

# Transportation Data Program

## *A Multi-Lab Coordinated Project*

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June 8, 2016

2016 U.S. DOE Hydrogen and Fuel Cells Program  
and Vehicle Technologies Office (VTO) Annual  
Merit Review and Peer Evaluation Meeting

*June 6-10, 2016*



# Overview

## Timeline



- Project start date: October 2015
- Project end date: September 2018
- Percent complete: 25%

## Barriers



- Barriers addressed
  - *Multi-Year Program Plan 2011 - 2015*  
Section 2.6 Outreach, Deployment and Analysis A, B, C  
Section 3.2 Program Analysis

## Budget



- Total project funding
  - \$750K / year

## Partners



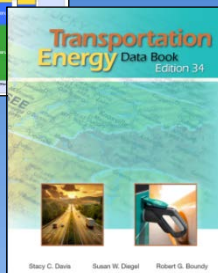
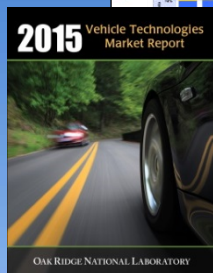
- Oak Ridge National Laboratory (ORNL)
- National Renewable Energy Laboratory (NREL)
- Argonne National Laboratory (ANL)

# Overview

Since 1975



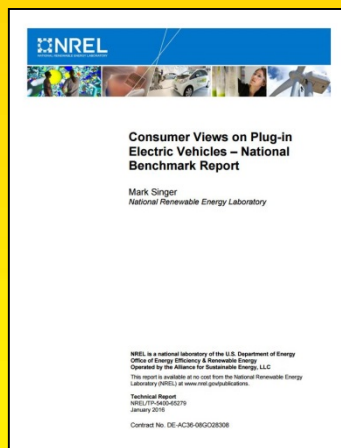
- Transportation Energy Data Book (TEDB)
- Vehicle Technologies Market Report (Market Report), and
- Vehicle Technologies Fact of the Week (FOTW)



Since mid-1990's



- Vehicle Technology Consumer Data
  - Consumer Views on Plug-In Electric Vehicles–National Benchmark Report



Since 1999

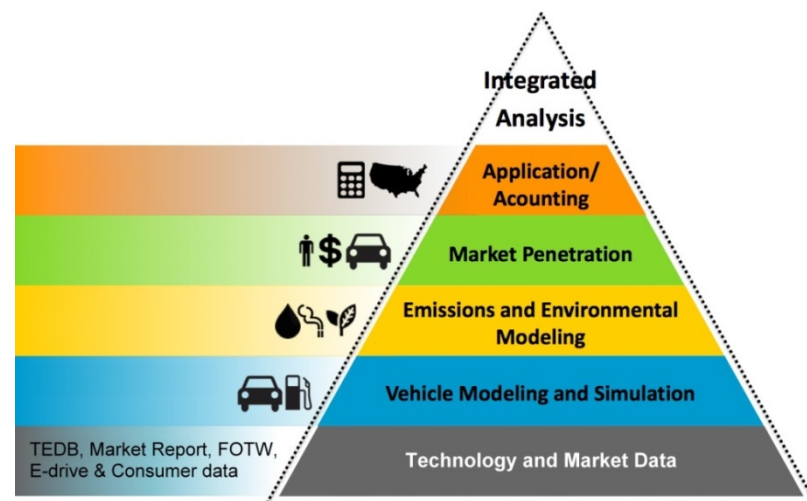


- Electric-drive (E-Drive) Vehicle Sales Data and Market Analysis
  - E-drive sales
  - Regional sales patterns
  - Vehicle ownership cost



# Relevance




- The Transportation Data Program provides the foundation for the Vehicle Technologies Analysis Program in the pursuit of energy-efficient and environmentally-friendly technologies.
- Policymakers, transportation analysts, and VTO staff require quality current and historical data and information on the transportation sector to affect good decisions for the future.
- Data Book is used by the GREET model, MA3T model, and GPRA analysis. Energy Information Administration's National Energy Modeling System and the Environmental Protection Agency's MOVES model for the National Emissions Inventory.
- E-drive data used by the DOE eGallon Initiative and the DOE Advanced Technology Manufacturing Loans Program. The National Science Foundation has a link to the E-drive data webpage.



The Mission of the Vehicle Technologies Office (VTO) is to develop and assist in the deployment of more energy-efficient and environmentally friendly technologies for highway transportation passenger and commercial vehicles that will meet or exceed performance expectations and environmental requirements, enabling the U.S. to use significantly less petroleum and reduce greenhouse gas emissions. - *Multi-Year Program Plan 2011 – 2015*



# Milestones

Quarter		Milestone Description	Milestones for each individual projects FY15	Milestones for the Transportation Data Program FY16
Quarter 1		Fact of the Week prepared weekly for posting on the Vehicle Technologies website	Complete	Complete
Quarter 2		Draft of Vehicle Technologies Market Report delivered to VTO	Complete	Complete
Quarter 3		U.S. E-drive Monthly Sales Report prepared monthly for posting on the E-drive website	Complete	On track
Quarter 4		Draft of Transportation Energy Data Book delivered to VTO	Complete	On track
Quarter 4		Draft of Consumer Views/Benchmark Report delivered to VTO	Complete	On track
Quarter 4		Go/no-go milestone Determine if VTO research efforts require continued transportation data program support	Complete	On track

# Approach - TEDB, Market Report & Weekly Fact

**Barrier Addressed:** Each of these data products contains a myriad of information as an outreach by DOE to improve analysis of the transportation sector, thus contributing to policies, programs, and technologies which reduce petroleum consumption & greenhouse gas emissions.

