E-drive Vehicle Sales Analyses

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Argonne National Laboratory

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Project VAN011

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

### Timeline

<table>
<thead>
<tr>
<th>Start Date: October 2013</th>
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<tbody>
<tr>
<td>End Date: Project continuation and direction determined annually by DOE</td>
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### Barriers

- Lack of readily available historical sales in the U.S. and other markets
- Lack of data on advanced vehicle usage and survival pattern
- Lack of data on cost components for levelized cost analyses
- Poor understanding of uncertainty in vehicle choice models and projections

### Budget

<table>
<thead>
<tr>
<th>Total Project Funding (DOE)</th>
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<tr>
<td>FY14: $84k</td>
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<td>FY14: $56k for Navigant research reports</td>
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### Partners

**Interaction/Collaborations**

- Hybridcars.com
- European Automotive Industry Newsletter
- Kelley Blue Book, NADA
- Navigant Research
- Tsinghua University, Beijing, China
- ORNL, NREL, SNL, TA Engineering


Objectives and Relevance

Data acquisition and analysis of sales, usage, cost to improve market modeling of electric-drive vehicle ecosystem and support DOE programs

Task 1: Track global E-drive vehicle sales
**Objective:** Provide reference data for vehicle choice modeling and DOE/EERE policy impacts analysis

Task 2: Examine HEV usage trends and survival rates
**Objective:** More realistic projections of utilization and resulting energy and emission reductions

Task 3: Extend levelized cost to include more components
**Objective:** More comprehensive levelized cost for advanced vehicle technologies

Task 4: Improve vehicle choice modeling using standardized inputs
**Objective:** More robust projections of vehicle market penetration and energy savings
## Approach and Accomplishments

<table>
<thead>
<tr>
<th>Task</th>
<th>Approach</th>
<th>Accomplishments</th>
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</table>
| **Task 1: Track global E-drive vehicle sales** | Document historical sales by make and model for each country/region  
Summarize both financial and non-financial policies matrix in each country/region | • Extensive Use by DOE Programs Such as eGallon  
• E-drive vehicle policy matrix for each country/region summarizing: numerical targets, regulation and fiscal incentives  
• Factors could impacting early E-drive sales |
| **Task 2: Examine HEV usage trends and survival rates** | Compare HEV daily travel usage with conventional vehicles using 2009 National Household Survey  
Examine HEV survival rate using Polk registration data | • Daily distance distribution, average speed, travel time, trips per vehicle of HEVs and conventional cars and SUVs |
| **Task 3: Extend levelized cost to include more components** | Collect data on key cost components for advanced vehicle technologies | • Total cost of ownership data for PEVs and conventional vehicles |
| **Task 4: Improve vehicle choice modeling using standardized inputs** | Comparing market penetration forecast of several vehicle choice models (VCMs)  
Analyze sensitivity to different vehicle attributes | • Difference in projections of market penetration |
## Milestones

<table>
<thead>
<tr>
<th>Due Date</th>
<th>Milestones</th>
<th>Status</th>
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<tbody>
<tr>
<td>1/31/2014</td>
<td>1. Publish collected electric-drive vehicle sales for selected regions</td>
<td>Completed</td>
</tr>
<tr>
<td>6/30/2014</td>
<td>2. Report on usage trends by technology and HEV survival rates</td>
<td>On schedule</td>
</tr>
<tr>
<td>6/30/2014</td>
<td>3. Report on levelized costs components for PEVs</td>
<td>On schedule</td>
</tr>
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</table>
Accomplishment 1: Extensive Use by DOE Programs Such as eGallon

- Publish monthly sales and market trend on both Argonne and DOE websites
- Support DOE/EERE programs and activities such as eGallon
- Develop extra charts and provide interpretation as needed for DOE project managers (market share, comparison of sales by model since market introduction, etc.)

