



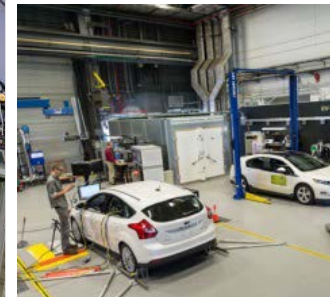
Overview of the DOE/VTO Vehicle Systems Program

June 8, 2015

David Anderson & Lee Slezak
Vehicle Systems Program

Overview

- Goals and Objectives
- Impact of VS Portfolio
- Vehicle Systems Focus Areas
 - Modeling and Simulation
 - Vehicle Technology Assessment
 - Codes and Standards
 - Vehicle Efficiency Improvements
- Vehicle Systems Budget
- Accomplishments
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 - Heavy Duty highlights
- Additional Information
- Conclusion
- Contacts



Goals and Objectives of Vehicle Systems

Accelerate market penetration of advanced vehicles and systems to displace petroleum consumption, reduce GHG emissions, and achieve vehicle electrification goals.

**Evaluate
technology
targets**

**Accelerate
efficient
designs via
tools, analysis,
& procedures**

**Provide
stakeholders
with data and
analysis to
support
decision
making**

**Support Codes
& Standards
development
for electric
vehicles**

**Develop
technologies
to enhance
energy
efficiency and
acceptance**

Vehicle Systems Serves the Vehicle Technologies Office

Vehicle Technologies Office

Hybrid Electric
Systems

Materials
Technology

Fuel
Technologies
and Deployment

Advanced
Combustion
Engines

Analysis,
Communications
and Education

Hybrid Electric Systems

Vehicle Systems



Energy Storage



Electric Drive
Technologies



Vehicle Systems Focus Areas

*Codes and
Standards*



*Vehicle
Technology
Evaluation*



*Modeling and
Simulation*



*Vehicle Systems
Efficiency
Improvements*



Tool, Data, Procedure and Results Integration

*Robust
standards to
support new
technology*

*Independent
and unbiased
data
dissemination*

*Tool
development,
benefits
forecasting*

*Technology
development*

System Context, Target Setting, Analysis

Vehicle Systems Portfolio Supports Many Activities

DOE VTO

- Hybrid Electric Systems
- Materials Technology
- Advanced Combustion Engines
- Analysis, Communications and Education



21CTP & SuperTruck



EV Everywhere



Workplace Charging Challenge



Connected and Autonomous Vehicles



Grid Modernization



Technology Incubator

EISA 2007
Section 131



Vehicle Systems

Codes and Standards



Vehicle Technology Evaluation



Modeling and Simulation



Vehicle Systems Efficiency Improvements



Note: This list of activities is not exhaustive



Standards



ANSI, IEEE, ISO, IEC, DIN,
JARI, CATARC, ...



VS Focus Area: Codes and Standards

Support development and adoption of codes and standards for electrified vehicles

- PEVs, EVSE and Smart Grid Expertise
 - Standards Development: testing, communications, interoperability, security, safety, and performance
 - Standards Validation: proof-of-concept hardware/software and validation of approaches
 - Strategic Coordination: ANSI standardization roadmap; NIST in-use electric refueling equipment
 - International Cooperation and Harmonization: interoperability procedures
- Facilitate technology deployment by:
 - Consistent customer experience through harmonization
 - Risk management: prevent under- (slower adoption) or over-prediction (hype) of technology benefits
 - Removing obstacles to market adoption



VS Focus Area: Vehicle Technology Evaluations

Utilize structured, repeatable testing methods and real world usage to establish technology benchmarks of powertrain systems and components