- **The Data Book is mostly tabular historical data, especially good for modeling use.**
- **The Market Report includes on data for the top nine U.S. manufacturers in the last five years.**
- **The Fact of the Week is widely varied on topic and source .**

Data Book Topics	Market Report Topics	Fact of the Week Topics
Petroleum	Energy & economics	All types of transportation topics, focused on highway vehicle data & technologies, as is VTO’s mission.
Energy	Light vehicles	
Light vehicles & characteristics	Heavy trucks	
Heavy vehicles & characteristics	Technologies	
Alternative fuel and advanced technology vehicles & characteristics	Policy	
Fleet vehicles & characteristics		
Household vehicles & characteristics		
Nonhighway modes		
Transportation & the economy		
Greenhouse gas emissions		
Criteria air pollutants		
Energy conversions		

**Primary mechanism:** Start with data discovery, provide due diligence for correct notations and citations, and provide outreach in the form of (1) websites serving not only pdf files, but Excel spreadsheets, (2) email subscription for the Weekly Fact, and (3) hardcopies of the Data Book.

# Approach - Consumer Data

**Barrier Addressed:** Provides DOE VTO a capability to track and investigate high-level consumer sentiments affecting VTO technology deployment.

- Provides the voice of the consumer to contextualize research.
- Stated and revealed preference differences limit application in modeling.

Sample of Topic Areas	Time Series	Deep-Dives
PEV awareness	●	
PEV exposure	●	
BEV range	◐	FY15
Willingness to pay for fuel economy and PEV	◐	FY15
Alternative fuel preferences	●	
Fuel economy perceptions	◐	FY15; FY16

- - Tracked annually across multiple questions
- ◐ - Tracked annually at high level

- Study structure and content is influenced by input from VTO Analysis Team experts and a broad working group representing partner agencies, DOE national laboratories, academia, and private researchers.
- Study results support VTO Analysis team efforts including the TEDB, VT Market Report, ORNL BEV range research, and the VT Quarterly Analysis Review amongst others.

**Primary Mechanism:** Subcontract with ORC International for Caravan omnibus telephone survey of 1,000 adults designed to reflect the general U.S. population.

ORC is a broadly recognized firm and founding partner of the Council of American Survey Research Organizations dedicated to promoting standards in survey research.

PEV = Plug-In electric vehicle; BEV = Battery electric vehicle.

# Approach - E-Drive Data & Market Analysis

**Barrier Addressed:** Provides readily used sales and ownership cost data, analyzes regional sales patterns to improve market modeling of electric-drive vehicle ecosystem and supports other DOE programs.

- Provides reference data for vehicle choice modeling and DOE/EERE policy impact analysis.
- Examines geographic distribution and demographics to characterize market.
- Creates more comprehensive levelized costs for advanced vehicle technologies.

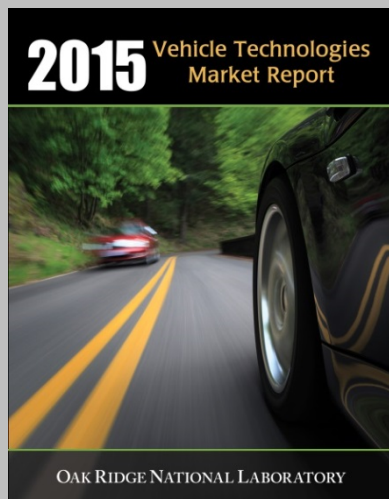
Topic	Data and Analysis Types (Examples)
U.S. E-drive sales	Monthly sales of HEV, PHEV and BEV
International sales	Monthly sales of HEV, PHEV and BEV in China, Europe, Japan
Policy and infrastructure	Incentives, regulations, targets, number of charging stations (by type)
Regional sales pattern	Cold states vs. Warm states Comparison between major MSAs
Vehicle ownership cost	Residual values of Volt, LEAF, Prius, Ford Energies, etc.

**Primary mechanism:** E-drive vehicle sales by make and model of four global markets (China, Europe, Japan and U.S) and ownership cost information of key PEV and HEV models.



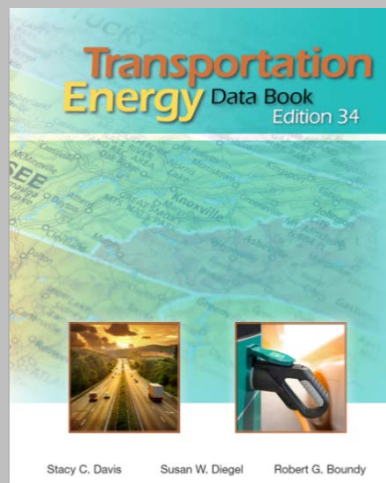
# Technical Accomplishments and Progress for Data Book, Market Report, and Fact of the Week

