Vehicle-to-Grid: V2G or V2G½?

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EV Roadmap 7
July 24, 2014
Portland, Oregon
DOE’s National Laboratories are solving America’s toughest challenges
Expanding campus, growing capabilities
Today’s Grid can supply 70% of our daily driving energy

Summary

- **Midwest**: support almost the entire LDV fleet
- **East**: somewhat smaller potential
- **West**: supports fewer vehicles

% figures denote the percentage of LDV fleet supported by idle electric capacity
**EV Loads as a grid asset**

- **With** communications as part of the AGC control
  - Provision of regulation services to minimize ACE
  - Requires high update rates via SCADA network
- **Without** communications
  - Based on frequency deviations from nominal AC frequency
  - Extremely low-cost
600,000 vehicles would provide 500 MW of regulation services (0.8 kW per vehicle diversified)
Autonomous Frequency Regulation

Power Line Frequency (Actual)

State of Charge and Rate of Charge

August 7, 2014
V2G½: Load can provide regulation services

V2G
- provides regulation service as a load and generator
- requires charging and discharging according to grid operators signal

V2G½
- provides regulation service as a load only
- requires only charging
- modulates charging

Max. charging (7.2 kW = 240V*30A)
Max. discharging (-7.2 kW)

Capacity value
(-7.2 to 7.2=14.4kW)

Never discharge!
Max. discharging (-7.2 kW)

Capacity value
(0 to 7.2=7.2 kW)
Vehicle to Grid (V2G) schemes propose to utilize numerous plugged-in vehicle batteries as a source of capacity or regulation services for the electric grid.

- Resulting frequent cycling would likely reduce the life expectancy of the battery or void manufacturer’s warranty.

- PNNL’s proprietary “V2G½” scheme uses rapidly varying charging demand as a means to provide regulation services for the grid.

- But only operates in the charging mode, so the battery is not cycled and life expectancy is not reduced.

- Regulation service is very valuable to the utility, thus may offset costs to the vehicle owner.

- Interconnection costs greatly reduced because no power flows back into the grid, thus minimal grid interconnection and protection equipment is required.
## Value of Vehicle to Grid “Half” (V2G\(\frac{1}{2}\))

### Annual Value of V2G half regulation services [$/MWh]

<table>
<thead>
<tr>
<th>Battery size</th>
<th>$20/MWh</th>
<th>$30/MWh</th>
<th>$40/MWh</th>
<th>$50/MWh</th>
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</thead>
<tbody>
<tr>
<td>5 kWh</td>
<td>$ 36.50</td>
<td>$ 54.75</td>
<td>$ 73.00</td>
<td>$ 91.25</td>
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<td>10 kWh</td>
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<td>$164.25</td>
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<tr>
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<td>$219.00</td>
<td>$292.00</td>
<td>$365.00</td>
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<tr>
<td>25 kWh</td>
<td>$182.50</td>
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<tr>
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<td>$292.00</td>
<td>$438.00</td>
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<td>$730.00</td>
</tr>
</tbody>
</table>

**California, Texas case**

- **PHEVs**
- **EVs**
Questions?

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