- Expertise and Facilities
 - In-depth laboratory testing of advanced technology vehicles, components and control behavior
 - Closed-track and on-road evaluation of light-duty advanced technology vehicles
 - In-fleet evaluations of medium- and heavy-duty advanced technologies with industry partners
 - Charging equipment evaluations and research in EVSE load management
- Disseminate unbiased, independent data:
 - Technology assessment: target setting
 - Simulation support: model development & validation
 - Support Codes and standards development
 - Independent public data and knowledge base used by academia, start-ups, suppliers, OEMs
 - <http://energy.gov/eere/vehicles/vehicle-technologies-office-avta-light-duty-alternative-fuel-and-advanced-vehicle-data>

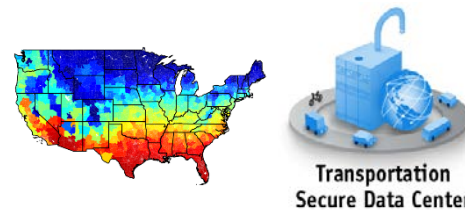
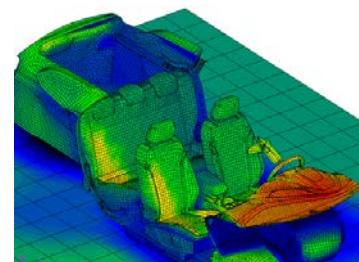


avt.inel.gov/
www.transportation.anl.gov/D3/
www.nrel.gov/transportation/fleetttest.html

VS Focus Area: Modeling and Simulation

Develop and use modeling and simulation tools to evaluate the efficiency potential of technologies, accelerate design process, and guide DOE R&D activities and goals

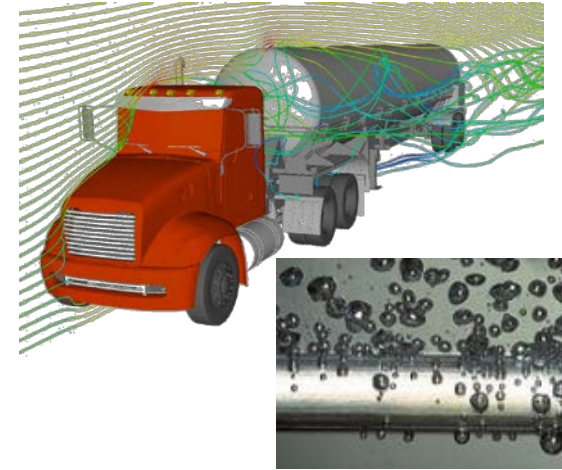
- **Simulation Expertise and Tool Capabilities**
 - Database of validated vehicles, powertrains and component models, and vehicle level control algorithms
 - Autonomie: Model Based Design tool with plug and play architecture. Features: light duty, heavy duty, component-in-the-loop, cost...
 - Specific models (e.g., AC) and data sets (e.g., TSDC) developed across the national laboratory system
- **Validated models and simulations:**
 - Determine component development requirements for DOE research from a system perspective
 - Estimate the fuel saving benefits of VTO technologies and research (BaSCE– congressional mandate)
 - Reduce time and cost of technology development
 - Identify “white space” innovation opportunities



VS Focus Area: Vehicle Systems Efficiency Improvements

Investigate systems optimization strategies and enabling technologies to enhance vehicle efficiency, reduce parasitic energy losses, and enable reductions in energy requirements

- The research projects in this area address innovation opportunities quantified in the other three areas.
- Current areas of R&D include:
 - Aerodynamic Drag Reduction for long haul trucks through modeling and wind tunnel testing
 - Friction and Wear Reduction through tribology
 - Thermal Control and Auxiliary Load Reduction ranging from advanced climate control systems to nanofluids and nucleated boiling
 - Smart Grid research and Fast Wireless Charging related to efficiency, safety, cyber security, and renewables integration
- Increase vehicle efficiency and reduce energy consumption through a systems approach by:
 - Reducing auxiliary loads
 - Reducing system losses
 - Optimizing system through better component interactions
 - Extending Electric Vehicle range