## Successful Outreach: Facts & Market Report published, Data Book coming



<http://cta.ornl.gov/data>

Edition 35 forthcoming

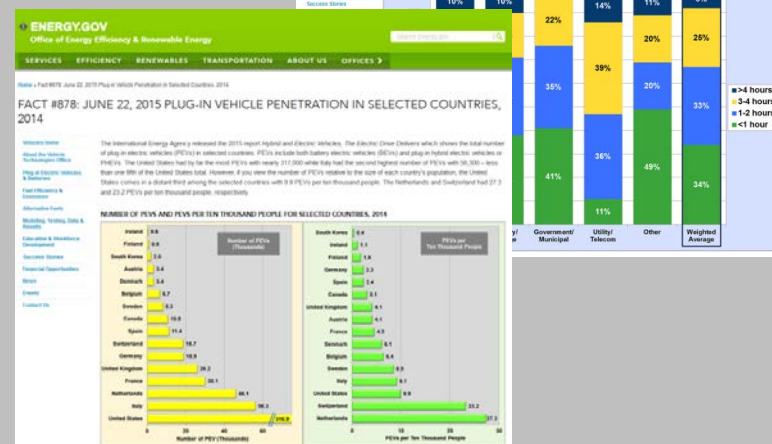
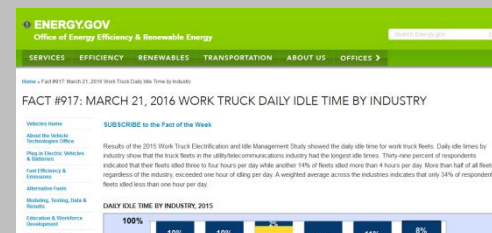


<http://cta.ornl.gov/vtmarketreport>

### Average Monthly Website Visitor Sessions

	Market Report	Data Book
FY15	3,524	6,502
FY16	4,237	11,564

Fewer hardcopies of the Data Book were distributed thus more using the website



<http://energy.gov/eere/vehicles/transportation-fact-week>

1,764 subscribers to the Fact of the Week Monday email distribution

# Technical Accomplishments for Transportation Energy Data Book

## Successful Outreach: Hardcopy mailing list purged and comments solicited

*"Leave well alone. An excellent publication."*

*"I love getting the print edition for quick access to many tables I need to scan. Online access is good for putting numbers into my work!"*

*"Even in the digital age, sometimes you want that physical book to refer to. Thanks for keeping this book going!"*

*"With VIUS a fading memory, more state level data – sales, fuel economy, technology penetration, and incentives would be helpful."*

### RETURN THIS FORM TO CONTINUE RECEIVING YOUR FREE COPY OF THE *Transportation Energy Data Book*

We are updating our mailing list for the *Transportation Energy Data Book*. We want to ensure that those of you who want a hard copy continue to receive one.

If you would like for us to continue to mail you a free printed copy of the Data Book, please fill in the information below and return this card to the address on the back (postage is paid). If you prefer, you may email your information to [DavisSC@ornl.gov](mailto:DavisSC@ornl.gov).

Name (required): \_\_\_\_\_

Update address below or check here ☐ if address has not changed.

Company: \_\_\_\_\_

Mailing Address Line 1: \_\_\_\_\_

Mailing Address Line 2: \_\_\_\_\_

City, State/Zip: \_\_\_\_\_

Email Address: \_\_\_\_\_

Comments or suggestions for improvement: \_\_\_\_\_

Thank you for your continued interest in the *Transportation Energy Data Book*.

*"Improves every year by including more statistical data. An outstanding publication that I use all the time."*

*"It's great – useful – no change needed!"*

*"This is my go-to book for academic and press writing. Thanks Ms. Davis and Uncle Sam!"*

*"Nice data book that I use in energy and transportation technology courses."*

*"Please include more maritime shipping data."*

*"Include as much on rail as possible."*

Of 375 replies, 322 had no comments, 40 said "thank you" or "excellent," and 13 had suggestions for improvement.

# Technical Accomplishments for Consumer Data

## Consumer Views on Plug-in Electric Vehicles National Benchmark Study

- The annual study tracks PEV awareness, acceptance, and perceived barriers to broader acceptance.
- Published first annual study: <http://www.nrel.gov/docs/fy16osti/65279.pdf>.
- Second annual study completed in February 2016 with publication to follow.

		Feb 2015	Feb 2016
PEV Awareness	Able to name a specific PEV	48%	46%
	Aware of PEV tax incentives	NA	33%
Barriers to PEV Acceptance	Able to plug in at home	53%	49%
	300 miles sufficient BEV range	56%	46%
	Unaware of PEV charging stations	79%	76%
	Willing to pay extra for a PEV	51%	49%
PEV Acceptance	Expect to consider a PEV (Expect to buy)	20-24% (2%)	19-23% (3-4%)

Initial trends show little movement in PEV sentiments. As the market matures, the annual study will allow for identification of changing perceptions.

