Electric Vehicle Program

Tuskegee University – (October 2015)
Kevin Schleith - University of Central Florida
DOT - Why EVs?

- **Domestic Policy Goals**
  - Mandated reduction of petroleum & greenhouse gases
  - Job creation and Economic Growth
  - Reduce dependence on foreign oil

- **Global Impact**
  - Climate change
  - China to balance growth with pollution
  - Governments have allocated funding for clean technology

- **Energy Independence**
  - Local energy sources reduce price volatility
  - Reduce export of dollars, particularly to unstable regions
  - Reduce dependence on few key regions

- **Developing Nations**
  - Lower-cost conventional vehicles support economic development goals.

*Transportation accounts for roughly 15% of energy related CO2 emissions globally.*
Our Mission

The future will be an integration of electric vehicles and power systems

- Fully Integrated Electric Highway Network
- Wireless Charging
- PV Grid Parity throughout U.S.
- Energy Efficient Homes throughout U.S.
Industry Collaboration

- Florida Department of Transportation
- Florida Turnpike Authority
- Alabama Power
- Alabama Department of Transportation
- Nissan North America, Inc.
- Florida Power & Light (FPL)
- Eglin Air Force Base
- GM Powertrain Global Headquarters
- HEVO, Inc.
Then and Now

Henry Ford’s wife drove and preferred an EV!
<table>
<thead>
<tr>
<th>Petrol (ICE)</th>
<th>Hybrid (HEV)</th>
<th>Plugin Hybrid (PHEV)</th>
<th>100% Battery (EV, GEV, BEV)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PHEV:</td>
<td>Plug-In Hybrid Electric Vehicle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>REEV:</td>
<td>Range Extended Electric Vehicle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>BEV:</td>
<td>Battery Electric Vehicle</td>
<td></td>
<td></td>
</tr>
<tr>
<td>EV:</td>
<td>Electric Vehicle</td>
<td></td>
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</tr>
</tbody>
</table>

Range Extended Electric Vehicles (coming 2016)
Electrical Vehicles (not just cars)...

2009 2010 2011 2012

Sport/Luxury
- Tesla Roadster

Compact
- Mini EV
- Wheego LiFe
- Zenn EV
- Mitsubishi i-MiEV
- Smart for two
- Think City
- Toyota Prius
- Honda Insight PHEV
- Chevy Spark

Light Trucks, Sedan/SUV
- GM Volt
- Nissan Leaf
- Coda EV
- Toyota Rav4 EV
- BYD e6 EV
- Ford Focus EV
- Smith Electric Edison
- Navistar eStar
- Ford Transit Connect
- Mercedes Vito E-cell
- Renault Kangoo
- Bright Auto Idea

Other Vehicles
- Tesla Model S
- Cadillac XTS PHEV
- Fisker Karma
- Volvo V70 PHEV
Best for 2015

80 -90 mile range on full charge or
110-120 miles per gallon equivalent
The Market is Growing

Electric Drive Market Snapshot:
May 2015

- Hybrids: 40,257
- Plug-In Hybrids: 4,416
- Battery EVs: 7,057
- Total Electric Drive Portfolio: 51,730

329,395 Total Plug-In Vehicles Sold in US Since 2010 Market Introduction

9,668 Public Charging Stations, with 24,925 Outlets
One Million Global Plug-Ins Milestone Reached (September 2015)

### Top selling models (rounded to Aug '15, 70% of sales)

<table>
<thead>
<tr>
<th>Rank</th>
<th>Model</th>
<th>Sales</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Nissan Leaf</td>
<td>Almost 200,000</td>
</tr>
<tr>
<td>2</td>
<td>Chevy Volt</td>
<td>Almost 100,000</td>
</tr>
<tr>
<td>3</td>
<td>Tesla Model S</td>
<td>About 85,000</td>
</tr>
<tr>
<td>4</td>
<td>Toyota PHV</td>
<td>About 74,000</td>
</tr>
<tr>
<td>5</td>
<td>Mitsu Outlander PHV</td>
<td>Over 70,000</td>
</tr>
<tr>
<td>6</td>
<td>Mitsubishi i-MIEV</td>
<td>About 50,000 (incl. minivans, trucks in Japan)</td>
</tr>
<tr>
<td>7</td>
<td>BYD Qin</td>
<td>38,930</td>
</tr>
<tr>
<td>8</td>
<td>BMW i3</td>
<td>~30,612</td>
</tr>
<tr>
<td>9</td>
<td>Renault Zoe</td>
<td>30,437</td>
</tr>
<tr>
<td>10</td>
<td>Ford Fusion Energi</td>
<td>24,104</td>
</tr>
</tbody>
</table>

### Top countries (93.2 percent of sales)

<table>
<thead>
<tr>
<th>Rank</th>
<th>Country</th>
<th>Sales Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>United States</td>
<td>363,265 passenger cars since 2008</td>
</tr>
<tr>
<td>2</td>
<td>China</td>
<td>157,354 cars since 2011 (plus over 65,000 HD vehicles)</td>
</tr>
<tr>
<td>3</td>
<td>Japan</td>
<td>121,000-plus passenger cars and vans since 2009</td>
</tr>
<tr>
<td>4</td>
<td>Norway</td>
<td>65,958 passenger and vans since 2003</td>
</tr>
<tr>
<td>5</td>
<td>Netherlands</td>
<td>61,025 passenger and vans</td>
</tr>
<tr>
<td>6</td>
<td>France</td>
<td>Over 59,000 passenger and vans since 2010</td>
</tr>
<tr>
<td>7</td>
<td>UK</td>
<td>39,616 passenger cars</td>
</tr>
<tr>
<td>8</td>
<td>Germany</td>
<td>38,154 passenger cars</td>
</tr>
<tr>
<td>9</td>
<td>Canada</td>
<td>14,429 passenger cars since 2011</td>
</tr>
<tr>
<td>10</td>
<td>Sweden</td>
<td>12,786 passenger cars</td>
</tr>
</tbody>
</table>
EV Transformation