DOE Website:
http://energy.gov/articles/visualizing-electric-vehicle-sales

ANL Website:
http://www.transportation.anl.gov/technology_analysis/edrive_vehicle_monthly_sales.html
Accomplishment 1(Cont’d): E-drive Vehicle Policy Matrix for Each Country/Region (For Example: in China)

- **Numerical Targets**: Chinese State Council established the goal that the accumulated sales of PEVs would reach 5 million in 2020 through “Ten Cities One Thousand Vehicles” energy-saving and new energy vehicle (NEVs) demonstration program.

- **Regulation/Emission Standards**: A target of achieving a fleet average fuel consumption rate of 5 L/100 km (47 mpg) by 2020.

- **Fiscal Incentives to Consumers**:
  - **Phase 1 Subsidy** (2009-2012), only for purchases of vehicles used for public service, such as taxis and transit buses.
  - Phase 1 Subsidy was extended in 2012 to nationwide. Subsidies were based on each vehicle’s battery capacity: about $490/kWh toward any private PEV purchase (maximum $8200 per PHEV and $9835 per EV).
  - **Phase 2 Subsidy** (9/2013- Present), the basis for obtaining a subsidy shift from battery capacity to electric range: about $5700 - $9800 for range over 30 miles.
Accomplishment 1 (Cont’d): Factors Could Impacting Early EV Sales (For Example: in Japan)

Fukushima earthquake
Purchase tax exemption expired
Incentive Extended
New incentive started
Mitsubishi released MiniCab Van
Mitsubishi accidents
Toyota released Prius PHEV
Incentive Extended
Mitsubishi released Prius PHEV

Chart showing monthly NEV vehicle sales with key events such as the Fukushima earthquake, Mitsubishi released MiniCab Van, Toyota released Prius PHEV, purchase tax exemption expired, incentive extended, Mitsubishi released Prius PHEV, and new incentive started.
Accomplishment 1 (Cont’d): Global E-drive Sales Comparison: Although the U.S. Sells More PEVs, Japan’s Sells Many More HEVs (and Much Higher Market Share)

U.S. Vs. Japan Vs. W. Europe
Sales and Market Share (of new car sales)

Note: Europe sales are BEV and PHEV combined
Accomplishment 1(Cont’d): E-drive Sales Forecast Using Navigant Smart Transportation Research Service

- Market-relevant data and analysis provided on a range of topics relevant to DOE:
  - PEV Adoption and Sustainable Transportation
  - Vehicle-to-Grid, Vehicle-to-Building
  - EV Charging, Carsharing

- Contract with Argonne gives VTO analysis team access to Navigant reports, data and analysts

Projection: North America, Light-duty vehicle sales shares

Accomplishment 1 (Cont’d): Navigant Reports on Following Topics are Available to VTO Analysis Team

- **Electric Vehicles**
  - Plug-in Hybrid Electric Vehicles
  - Battery Electric Vehicles
  - Hybrid Electric Vehicles
  - Electrified Trucks and Buses
  - Electric Bicycles, Motorcycles, and Scooters
  - Electric Vehicle Battery Technologies
  - Electric Vehicle Charging Infrastructure
  - Consumer Attitudes, Preferences, and Behavior

- **Advanced Transportation Technologies**
  - Intelligent Transportation Systems
  - Emerging Drivetrain Technologies
  - Refueling and Charging Infrastructure
  - Transportation / Smart Grid Integration
  - Natural Gas Vehicles
  - Autonomous Vehicles
Summary of Task 1 Accomplishments

Task 1: Track Global E-drive Vehicle Sales

What we have:
- Detailed global sale data by make/model
- Policy matrix by each country/region
- Market projection for major vehicle technologies

Why DOE needs the details:
- Compare market status and policies cross regions
- Provide reference data for vehicle choice modeling and policy impacts analysis
Accomplishment 2: Daily Distance, Average speed, Travel time, Trips per vehicle Show No Significant Difference between HEVs and Conventional Vehicles