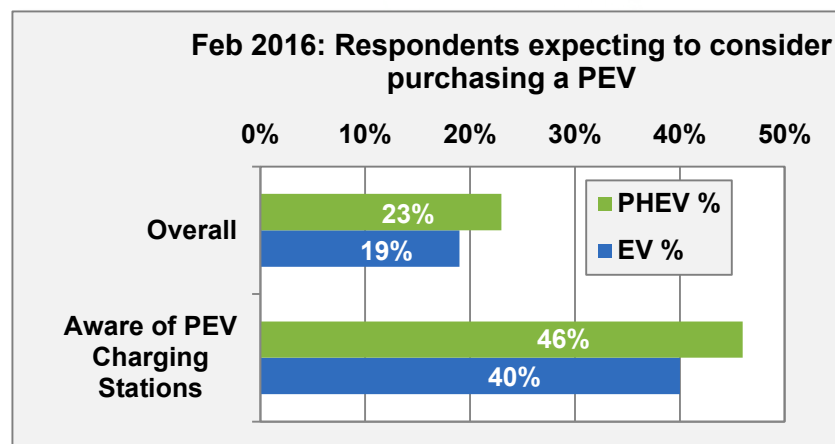
*In an early adoption market it is helpful to identify where further investigation is warranted.*

**Example:** Awareness of existing charging stations appears to correlate with higher acceptance.

→ Why? Is additional infrastructure necessary?

### Data notes:

Sample weight adjusted to reflect general U.S. population; 2016 Sample Size: 1,008 respondents  
Margin of error of  $\pm 3\%$  at the 95% confidence level

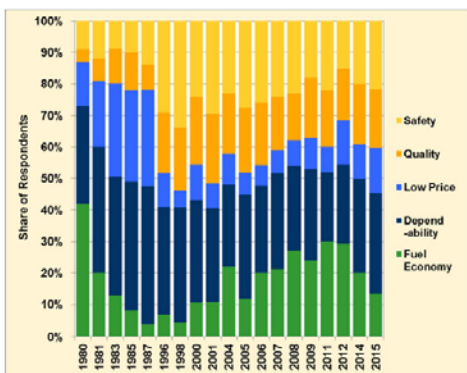


# Technical Accomplishments for Consumer Data

## Consumer Data feeds into other VTO Analysis Program work

### Only Thirteen Percent of Survey Respondents Consider Fuel Economy Most Important when Purchasing a Vehicle

A 2015 survey asked a sample of the U.S. population the question "Which one of the following attributes would be MOST important to you in your choice of your next vehicle?" The choices were fuel economy, dependability, low price, quality, and safety. This same question was asked in previous surveys and the results are compared in the graph below. Dependability was chosen most often in nearly every survey after 1980, but fuel economy surpassed it in 2011 and 2012. In 2015, 31% of the survey respondents indicated that dependability would be the most important vehicle attribute while 13% of the survey respondents chose fuel economy—the lowest share since 2005.



Sources:  
1980-87: J. D. Power (based on new car buyers). 1998-2015: Opinion Research Corporation International for the National Renewable Energy Laboratory (Sample size = 1,000 in the general population).

CHAPTER 1  
ENERGY AND ECONOMICS

20

2015 VEHICLE TECHNOLOGIES  
MARKET REPORT

2015 Vehicle Technologies Market Report,  
and future Facts of the Week

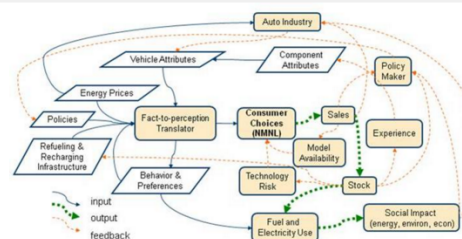
The consumer data will be used to inform VTO consumer choice models, such as the MA<sup>3</sup>T Model, on the value of plug-in vehicle range and vehicle fuel economy.

### MA<sup>3</sup>T Model

Modeling the Market Acceptance of Advanced Automotive Technologies

#### MA<sup>3</sup>T Model Overview, January 17, 2014

Understanding the diverse purchasing behaviors among individuals is key for designing efficient and effective policies for promoting advanced vehicle technologies. To address this need, ORNL developed the Market Acceptance of Advanced Automotive Technologies (MA<sup>3</sup>T) model, a market simulation model for the DOE Vehicle Technologies Program. Implemented using Microsoft Excel for Windows, MA<sup>3</sup>T simulates market demand for advanced vehicle technologies by representing relevant attributes of technologies and consumer behavior such as technological learning by doing, range anxiety, access to recharging points, daily driving patterns, and willingness to accept technological innovation. Much remains to be learned about how consumers will evaluate novel vehicle technologies and how these vehicles are likely to be operated. Because of this, the approach taken in developing the MA<sup>3</sup>T model was to create a framework for integrating data and behavioral models at an appropriate level of detail, whether or not the data are fully available or the behaviors fully understood. As more is learned about the advanced vehicle technologies and consumer preferences toward them, the model will be continuously updated and improved.





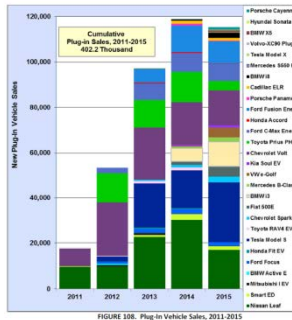
# Technical Accomplishments for E-Drive Data

Extensive use of data products by DOE programs and other agencies

## 2015 Vehicle Technologies Market Report

### Plug-In Vehicle Sales Total over 115,000 Units in 2015

The number of plug-in vehicles sold in the United States in 2015 fell to a little over 115,000, down from 120,000 the previous year. Nissan and Chevrolet had the best sales in 2015, with the Leaf and the Volt, but were joined by several other manufacturers in 2015. There were 27 different plug-in models available in 2015, many selling less than 5,000 units. The biggest plug-in sellers in 2015 were the Tesla Model S, Nissan Leaf, Chevrolet Volt, BMW i3, and Ford Fusion Energi.