Vehicle Systems R&D Budget

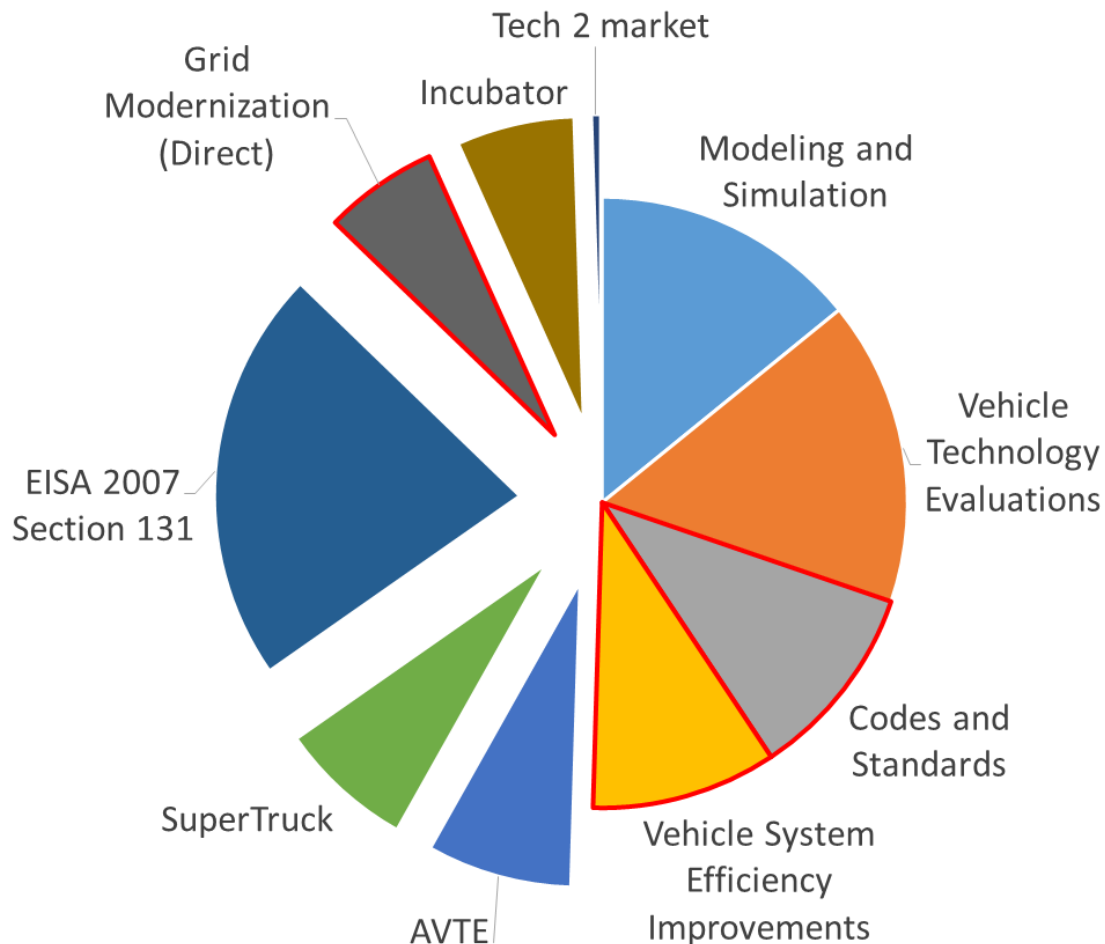
Accelerate market penetration of advanced vehicles and systems to reduce petroleum consumption, reduce GHG emissions, and achieve vehicle electrification goals.

