Electric Vehicles as Grid Assets
GIV Technology and Policy Considerations

For
The National Governors Association
Electric Vehicle Grid Integration Policy Summit

By
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Grid-Integrated Vehicle (GIV) Systems Concept

GIVS can provide a variety of benefits to consumers, ratepayers, and the grid.

• Bring down TCO of EVs
• Turn an uncontrolled influx of demand (EVs) into a controlled load
• Mitigate the variability of high integration of renewables
• Provide a cheaper, readily-available storage resource for grid services

Technology is proven and maturing, with OEMs producing V2G-enabled vehicles and aggregators realizing market value.
Vehicles as Grid Assets

- EVs have battery and power conversion equipment (charger and motor drive) for grid storage
- Average light vehicle is parked 95% of the time, typically near a plug
- To provide grid services, may need minor adjustments, e.g.:
  - Change charger to bidirectional charge and discharge (vehicle-to-grid, V2G)
  - Add controls and signaling to respond to grid, not just by time of day
  - Integrate into aggregation to meet trip needs of any individual and meet aggregate need for RTO

<table>
<thead>
<tr>
<th>Service</th>
<th>Gross Annual Revenue Range (Per 100 kW bid)</th>
<th>Hours per year needed or standby</th>
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<td>Arbitrage</td>
<td>$500 - $3,000</td>
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<td>Customer Peak Reduction</td>
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<td>Upgrades</td>
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<tr>
<td>Capacity</td>
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<td>A/S Regulation</td>
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<td>A/S Spinning Reserves</td>
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EV Storage Economics

- **On-board (AC) charger, lower capital cost.**
  - AC charging 1/3 to 1/2 cost of DC charging equipment

- **Bidirectional (V2G), higher revenue.**
  - 13x revenue of controlled charging, but more complex.

- **Higher power per car, higher revenue.**
  - Charging power is key (more kW in/out), may not need bigger kWh battery.

- **Consistent driver plug-in when parked, higher revenue**

- **Policy amendments for market access**

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**EV storage:**
- Demo $227/kW
- OEM production $45/kW
Examples of GIV Systems in Operation

UD “Demand-side Resource”
PJM regulation: $1,200 / EV / year

Energinet.dk Primary reserves market, earning €1,600/EV/year

Testing 3-phase charging standards at National Renewable Energy Lab, Golden, CO

UK, Commercial GIV Fleets, multiple grid services – installed 2019/2020
Participating OEMs

OEM= Original Equipment Manufacturer, (i.e. Automotive Manufacturers)

- BMW (demonstrations)
- Honda (Pre-production EVs with AC V2G built-in)
- Nissan Europe (selling Leafs & eNV200s warrantied for V2G via DC)
- The Lion Electric (selling AC V2G busses)
- BYD (40 kW AC V2G demonstration, 28 transit buses)
- Bluebird (DC V2G buses, pre-production)
- Renault (mass produced AC V2G capable vehicle)

Most of the above have done detailed studies of effect on warranty and battery life and decided that is not a problem.

Auto Alliance indicates need for 5-year lead time from design to mass production. Regulators must demonstrate markets will be accessible.

“V2G AC Resources represent a potentially lower-cost form of mobile storage that supports renewable integration and improves vehicle-grid integration for the purposes of distribution planning.”
– Auto Alliance in submission to CA PUC.
Policy Actions for Market Entry to Reveal Full Value

- Modify storage policies to recognize both stationary and mobile storage systems (i.e. GIVS). This ensures DC GIVS can interconnect.
- Review and potentially raise fast-track interconnection pathways, to enable low-cost study when appropriate.
- Modify inappropriate safety standards to incorporate policy flexibility and adopt SAE J3072 for the interconnection of AC GIVS.
- Ensure technology not penalized at retail level through mechanism such as credit-for-export.
- Work with utilities to design and implement phase 0 implementations of the technology.

**Adopted or Available**

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Thank You.

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Or visit:

https://crew.udel.edu/v2g/