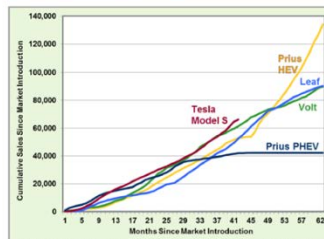


Source: Data provided by Yan (Joann) Zhou, Argonne National Laboratory. <http://www.anl.gov/energy-systems/projects/light-duty-electric-drive-vehicles-monthly-sales-updates>

CHAPTER 4 TECHNOLOGIES 134 2015 VEHICLE TECHNOLOGIES MARKET REPORT

### Sales from Introduction: Some Plug-In Vehicles Beat Hybrid-Electric Sales in the First Four Years

The Toyota Prius hybrid-electric vehicle (HEV) was first released in the U.S. market in January 2000 and 324 were sold in the first month. The Chevrolet Volt, a hybrid-electric plug-in, and the Nissan Leaf, an all-electric plug-in vehicle, were first released in December 2010. The Prius plug-in hybrid-electric vehicle (PHEV) began sales in April 2012. The chart below shows a comparison of the sales of the Prius HEV from when it was first introduced, to the sales of the Volt, the Leaf, the Prius PHEV, and the Tesla Model S when they were first introduced.



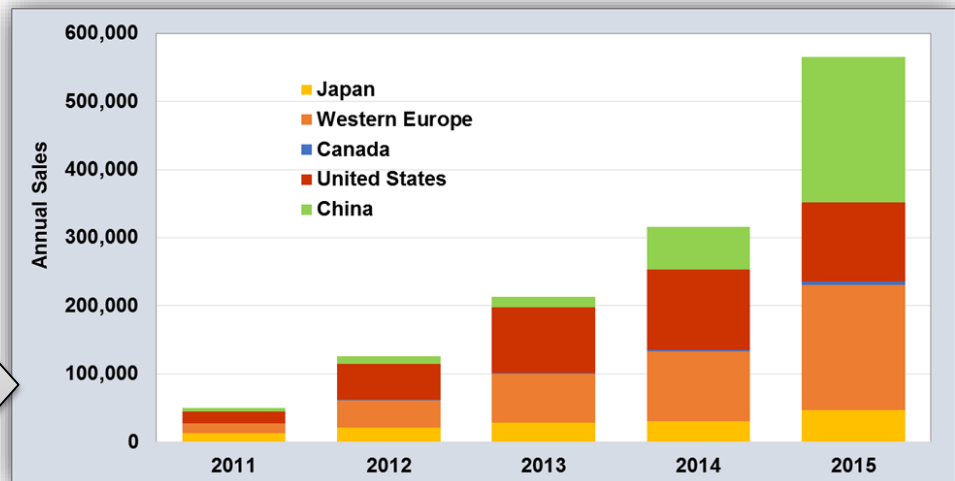
Notes: The Prius HEV was first released in the U.S. market in January 2000. The Prius PHEV was first released in the U.S. market in April 2012. The Volt and Leaf were first released in the U.S. market in December 2010. The Tesla Model S was first released in the U.S. market in June 2012. Tesla sales are estimated.

Source: Provided by Argonne National Laboratory. <http://www.anl.gov/energy-systems/projects/light-duty-electric-drive-vehicles-monthly-sales-updates>

2015 VEHICLE TECHNOLOGIES MARKET REPORT 135 CHAPTER 4 TECHNOLOGIES

**Fact #918: March 28, 2016 Global Plug-in Light Vehicle Sales Increased by About 80% in 2015**

- Successfully published sales and market trends on website monthly <http://www.anl.gov/energy-systems/project/light-duty-electric-drive-vehicles-monthly-sales-updates>
- Supported DOE/EERE programs and activities such as eGallon, EV Everywhere, Market Report, and Fact of the Week



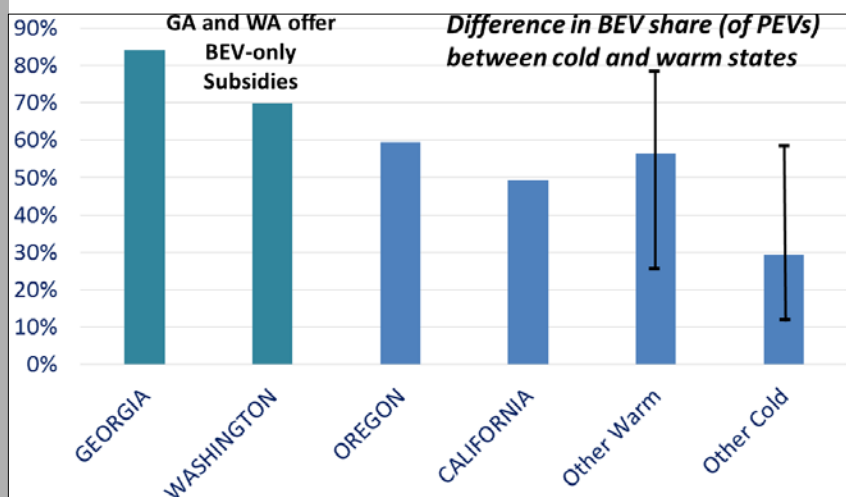


# Technical Accomplishments for E-Drive Data

Successfully delivered regional PEV sales patterns and possible contributing factors to VTO in quarterly charts/spreadsheets. Also sent to EV Everywhere program upon request.