Vehicle Systems R&D Funding (\$M)

FY 2014	43.5
FY 2015	40.3
FY 2016*	68.1

*Increase to support Grid Modernization and SuperTruck efforts

FY 2015 R&D activities



Grid Modernization Crosscut

Accomplishments: Codes and Standards

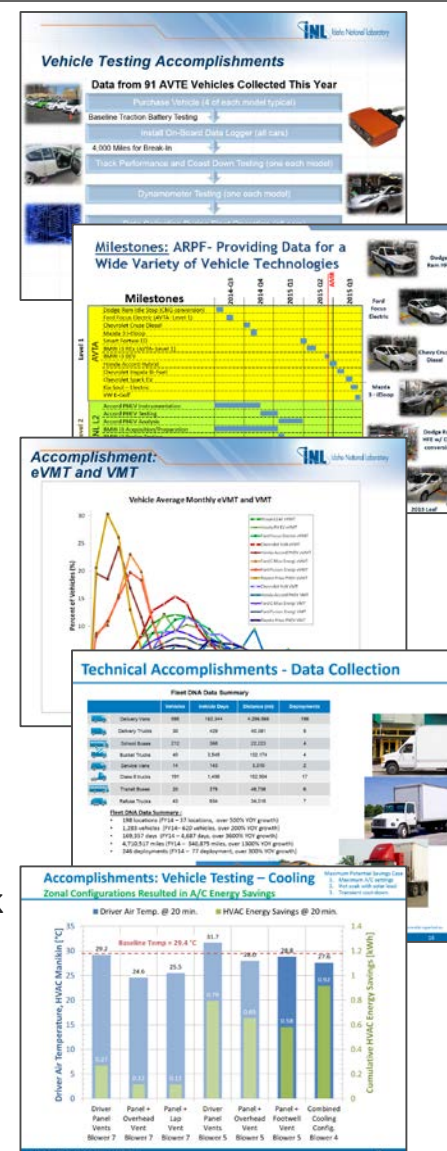
- Powertrain System Power Rating for SAE J2908 (VSS143)
 - Standardized calculation method for Nominal System Power
 - Down selecting methods for System Power Test
- Wireless & Conductive Charging Testing to support SAE J2954 (VSS096)
 - Power transfer efficiency measurements and EMI measurements in vehicle and on bench (including Charger Power Quality)
 - Evaluated 4 smart grid capable EVSEs
- EV-Smart Grid and Interoperability (VSS095)
 - US and EC EV Interoperability Centers established
 - Harmonization of standards, technology and test procedures
 - Standard connectivity, communications and verification
 - Common platform development and open source software for grid integration
- PEV-EVSE Interoperability Testing for SAE J2953 (VSS169)
 - 2500 individual tests on PEV-EVSE pair (14 PEVs from 12 vehicle OEMs and 14 EVSE units from 12 infrastructure OEMs)
 - Mixed results from some EVSE/PEVs combinations
- Green Racing Protocols (VSS144)
 - Accelerate technology development and customer outreach/education through motorsports competition



Supporting standards committees with public and independent data

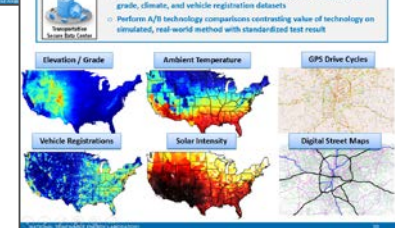
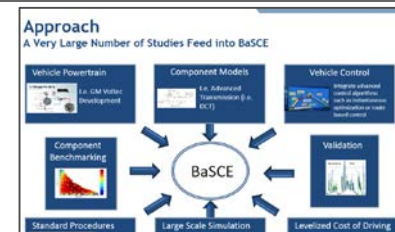
Accomplishments: Vehicle Technology Evaluations

