Vermont IEEE PES
Drive Electric Vermont Update
February 19, 2015

David Roberts
VEIC Senior Consultant
droberts@veic.org
802-540-7835
Agenda

1. Transportation Efficiency Policy
2. Types of EVs
3. EV Characteristics
4. EV Charging
5. Drive Electric Vermont
6. Grid Integrated Vehicles
Vermont Greenhouse Gas Emissions 2011

Transportation 46%

Residential, Commercial & Industrial Use 31.3%

Agriculture 10.4%

Industrial Processes 3.6%

Waste Management 3.3%

Electricity Supply (Consumption) 5.3%

Fossil Fuel Industry 0.2%
Transportation Efficiency

- Conventional car solo driver: 5,000 Btu/passenger mile
- Transit bus (average occupancy): 4,500 Btu/passenger mile
- Electric Vehicle solo driver: 1,500 Btu/passenger mile
- Transit bus (seats filled): 1,200 Btu/passenger mile
- Walking: 200 Btu/passenger mile
- Bicycle: 100 Btu/passenger mile

Source: US DOE Transportation Energy Data Book
Comprehensive Energy Plan

Transportation Strategies

- Increase Consumer Choices
  Non-SOV travel

- Deploy New Technology
  Efficient vehicles, including plug-in electric vehicles

http://publicservice.vermont.gov/publications/energy_plan
Introduction to Electric Vehicles

- All Electric Vehicle
  Powered solely by electric energy stored in a battery

- Plug-in Hybrid Electric Vehicle
  Powered by battery and gasoline for extended range
<table>
<thead>
<tr>
<th>OEM</th>
<th>Current EVs</th>
<th>Upcoming Models</th>
<th>Goals/Targets</th>
</tr>
</thead>
<tbody>
<tr>
<td>BMW</td>
<td>i3 (AEV/PHEV), i8 (PHEV)</td>
<td>X5 eDrive (PHEV)</td>
<td></td>
</tr>
<tr>
<td>Chrysler / Fiat</td>
<td>500e (AEV)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Ford</td>
<td>Focus (AEV), Fusion (PHEV), C-Max (PHEV)</td>
<td></td>
<td>10-25% of 2020 sales electric</td>
</tr>
<tr>
<td>GM</td>
<td>Volt (PHEV), Spark (AEV), Cadillac ELR (PHEV)</td>
<td>Bolt (AEV)</td>
<td>10% of 2020 sales electric, hybrid</td>
</tr>
<tr>
<td>Honda</td>
<td>Fit (AEV), Accord (PHEV)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kia</td>
<td>Soul (AEV)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mercedes</td>
<td>Smart ED (AEV), B Class Electric (AEV)</td>
<td>S500 (PHEV), C350e (PHEV)</td>
<td></td>
</tr>
<tr>
<td>Mitsubishi</td>
<td>i-MiEV (AEV)</td>
<td>Outlander (PHEV)</td>
<td>20% electric and hybrid by 2020</td>
</tr>
<tr>
<td>Nissan</td>
<td>Leaf (AEV)</td>
<td>e-NV200 (AEV), Infinity LE (AEV)</td>
<td>10% of 2020 sales electric</td>
</tr>
<tr>
<td>Tesla</td>
<td>Roadster, Model S (AEV)</td>
<td>Model X (AEV), Model III (AEV)</td>
<td>N/A (all electric)</td>
</tr>
<tr>
<td>Toyota</td>
<td>Prius Plug-in (PHEV)</td>
<td></td>
<td>30% of 2020 sales electric and hybrid</td>
</tr>
<tr>
<td>VW / Audi / Porsche</td>
<td>E-Golf (AEV)</td>
<td>A3 E-Tron (PHEV), Q7 E-Tron (PHEV), Panamera (PHEV), 918 (PHEV)</td>
<td></td>
</tr>
</tbody>
</table>
EV Benefits

- Save money
- Great performance
- Luxury features
- Reduced emissions
  - AEVs have no tailpipe
  - “Well-to-Wheels” Benefits
  - Health Benefits
Monthly Transportation Energy Cost

- Gasoline: $4,300 Savings over 5 years

Chart showing the monthly transportation energy cost for gasoline and electric vehicles from 2006 to 2011.
Reduced Maintenance

ELECTRIC MOTOR

INTERNAL COMBUSTION ENGINE
Performance

• Less Gas = More Fun
Performance – UVM Racing

http://www.uvmaero.org/
Cold Weather Operation

Nissan Leaf & Chevrolet Volt: Range vs. Temperature
Spanning All Model Years in the FleetCarma Database

20-50% Decrease in range at colder temps

Leaf = 7375 trips
Volt = 4043 trips
*For the Volt, trips below 25°F (-4°C) were removed since the engine turns on during those trips.
Safety

• Crash Ratings
• Vehicle fires

187,500 fires in 2011
+5,000 at fueling

< 10 as of Feb 2015

• First responder trainings
  o Decal requirements
Leasing Options

- 90% of EVs in the USA are Leased
- Federal incentive passed through by leasing company
- Technology is rapidly changing
- Protected from depreciation
- Accelerate used vehicle availability