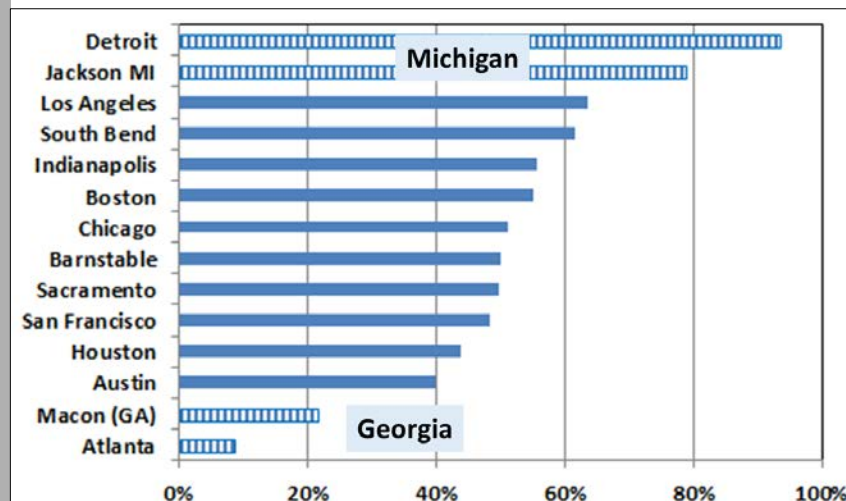
GA & WA “BEV only” incentives proved to be very effective in promoting BEVs, especially mass market vehicles (MSRP < \$40,000)

BEV Share of PEVs



Cold Climate Reduced the BEV Share Elsewhere

PHEV Share of PEVs



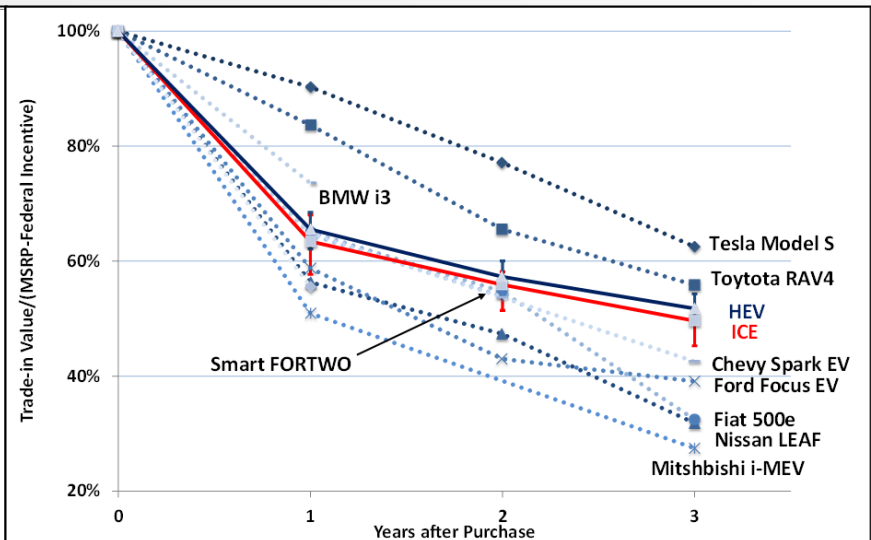
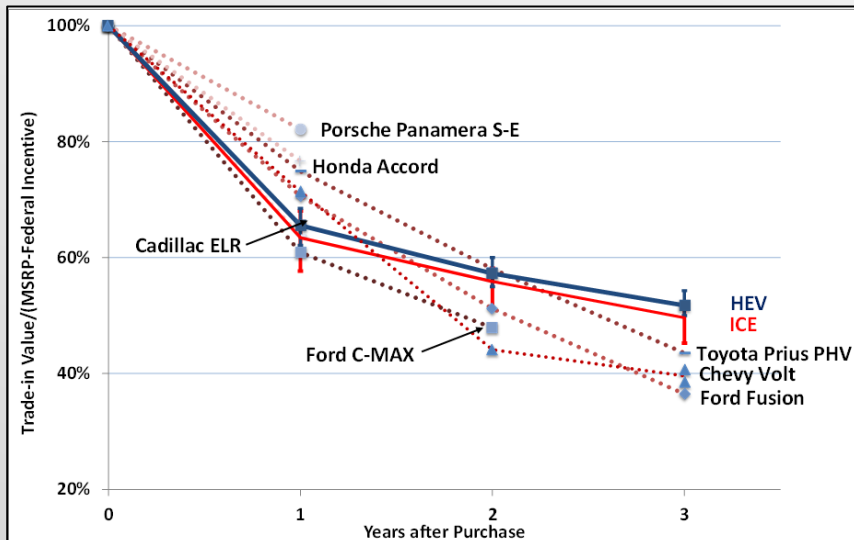
# Technical Accomplishments for E-Drive Data

Published paper "Comparison of Value Retention of Plug-in Vehicles and Conventional Vehicles and Potential Contributing Factors" in January 2016 Transportation Research Board Proceedings.