- Advanced Vehicle Testing Activity (VSS029, 021, 030,168)
 - Baseline track testing, high-mileage fleet testing with onboard data logger, Interim component testing (batteries, alt fuel ICE,...)
 - Vehicle and component assessment on dynamometer in thermal chamber for energy consumption, performance and emissions measurement.
 - In-progress: 5 PHEV cont'd, 5 PHEV new, 10 BEVs, 4 Conventional (ICE) models
 - 12V Auxiliary Load On-road Analysis for conventional vehicles
 - Reports and data available at: avt.inel.gov/ and www.transportation.anl.gov/D3/
- Analysis of Electric Vehicle Miles Traveled (VSS171)
 - 21,000+ vehicles, 150+ M miles. Annual eVMT ranged from
 - BEV: 9,548 to 9,697 mi & PHEV / E-REV: 2,484 to 9,112 mi
 - Analysis presented to industry and policy makers
- Medium & Heavy Duty Field Evaluation (VSS001, 159, 160)
 - MD & HD Vehicle Field Evaluations
 - Fleet DNA: real world drive cycle database and analysis www.nrel.gov/fleetdna
 - ARRA data reporting and analysis (Smith Electric, Navistar, ShorePower truck stop electrification and Odyne PHEV utility truck)
- EDV Climate Control Load Reduction (VSS097)
 - Solar load reduction (e.g., shading, window films, reflective coatings), pre-ventilation, and zonal air flow evaluations



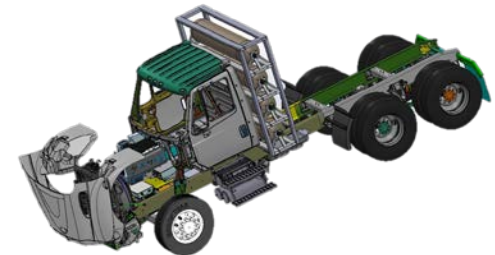
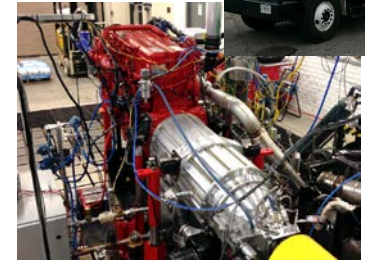
Accomplishments: Modeling and Simulation

- VTO Baseline and Scenario (BaSCE) activity (VSS164):
 - Estimate benefits of VTO technologies in terms of petroleum displacement and cost through 2045. Simulates 4000 vehicle with different powertrain configurations and component technologies.
- Autonomie Studies and Improvements (VSS166, VSS154, VSS153)
 - Advanced Transmission Modeling, including updated shift algorithms, validated DCT and CVT model
 - Fuel Displacement Potential of Advanced Technologies under different thermal conditions: Thermal models and controls validated for Conv., HEV, PHEV, E-REV, and EV
 - Autonomie for Model Based System Engineering: new features such new physical and thermal models, large scale simulation upgrades, UI enhancements (www.autonomie.net)
- Thermal Cabin Modeling (VSS134, VSS075)
 - Developed and validated vehicle thermal system models integrating cabin thermal management systems to powertrain cooling system
 - Refined CoolCalc as well as experiments used to investigate solar loading depending on parking orientation, insulation, paint color and curtains (35+% reduction possible).
- Real-World Vehicle Efficiency Benefits (VSS155)
 - Developed method to estimate national fuel economy benefit of technologies based on the Transportation Secure Data Center (TSDC) drive data, US climate distributions, solar intensity, experimental thermal powertrain data, and national vehicle registration.