Q: Are HEV used differently than conventional counterparts?  
A: No, based on T-test performed on daily travel items
Accomplishment 3: Depreciation Rate Comparison: PEVs Vs. Conventional

Q: Is cost structure of owning PEV different from conventional?
A: Yes, PEV may depreciate fast at first

Summarized 5-year ownership cost of major PEV models and comparable conventional models (using data from KBB, Edmunds and NADA)

(On-going work) Compiling a cost list of market available EVSE models (Level 1, 2 and DC fast charger)
Accomplishment 4: Developed Standardized Inputs for Vehicle Choice Model Comparison

LVChoice (TA Engineering)

MA3T (ORNL)

LAVE-Trans (ORNL)

ADOPT (NERL)
Accomplishments 4(Cont’d): Why Do Projections Differ? Answers are Important for Model Improvement

- Not all inputs were the same, e.g. differences in
  - Make/model diversity
  - Market segmentation
  - Number of vehicle technologies

- Diversity built in model structures help VTO to approach the same question differently

- Models have different sensitivity (For example: a 10% improvement to PEV attribute has different “Implied value”)

[Graph showing value of a 10% improvement for different attributes]
Collaboration and Coordination

Explore opportunity for data acquisition and analysis with Navigant Research

Collaborate with Z. Lin (ORNL), C. Liu (ORNL), A. Birky (TA Engineering, Inc.), A. Brooker (NREL) and D. Manley (Sandia) on standardizing vehicle choice inputs, VCM comparison and overall VTO analysis coordination

European Automotive Industry Newsletter (based in UK) provides European sales and gives permission to use the data

Tsinghua University, Beijing provides sales from China and Japan market
# Proposed Future Work

<table>
<thead>
<tr>
<th>Area</th>
<th>Task</th>
<th>Future Work</th>
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</table>
| Data Collection             | **Task 1**: Track global E-drive vehicle sales             | • Continue tracking monthly sales in four major markets: U.S., Europe, China and Japan  
• Gather and maintain international E-drive vehicle sales and incentives databases for comparing market development and related market and policy analysis  
• Investigate sales by battery capacity and type |
| Market and Policy Analysis  | **Task 2**: Examine HEV usage trends and survival rates    | • PEV Market Niches: Examine advanced vehicle sales trends geospatially using national and regional Polk data  
• Estimated levelized cost by market niche                                                                |
|                             | **Task 3**: Extend levelized cost to include more components |                                                                                                                                               |
|                             | **Task 4**: Improve vehicle choice modeling using standardized inputs | • Additional scenarios  
• Additional models (ParaChoice from Sandia)  
• Sensitivity analysis                                                                                   |
Summary

- **Relevance**
  - Support vehicle choice and market modeling and related energy and GHG emission estimation in support of DOE advanced vehicle programs

- **Approach**
  - Collect sales from collaborators and provide analysis & interpretation
  - Examine travel survey data to understand advanced vehicle usage pattern
  - Collect key ownership cost items for advanced vehicle technologies
  - Compare market penetration projections from VCMs using similar inputs

- **Technical Accomplishments**
  - U.S. E-drive sales by make and model published on both ANL and DOE websites
  - E-drive vehicle policy matrix for different countries/regions
  - Sales trends comparison of HEV, PHEV and EV from different counties/regions
  - Factors impacting early E-drive vehicle sales
  - HEV daily usage pattern comparison with conventional vehicles
  - Total cost of ownership data for PEVs and comparable conventional vehicles
  - Difference in projections of market penetration
Summary (Cont’d)

▪ Collaborations
  – Collect data and information from Tsinghua University and other agencies
  – Collaborate with other national labs for standardizing inputs in VCM comparison