- High mileage customers may have issues with leasing
EV Charging

- Home
- Workplace
- Public

Away From Home Charging
Charging Equipment

Level 1 charging
120V

Level 2 charging
208/240V

DC fast charging
208-480V
Brattleboro Tesla Supercharger
### Charging Speed

**Level 1 charging**
- Voltage: 120V
- Current: 20A

**Level 2 charging**
- Voltage: 208/240V
- Current: 15-80A

**DC fast charging**
- Voltage: 208-480V
- Current: Up to 200A

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**EV Miles per Hour of Charging**

- Level 1: 5 miles
- Level 2: 20 miles
- DC fast: 75 miles
# Charging Station Installation Costs

<table>
<thead>
<tr>
<th></th>
<th>Level 1</th>
<th>Level 2</th>
<th>DC Fast</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Charge Duration</strong></td>
<td>6-10 hours</td>
<td>1-3 hours</td>
<td>15-30 minutes</td>
</tr>
<tr>
<td><strong>Equipment</strong></td>
<td>$30 – 900</td>
<td>$600 – 9,000</td>
<td>$15,000 – 60,000</td>
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<tr>
<td><strong>Installation</strong></td>
<td>$200 – 450</td>
<td>$1,000 – 12,000</td>
<td>$10,000 – 25,000</td>
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<tr>
<td><strong>Total</strong></td>
<td>$230 – 1,350</td>
<td>$1,600 – 21,000</td>
<td>$25,000 – 85,000</td>
</tr>
</tbody>
</table>
Charging Station Planning

Access to Power
Public EV Charging Equipment

Waterbury

S Burlington

Montpelier
Vermont EV Policy

- Stakeholder group coordinating public-private investments
  - Vehicle and charging station outreach
- Pilot incentive program at point of purchase with dealer participation
- Downtown charging station grants
- State Infrastructure Bank low interest loans for charging
- Clean Fuels / Fossil Fuel Reduction programs
VERMONT ELECTRIC VEHICLE REGISTRATIONS

<table>
<thead>
<tr>
<th>Month</th>
<th>Total Passenger EVs in Vermont</th>
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<tbody>
<tr>
<td>Jul 2012</td>
<td>88</td>
</tr>
<tr>
<td>Oct 2012</td>
<td>120</td>
</tr>
<tr>
<td>Jan 2013</td>
<td>188</td>
</tr>
<tr>
<td>Apr 2013</td>
<td>238</td>
</tr>
<tr>
<td>Jul 2013</td>
<td>291</td>
</tr>
<tr>
<td>Oct 2013</td>
<td>432</td>
</tr>
<tr>
<td>Jan 2014</td>
<td>596</td>
</tr>
<tr>
<td>Apr 2014</td>
<td>631</td>
</tr>
<tr>
<td>Jul 2014</td>
<td>700</td>
</tr>
<tr>
<td>Oct 2014</td>
<td>801</td>
</tr>
<tr>
<td>Jan 2015</td>
<td>867</td>
</tr>
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Source:
VT Agency of Natural Resources;
VT Dept of Motor Vehicles

Source: DriveElectricVT.com
### Electric Vehicles Per Capita in Vermont Counties

**As of January 2015**

<table>
<thead>
<tr>
<th>County</th>
<th>Population</th>
<th>All Electric</th>
<th>Plug-in Hybrid</th>
<th>Total EVs</th>
<th>Plug-ins per Capita</th>
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<tbody>
<tr>
<td>Lamoille</td>
<td>15,741</td>
<td>3</td>
<td>6</td>
<td>9</td>
<td>0.0025</td>
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<tr>
<td>Caledonia</td>
<td>15,712</td>
<td>2</td>
<td>7</td>
<td>9</td>
<td>0.0025</td>
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<tr>
<td>Washington</td>
<td>55,543</td>
<td>17</td>
<td>99</td>
<td>116</td>
<td>0.0033</td>
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<tr>
<td>Chittenden</td>
<td>49,646</td>
<td>99</td>
<td>191</td>
<td>290</td>
<td>0.0043</td>
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<tr>
<td>Addison</td>
<td>35,821</td>
<td>17</td>
<td>30</td>
<td>47</td>
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<tr>
<td>Windham</td>
<td>94,131</td>
<td>11</td>
<td>41</td>
<td>62</td>
<td>0.0033</td>
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<tr>
<td>Orange</td>
<td>28,936</td>
<td>9</td>
<td>21</td>
<td>30</td>
<td>0.0027</td>
</tr>
<tr>
<td>Grand Isla</td>
<td>28,036</td>
<td>3</td>
<td>4</td>
<td>7</td>
<td>0.0025</td>
</tr>
<tr>
<td>Orleans</td>
<td>37,231</td>
<td>2</td>
<td>25</td>
<td>27</td>
<td>0.0019</td>
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<tr>
<td>Bennington</td>
<td>84,125</td>
<td>5</td>
<td>31</td>
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<td>0.0011</td>
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<tr>
<td>Windsor</td>
<td>115,671</td>
<td>19</td>
<td>28</td>
<td>47</td>
<td>0.0027</td>
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<tr>
<td>Franklin</td>
<td>47,476</td>
<td>6</td>
<td>24</td>
<td>30</td>
<td>0.0007</td>
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<tr>
<td>Rutland</td>
<td>61,842</td>
<td>2</td>
<td>22</td>
<td>24</td>
<td>0.0008</td>
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<tr>
<td>Essex</td>
<td>6,396</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0.0000</td>
</tr>
</tbody>
</table>

This material is based upon work supported by the Vermont Public Service Department, Vermont Agency of Natural Resources, Vermont Agency of Transportation, and the Vermont Department of Buildings and General Services.