Average Adjusted Value Retention Rates:  
PHEVs vs. ICEVs, and BEVs vs. ICEVs, with p-values shown in parentheses

	1 year	2 years	3 years
ICEVs	63%	56%	50%
PHEVs	72% (0.03)	50% (0.16)	40% (0.03)
BEVs	66% (0.49)	57% (0.85)	43% (0.41)
BEVs, no Tesla	64% (0.94)	53% (0.48)	39% (0.17)

PHEVs and BEVs appear to have higher retention rates than those of comparable ICEVs for one to two years when taking incentives into account, but are slightly lower at three years.



PEV = Plug-In electric vehicle; PHEV = Plug-In hybrid electric vehicle; ICEV = Internal combustion engine vehicle; BEV = Battery electric vehicle.

# Previous ORNL Reviewers' Comments

- ***What mechanisms are used to collect user feedback?***

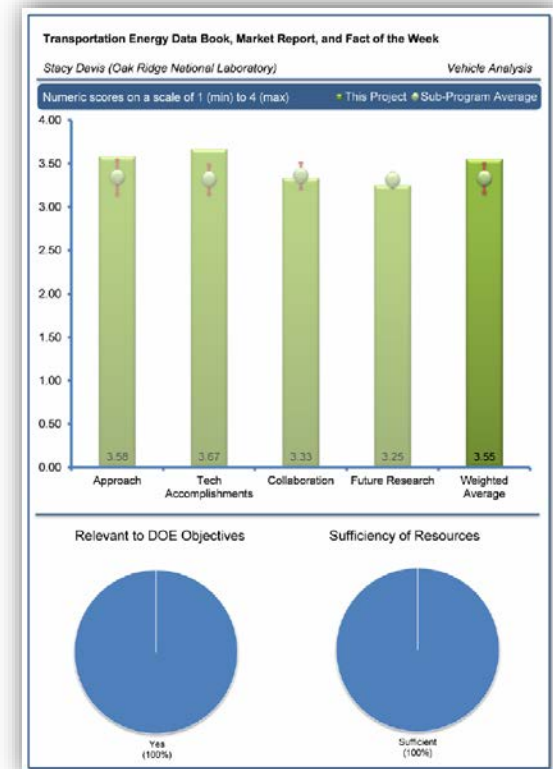
- Dating back to Edition 5 in 1981, Data Book users are encouraged to give feedback to the project sponsor and/or lead author, with contact information provided after the title page in each Edition.
- The same information is found via a “Contact Us” link at the bottom of every page on the Data Book and Market Report websites.
- In addition, this year the Market Report website has a new user feedback icon. This same icon will be on the Data Book website when it is updated to Edition 34.
- A postage-paid mail-back card which asked for comments or suggestions for improvement was sent with every Edition 33 Data Book mailed out in 2014.

- ***Is there an opportunity to print fewer copies of the Data Book?***



- Yes, the mailing list was purged and postage-paid mail-back cards were sent with the Edition 33 hardcopy mailing. Only those who returned the cards or emailed responses will be kept on the hardcopy mailing list, reducing the list from 1,300 to about 400.

- ***“Splitting the Data Book or the web-based report into sections that are updated periodically would have greater value to users.”***

- In verbal contact, emails, and feedback cards, Data Book users have made it clear that they do not want changes to the chapters or sections of the report. Users are able to quickly find the content needed when chapters do not vary greatly from one year to the next. However, when changes in the transportation sector warrant a new chapter or changes to the current chapters, the authors will make changes.



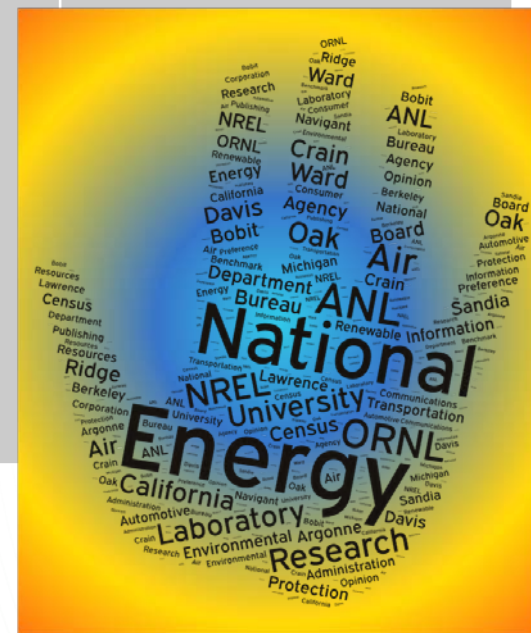
# Previous NREL and ANL Reviewers' Comments