▪ Future Work
  – Continue tracking monthly sales in four major markets: U.S., Europe and Japan
  – Gather and maintain an international E-drive vehicle sales and incentives databases for comparing market development and related market and policy analysis
  – Separate sales by battery capacity and material for further comparison
  – PEV Market Niches: Examine important advanced vehicle sales trends geospatially using national and regional Polk data
  – VCM Comparison Expansion
Technical Back-up Slides
## China’s Phase I and Phase II EV incentives for both passenger vehicles and buses

<table>
<thead>
<tr>
<th></th>
<th>Phase 1</th>
<th>Phase 1</th>
<th>Phase 2</th>
</tr>
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<tbody>
<tr>
<td><strong>Target market</strong></td>
<td>Public</td>
<td>Private</td>
<td>Public and Private</td>
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<tr>
<td><strong>Incentive duration</strong></td>
<td>2009-2012</td>
<td>2010-2012</td>
<td>2013-2015</td>
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<tr>
<td><strong>Incentive scope</strong></td>
<td>HEV, PHEV, BEV, FCEV</td>
<td>PHEV, BEV</td>
<td>PHEV, BEV, FCEV</td>
</tr>
<tr>
<td><strong>Subsidy Standard</strong></td>
<td></td>
<td></td>
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<tr>
<td>HEV PV</td>
<td>Up to 50,000¥</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Bus</td>
<td>Up to 420,000¥</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>(L&gt;= 10 m)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>PHEV PV</td>
<td>Up to 50,000¥</td>
<td>3,000¥/kWh</td>
<td>35,000¥ (R&gt;=50 km)</td>
</tr>
<tr>
<td>Bus</td>
<td>Up to 420,000¥</td>
<td></td>
<td>250,000¥ (L&gt;=10 m)</td>
</tr>
<tr>
<td></td>
<td>(L&gt;= 10 m)</td>
<td></td>
<td></td>
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<tr>
<td>BEV PV</td>
<td>60,000¥</td>
<td>3,000¥/kWh</td>
<td>35,000¥ (80km &lt; R&lt; 150 km)</td>
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<tr>
<td>Bus</td>
<td>500,000¥</td>
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<td>300,000¥ (6m&lt; L&lt;8m)</td>
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<td></td>
<td>(L&gt;=10 m)</td>
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<td>400,000¥ (8m&lt; L&lt;10m)</td>
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<td></td>
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<td>500,000¥ (L&gt;=10m)</td>
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<tr>
<td>SPV</td>
<td>2,000¥/kWh</td>
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<tr>
<td>FCEV PV</td>
<td>250,000¥</td>
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<td>200,000¥</td>
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<tr>
<td>Bus</td>
<td>600,000¥</td>
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<td>500,000¥</td>
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<td></td>
<td>(L&gt;=10 m)</td>
<td></td>
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<tr>
<td><strong>Phase-out mechanism</strong></td>
<td>NA</td>
<td>NA</td>
<td>10% reduction in 2014</td>
</tr>
<tr>
<td>Pilot cities</td>
<td>25 cities</td>
<td>6 cities</td>
<td>20% reduction in 2015</td>
</tr>
</tbody>
</table>

28 cities and regions

1 US dollar = 6.1 Chinese Yuan (¥); L = length, R = range, PV = passenger vehicle, SPV= special purpose vehicle
China: E-drive bus production has experienced steady increases since the 2008 Olympic games and the 2009 “Ten Cities One Thousand Vehicles” EV demonstration program.
We compared PEV sales with HEV sales trend:
Reason for optimism for PEV sales growth in the US

Generation 1 PEV sales (starting in 2010) in the US has outpaced those of Generation 1 HEVs (starting in 1999).
Cumulatively, over 4 million HEVs have been sold in the U.S. since 1999.
Like the U.S., Norway and the Netherlands’ PEV yearly share of passenger cars has exceeded 1% of the new car market.
Norway, Netherlands, Germany and France are leading the PEV sales in W. Europe

Last minute rush for tax saving which expired in the Netherlands by the end of 2013