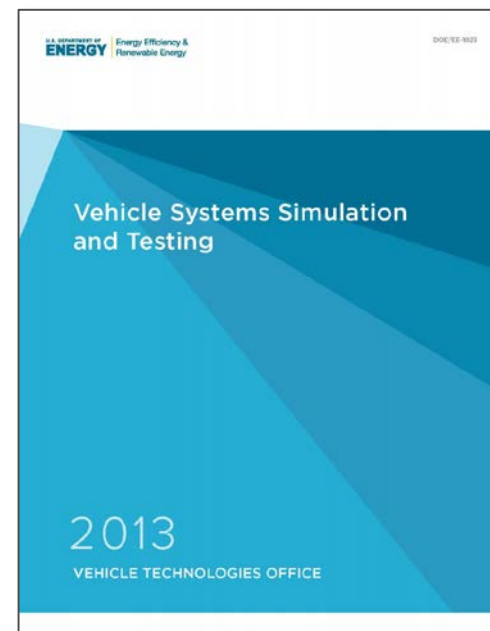
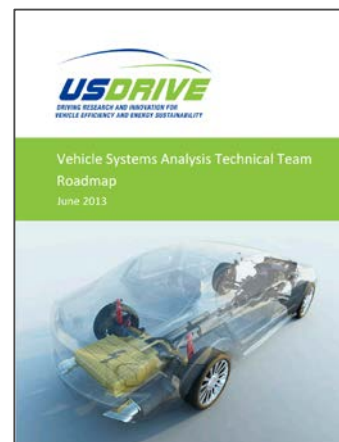
Heavy Duty Accomplishments Across VS Focus Areas

- Vehicle System Efficiency Improvements
 - Advanced tire materials for fuel efficiency (VSS163)
 - Improved Aerodynamics for HD Vehicles including platooning (VSS006)
 - Multi speed transmission for MD commercial delivery PEV (VSS161)
 - MD & HD Accessory Hybridization research through modeling and testing (VSS133)
 - HD Line Haul Truck powertrain hybridization and controls optimization with hardware (VSS141)
- Demonstrations
 - Zero Emissions Cargo Transport Projects I & II (VSS116, 158)
 - Zero Emissions HD Drayage Truck (VSS115)
 - PHEV MD truck demonstration. Class 2 pick up, class 6-8 Aerial truck, class 2 van (VSS083)
- SuperTruck 50+% Freight Efficiency Improvements
 - Navistar (VSS064)
 - Volvo (VSS081)
 - Daimler (ARRAVT080)



VTO Vehicle Systems R&D Road Maps and Reports

- USDRIVE Vehicle Systems Analysis Tech Team and Grid Interaction Tech Team R&D Roadmaps
 - Describe ongoing/planned R&D efforts by US DRIVE Tech Teams supported by the Vehicle Systems Program
 - http://energy.gov/sites/prod/files/2014/02/f8/vsatt_roadmap_june2013.pdf
 - http://energy.gov/sites/prod/files/2014/02/f8/gitt_roadmap_june2013.pdf
- Vehicle System R&D Annual Progress Report for FY2013
 - Describes all Vehicle Systems R&D projects funded by DOE Vehicle Technologies Office (VTO) at a national laboratory or in partnership with industry.
 - http://energy.gov/sites/prod/files/2014/04/f15/2013_vsst_report.pdf



Conclusion: *Vehicle Systems – Something for Everyone!*

- Vehicle System's goal is to accelerate market penetration of advanced vehicles and systems
 - Evaluate impacts of technologies at the vehicle systems level
 - Develop tools, analysis, and procedures
 - Provide stakeholders with data and analysis
 - Support Codes & Standards development
 - Develop technologies that enhance energy efficiency and consumer acceptance
- More than **40** active projects working to achieve real world impacts

Day	Topics
Tuesday AM	CS: Power Rating, Wireless charging, Green racing
Tuesday PM	VTE: Lab and field Advanced Vehicle Testing Activity VSEI: EV AC load reduction, power electronics cooling
Tuesday PM	MS, VTE, CS & VSEI: 12 posters
Wednesday AM	VSEI: Grid Integration; Wireless charging
Wednesday PM	MS: MBSE, AC systems, Temperature impact on energy consumption, Real world efficiency VSEI: Accessory loads, thermal management to extend range
Thursday AM	VSEI: Heavy Duty Tire efficiency, Aero improvements, Zero Emission Cargo Transport demonstration
Thursday PM	VSEI: Heavy Duty SuperTruck, Hybridization

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