Data Source:
Vermont Dept of Motor Vehicles vehicle registration database as of 12/24/2014.
Data processed by Vermont Agency of Natural Resources Dept of Environmental Conservation. EVs distinguished by fuel type, model and/or VIN.
County data summarised from zip code geography. Population from 2010 US Census. Does not include 10 vehicles with registrations zip codes outside of Vermont.
EVs in Vermont

Public Electric Vehicle Charging Locations
As of January 15, 2015

Legend
52 Total
- DC Fast Charging Operational (9)
- DC Fast Charging Planned (2)
- Level 2 Operational (34)
- Level 2 Planned (5)
- Level 1 Operational (2)

Electric Vehicles Registered in Vermont
As of January 2015

Legend
EV Registrations in Zip Code
- 1 - 4
- 5 - 9
- 10 - 19
- 20 - 50

Data Sources:

This material is based upon work supported by the Vermont Public Service Department, Vermont Agency of Natural Resources, Vermont Agency of Transportation, and the Vermont Department of Buildings and General Services.
Potential Growth Scenario

- EV Sales Market Share
- % of Total Fleet

Short of Vermont goal of 25% renewable by 2030
Fleets

• State of Vermont will have more EVs in the fleet
• Several municipalities and CCRPC have leased / purchased
• Utilities and businesses

Winooski’s EV Fleet: https://www.youtube.com/watch?v=W_EKSRYsMVY
Solar PV and EVs

- EVs typically travel 3-4 miles per kWh
- Driving 12,000 miles per year will require 3,000-4,000 kWh
Vehicle to Grid / Vehicle to Building

Fort Carson, CO Microgrid Project

Nissan EV Power Station
Honda Smart Home Demonstration

Welcome to Honda Smart Home US. There are no alerts at this time.
Electric School Buses

Quebec pins hopes on all-electric school bus unveiled in Laval

By Martin C. Barry | Fri, 11/14/2014 - 12:45

Quebec Transport Minister Robert Poitras has been seen here connecting the all-electric school bus for recharging with Mille-Îles Liberal MNA Francine Charbonneau and Minister of Sustainable Development David Heurtel.

Quebec’s Liberal government is hoping that a 100 per cent electric school bus unveiled in Laval and which is regarded as a first of its kind in North America will sell briskly to transportation companies and school boards and return at least some of the investment Quebec made in its development.

A Lion of a bus

Quebec Transport Minister Robert Poitras has joined Sustainable Development Minister David Heurtel and Minister Responsible for the Laval Region Francine Charbonneau with Chomedey Liberal MNA Guy Ouellette at school transportation specialist Charter Inc.’s depot on Montée Masson in Laval’s east end on Nov. 7 for the official unveiling of the 72-seat C-type E-Lion school bus made entirely in Quebec by Lion Bus.

Google Launches Free EV Shuttle Service in Mountain View, CA

February 5th, 2015 by Aisha Abdelhamid

Four new 100% electric community shuttle buses have hit the road in the beautiful Silicon Valley city of Mountain View, California. The four electric shuttles are free to the public, thanks to Google, and are equipped with seating for 16 passengers, a wheelchair lift, space for two wheelchairs, Wi-Fi connectivity, and bicycle racks on the outside of the shuttle. This sounds more tempting to me than a Tesla.
Outreach

• Event recommendations for demos
• Newsletters or other outlets
• DEV stakeholder meetings
• EV charging priorities
  o Projects with construction activity in parking areas
  o Major employers
  o Multifamily properties
  o State Infrastructure Bank opportunities
The Solar Assisted Rickshaw Van: A Complete Off-Grid Solution

by: AKM Abdul Malek Azad For some countries, Rickshaws are intrinsic elements of a national transportation system. As much as one enjoys a rickshaw ride, however, there is no overlooking the significant amount of labor and effort exerted by the rickshaw puller. Battery-powered, 'electric' rickshaws pioneered by companies like Beevtech Ltd seemed to be a very popular solution when they were first introduced. However, there were a number of drawbacks [1,2]...

http://electricvehicle.ieee.org/
Resources

• Drive Electric Vermont
  • http://driveelectricvt.com
  • https://www.facebook.com/DriveElectricVT

• National EV websites
  • http://www.afdc.energy.gov/fuels/electricity.html
  • http://goelectricdrive.com
  • http://www.pluginamerica.org
  • http://www.northeastevs.com
  • http://www.greencarreports.com/
New England regional mix provides 75 MPG GHG equivalent