- Auto OEM
  - Ford
  - GM
  - Toyota

- Fuel Production
  - Shell
  - Exxon

- Fueling Location
  - Gas Station

- Data Collection
  - Speedometer

- Vehicle Sales
  - Best Buy

Gasoline

Electric

- Leaf, Volt
- Escalade, Caravan

EV Tax Credits
- Prius, Focus

150K+ EVs *built* in U.S. (Ford, GM, Nissan)

- 25% of new vehicles electric*
- 90% of new vehicles electric by 2050?

Extended Range EV

Electric Vehicle Timeline

- 2010
- 2015
- 2030?
- 2050?
EV Charging Stations
AAA Adds EV Charging Station Locations to Mapping Tools
Operational / Environmental Metrics

• If 10,000 vehicle owners switched from gas-powered passenger cars to EVs, over 33,000 metric tons of CO2 emissions could be avoided annually.

• EV owner will save about 75% of the annual fuel by switching from gas to electric
Benefits

**Consumer Fuel Savings**
350k EVs today = $290 M
4 M EVs in 10 years = $3.3 B
Convert 50% Gov. fleet = $248 M

**Annual Societal Benefits (4 M EVs)**
Urban Air Pollution = $1.5 Billion
Human Health = 43,900 (DALY)
Employment = 136,000 jobs
U.S. GDP = $16.6 Billion
Business Profit = $10 Billion
Additional Income = $5.8 Billion

*DALY – disability-adjusted life year*
Key Drivers for EV Growth

1. Government Incentives
   Clean Air Regulations
   Mandate for Higher Fuel Efficiencies

2. Auto Manufacturer EV Pipeline

3. The Energy Conscious Consumer
Key Drivers

Auto Manufacturer Incentives - $8B loans for Advanced Vehicle Technologies

• $5.9B to Ford (factories in Ohio, Illinois, Kentucky, Michigan, Missouri, Ohio)
• $1.6B to Nissan (factory in Tennessee)
• $465M to Tesla (factory in California)

Fuel Efficient Vehicles Tax Incentives for Consumers

• Tax credit for EV’s, up to $7,500
• Tax credit for charging stations up to $2,000 for consumers and $50,000 for public charging or 50% of the cost
Auto Manufacturer

30+ Manufacturers – 60+ Different Models

Source: www.electricdrive.org
Electric Vehicles and Power Systems

Chevrolet

Nissan

Tesla/SolarCity
Current Research Activities

FSEC Charging Station

- Charging Technologies
- Electric Grid Integration
- Environmental Effects
- Transportation Planning
Current Research Activities
FSEC EV Laboratory

• Charge vs Discharge
• V2G Applications
• Charging Optimization
• Electrical Demand
Current Research Activities
FSEC EV Laboratory - Wireless Charging
Current Research Activities
Florida Turnpike Charging Station Optimization Study

- Infrastructure Requirements
- Capabilities
- Locations
EV’s and You

Tuskegee University Electric Vehicle Transportation Center (EVTC) Day
# Technical Career Opportunities

(US Auto Industry Employs 716,000)

<table>
<thead>
<tr>
<th>Profession</th>
<th>Salary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Chemical engineers</td>
<td>$97,480</td>
</tr>
<tr>
<td>Electrical engineers</td>
<td>$87,580</td>
</tr>
<tr>
<td>Electronics engineers, except computer</td>
<td>$100,450</td>
</tr>
<tr>
<td>Industrial engineers</td>
<td>$77,160</td>
</tr>
<tr>
<td>Materials engineers</td>
<td>$89,000</td>
</tr>
<tr>
<td>Mechanical engineers</td>
<td>$81,290</td>
</tr>
<tr>
<td>Mechanical engineering technicians</td>
<td>$52,950</td>
</tr>
<tr>
<td>Mechanical drafters</td>
<td>$53,840</td>
</tr>
<tr>
<td>Software developers, applications</td>
<td>$94,680</td>
</tr>
<tr>
<td>Commercial and industrial designers</td>
<td>$67,790</td>
</tr>
</tbody>
</table>

http://www.bls.gov/green/electric_vehicles/
Other Career Opportunities
(US Auto Industry Employs 716,000)

<table>
<thead>
<tr>
<th>Role</th>
<th>Salary</th>
</tr>
</thead>
<tbody>
<tr>
<td>Urban and regional planners</td>
<td>$63,040</td>
</tr>
<tr>
<td>Electrical power-line installers and repairers</td>
<td>$58,030</td>
</tr>
<tr>
<td>Electricians</td>
<td>$48,250</td>
</tr>
<tr>
<td>Retail salespersons(2)</td>
<td>$36,470</td>
</tr>
<tr>
<td>Customer service representatives</td>
<td>$31,400</td>
</tr>
</tbody>
</table>


http://www.bls.gov/green/electric_vehicles/