Electric Vehicles as a Grid Resource
In ISO-NE and Vermont
Vermont Energy Investment Corporation

- Nonprofit with 25 years experience reducing economic, environmental costs of energy
- Comprehensive focus and results
  - Energy efficiency – Renewable energy – Transportation
- National & international consulting & implementation
  - Program design, planning, & evaluation – policy & advocacy – research
- Clients are government agencies, regulators, utilities, foundations, advocates
- Operate 3 Energy Efficiency Utilities
EV - Opportunity

- New demand for electricity
- More efficient use of utility resources
- Contribute to grid reliability as a resource in various wholesale markets
Opportunities

- Storage allows demand or load to be decouple from generation
- Vehicles are in use for mobility less than 5% of the time
- EVs need to be charging for approximately 10-20% of the day
- EVs represent a flexible load amenable to shifting
Vermont Electric Market Structure

Adapted from Harvey, Hal and Sonia Aggarwal. “America’s Power Plan. Overview: Rethinking Policy to Deliver a Clean Energy Future.”
Incremental Approach

- Demand Side Management programs.
- Aggregated EVs serving as resources in the wholesale level ancillary service markets.
- Fully integrated system - aggregated EVs provide storage resources coupled with renewable energy sources providing distributed generation guarantees in capacity markets.
Demand Side Management

- **Indirect: Time of Use Rates**
- **Direct: Controlled Charging**

Wholesale Markets: Vehicles Needed for Minimum Resource Size

<table>
<thead>
<tr>
<th>Vehicles</th>
<th>Connection Level</th>
<th>Power Level (kW)</th>
<th>Number of EVs Needed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average EVs currently on the road</td>
<td>Level 1</td>
<td>1.4</td>
<td>715</td>
</tr>
<tr>
<td>Average EVs currently on the road</td>
<td>Level 2</td>
<td>3.6</td>
<td>278</td>
</tr>
<tr>
<td>Higher power EVs becoming available</td>
<td>Level 2</td>
<td>6.6</td>
<td>152</td>
</tr>
<tr>
<td>EVs retrofitted with more powerful charger</td>
<td>Level 2</td>
<td>15</td>
<td>67</td>
</tr>
<tr>
<td>Electric school buses (or other large vehicles) retrofitted with high power charger</td>
<td>DC Fast Charging</td>
<td>60</td>
<td>17</td>
</tr>
</tbody>
</table>
## Potential Regulation Resource Values

<table>
<thead>
<tr>
<th>Scenario</th>
<th>Level of Participation and Configuration</th>
<th>Regulation Clearing Price ($/MWh)</th>
<th>Monthly Benefit per Vehicle</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Illustrative Examples</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Individual vehicles, connected through Level 2 EVSE, aggregated through third party</td>
<td>1 MW resource, 3.6 kW connection, 50% participation rate (360 hrs/month), 417 vehicles</td>
<td>$6.74 - $46.66</td>
<td>$5 - $40 / month</td>
</tr>
<tr>
<td>Electric school buses, connected through Fast charging EVSE, aggregated through fleet management</td>
<td>1 MW resource, 60 kW chargers, 50% participation rate (360 hrs/month), 25 vehicles</td>
<td>$6.74 - $46.66</td>
<td>$97 - $672 / month</td>
</tr>
<tr>
<td><strong>Demonstration Findings</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>University of Delaware PJM Regulation pilot project</td>
<td>100 kW resource, 18 kW chargers, 15 vehicles</td>
<td>$31.64</td>
<td>$150 / month</td>
</tr>
</tbody>
</table>
Recommendations

- EV Rates
- Coordination of Participants and Stakeholders
- Standardization
- Cost-Benefit Analyses
- Demonstration
- EVs as part of the conversation
Thank You

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