Comment	Response
<div data-bbox="170 297 421 382">  </div> <p>The effort relies too heavily on stated preference data</p> <p>Historically the effort has not provided longitudinal time series data.</p>	<p>Revealed preference data is preferential whenever available, and the Consumer Data task seeks out opportunities contextualize study results with robust data sets such as IHS (formerly Polk) vehicle registration and U.S. Census data. Broadly, the effort provides a voice of the consumer when technologies are not yet available or new to a marketplace and actual behaviors cannot be tracked. While study results can be interpreted to reveal a lack of consumer understanding about study topics, this lack of understanding is in itself a useful finding.</p> <p>The core deliverable for the effort is now the Consumer Views on Plug-in Electric Vehicles National Benchmark Report that investigates the same set of questions annually to allow for trending of key metrics describing awareness and acceptance of PEVs as well as barriers to broader PEV acceptance.</p>
<div data-bbox="170 796 421 896">  </div> <p>How the project will reduce the uncertainty and variability of DOE models' EV projections.</p> <p>All data used is from third parties – primarily Navigant, as some of it (e.g., the National Household survey) appears to be very old</p>	<p>Historical sales data are used to calibrate several vehicle choice models supported by VTO. We recognized that more information such as resale values and vehicle incentives are needed to better estimate vehicle total cost of ownership.</p> <p>We subscribed some Navigant reports with VTO's support. Navigant has been providing vehicle sales projections and historical electricity consumption by PEVs under a subcontract through Argonne.</p> <p>We also recognized that NHTS could be outdated to assess PEV usage. However, that is the only comprehensive national travel survey we have. The available GPS travel data are also outdated and limited to regional. We will re-do our analysis once the new NHTS is released.</p>

# Collaboration and Coordination with Other Institutions

Government Agencies	Private Sector	National Laboratories	Academia
<ul style="list-style-type: none"> <li>• DOE Clean Cities Program</li> <li>• Dept. of Transportation</li> <li>• Environmental Protection Agency</li> <li>• Energy Information Administration</li> <li>• Census Bureau</li> <li>• California Air Resources Board</li> <li>• Bureau of Economic Analysis</li> <li>• Bureau of Labor Statistics</li> </ul>	<ul style="list-style-type: none"> <li>• Opinion Research Corporation</li> <li>• IHS Automotive/Polk</li> <li>• Ward's Automotive</li> <li>• Crain Communications</li> <li>• Navigant Research</li> <li>• European Alternative Fuels Observatory, Brussels</li> <li>• Automotive Industry Newsletter, London, England</li> <li>• International Energy Agency</li> <li>• American Public Transportation Association</li> </ul>	<ul style="list-style-type: none"> <li>• ANL</li> <li>• NREL</li> <li>• ORNL</li> <li>• Lawrence Berkeley National Laboratory</li> <li>• Pacific Northwest National Laboratory</li> <li>• Sandia National Laboratory</li> </ul>	<ul style="list-style-type: none"> <li>• University of California –Davis</li> <li>• University of Michigan</li> <li>• Tsinghua University, Beijing, China</li> </ul>

**ORNL, NREL, and ANL work with these and other institutions on the transportation data that are produced by this project.**





# Proposed Future Work



## Remainder of FY16

- Fact of the Week
- Transportation Energy Data Book

## FY17

With additional sources and continually evolving displays of data, the Weekly Fact, Market Report and Data Book will provide easy access to critical data that form the foundation for transportation analysis worldwide.



## Remainder of FY16

- Benchmark study
- Support deep-dive investigations & hot topic areas

## FY17

The effort will continue to refine question sets based on working group feedback and investigate new areas of research interest as the market for VT technologies evolves

- Benchmark study
- Deep-dive investigations of hot topics
- Look for opportunities to expand collaboration efforts



## Remainder of FY16

- Monthly National E-drive sales
- Quarterly Regional PEV sales
- Quarterly Global PEV sales

## FY17

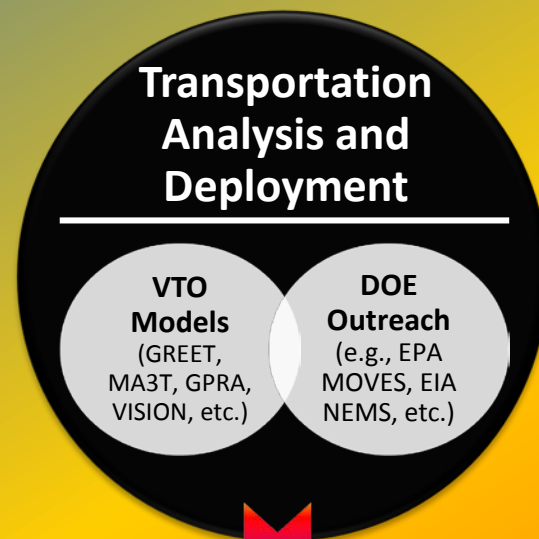
In light of the evolving EV market:

- Keep track of monthly PEV sales
- Investigate new contributing factors in regional sales
- Analyze ownership data of more PEV and HEV models

Answer ad hoc data requests from VTO staff and Analysis Program team members

# Summary

Successful weekly, monthly, and annual milestones delivered on-time and within budget – improving over time



New policies, programs and technologies addressing transportation efficiency



Reduce petroleum use and greenhouse gas emissions

Collaboration with government, private sector, academia, & other laboratories



# ACKNOWLEDGEMENTS

**Jacob Ward**

*Office of Vehicle Technologies  
US Department of Energy*

**Philip Patterson, retired**

*Formerly of the Office of Vehicle Technologies  
US Department of Energy*

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