economy testing, then accelerated reliability

  - (4) 2016 Chrysler Town & Country PHEV
  - (4) 2016 Toyota Rav4 HEV

Fleet (unless noted) Vehicle Testing FY-16: cont'd

- (4) 2016 Chevrolet Malibu HEV
- (2) 2016 Volvo XC90 PHEV – look at two due to price of vehicle
- (2) 2016 BMW x5 xDrive e40 – look at two due to price of vehicle
- (IMPORT) 2016 Mitsubishi Outlander PHEV – Vehicle delays for selling in the USA
- (IMPORT) European Pre-Transmission PHEV – Interest from modeling group at ANL
- (4 When Available – Potentially in FY-17) 2017 Chevrolet Bolt BEV
- (2 When Available – Potentially in FY-17) 2017 Cadillac CT6 PHEV

Fleet (unless noted) Vehicle Testing FY-16: cont'd

Modelers

- **Please provide your data requests <u>now</u>**
- **Before we buy vehicles and program the data loggers**

Project Management: SMART Milestones

End FY 2017 Smart Milestone

INL will issue an analysis report that will use 10-years of AVTA and AVTE test results to document historical trends in fuel economy, overall cost of ownership, and estimated future benefits of advanced technology vehicles

Every quarter, INL also submits quarterly progress reports via DOE systems and publishes fact sheets and test reports as completed

Summary: 1 of 3

- INL's conduct of the AVTA/AVTE includes private industry being closely involved in the testing process
- This includes cost sharing of testing costs and determining program direction
- INL highly leverages private sector involvement in order to provide the greatest value for DOE's investments in vehicles and components

Summary: 2 of 3

- AVTE has multiple audiences for the benchmarked results, including testing partners, OEMs, universities, fleets, electric utilities, DOE laboratories, and private industry
- Information exchanges occur via multiple pathways that include:
  - Industry presentations
  - Peer-reviewed technical papers
  - Lessons learned white pagers
  - Clean Cities groups
  - Stakeholder requests for information
  - INL's AVTA program homepage

Summary: 3 of 3

- Vehicle technologies and components selected for testing are chosen to represent:
  - DOE's investments in technology development
  - Interesting nondomestic technologies
- INL and its national laboratory and industry partners are DOE's ultimate information source on how well DOE's investments in technologies reduce real-world petroleum use
- While new technologies can add barriers and challenges to testing vehicles, current INL staff and test partners have a 22-year history of developing new testing methods based on industry input
  - This includes proper instrumentation, CAN cracking, and use of custom-designed sensors and instrumentation