DoD Plug-In Electric Vehicle Program

The DOD V2G Pilot Project
Overview

Presented by
Camron Gorguinpour, PhD
Office of the Assistant Secretary of the Air Force
Installations, Environment & Logistics
Camron.Gorguinpour@pentagon.af.mil
Overview

- DOD PEV Program Summary
- V2G Services & Case Study
- DOD V2G Demonstration
- Conclusion
PEV Program

GOALS
- Develop knowledge base/technology/skill sets to implement PEV strategy
- Develop proof of concepts to show PEVs can meet energy directives
- Explore related benefits of PEV technology, to include revenue generation
- Initiate large scale integration of PEVs into DOD non-tactical ground fleet

OBJECTIVES
- Develop strategy to initiate large scale PEV implementation considering:
  - PEVs must meet mission requirements
  - Total cost of ownership for vehicles and infrastructure
  - Vehicles acquired at cost parity
  - Requisite RDT&E activities
Activities Completed to Date

- Worked with GSA to develop PEV residual value and lifecycle cost model
- Implemented detailed PEV charging infrastructure analyses at 16 DOD installations, including cost-benefit analysis for V2G
- Initiated effort to make Los Angeles AFB the first federal facility to convert its entire general purpose fleet to PEV’s
- Completed thorough business case analysis for V2G and non-V2G fleet electrification efforts
- Executed four Requests for Information (RFIs), two industry events, and extensive market research
- Launched V2G Pilot Initiative on 6 DOD installations
  - Additional V2G work ongoing at Ft Carson, Wheeler AAF & Port Hueneme
V2G Ancillary Services

- **Power (MW)**
- **Time of Day**

**Spinning Reserves**
Extra generation available to serve load in case of unplanned event
Good match for V2G

**Aggregate Daily Load Curve**
Peak Power Shaving
Generation at times of high power demand
May be used for V2G

**Frequency Regulation**
Used to regulate frequency and voltage of the grid by matching instantaneous generation supply to load demand
Best match for V2G
Where is frequency regulation valuable?

[Map of Regional Transmission Organizations]
Case Study: EV Fleet Sedan in Southern California

- **Assumptions:**
  - Lease Price: $200/month
  - 15kw bi-directional capability
  - Participation in Frequency Regulation Market only
  - 12,000 miles driven per year
  - Typical operation from 9am to 5pm
  - 2011 remuneration values for California ISO, in Southern California
V2G Case Study (cont’d)

- How much was 15kw of bi-directional capacity worth in 2011?
  - Southern California (south of Path 26) remuneration for 2011 was approximately $168/kw for storage available 24/7
    - Assumes resource is simultaneously participating in both up- and down-regulation markets
  - Total value of approximately $2,520 for the year or $210/month
    - Markets are highly variable by both time of day and time of year
    - Markets are open 24/7 for 365 (or 366) days per year

- Bottom line: Frequency Regulation alone can reduce the monthly lease price of a PEV sedan by about 72%.
  - Frequency regulation revenues are expected to rise as natural gas prices increase and per the implementation of FERC Order 755
V2G Case Study (cont’d)

- Assuming vehicles are “used” during normal business hours (8am-5pm, M-F), approximately 73% of frequency regulation value is retained.
  - Financial value does not change in non-business hours

- What does this mean for leasing a V2G-capable sedan?

<table>
<thead>
<tr>
<th>ICE Sedan</th>
<th>V2G Sedan</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSA lease price: $174/month</td>
<td>Base lease price: $200/month</td>
</tr>
<tr>
<td>Operating cost ($0.145/mile):</td>
<td>Operating cost ($0.06/mile):</td>
</tr>
<tr>
<td>$145/month</td>
<td>$60/month</td>
</tr>
<tr>
<td>Net Cost: $319/month</td>
<td>V2G value: $150/mo</td>
</tr>
<tr>
<td>Net Cost: $110/month</td>
<td>Net Cost: $110/month</td>
</tr>
</tbody>
</table>

Net Savings for V2G: $209/month
## Impact of V2G Activities on Batteries

### Truck

**Truck Total Energy Cycles**

<table>
<thead>
<tr>
<th>Energy cycles per year</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Driving</td>
<td>240</td>
<td>cycles at</td>
<td>39%</td>
<td>% SOC/day</td>
</tr>
<tr>
<td>Peak-shaving</td>
<td>72</td>
<td>cycles at</td>
<td>60%</td>
<td>DOD/day</td>
</tr>
<tr>
<td>Frequency Regulation</td>
<td>61,020</td>
<td>cycles at</td>
<td>2.1%</td>
<td>Ave. change in SOC%/cycle</td>
</tr>
<tr>
<td>Other</td>
<td>24</td>
<td>cycles at</td>
<td>60%</td>
<td>DOD/day</td>
</tr>
</tbody>
</table>

### Auto

**Auto Total Energy Cycles**

<table>
<thead>
<tr>
<th>Energy cycles per year</th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Driving</td>
<td>240</td>
<td>cycles at</td>
<td>50%</td>
<td>% SOC/day</td>
</tr>
<tr>
<td>Peak-shaving</td>
<td>72</td>
<td>cycles at</td>
<td>60%</td>
<td>DOD/day</td>
</tr>
<tr>
<td>Frequency Regulation</td>
<td>61,020</td>
<td>cycles at</td>
<td>2.1%</td>
<td>Ave. change in SOC%/cycle</td>
</tr>
<tr>
<td>Other</td>
<td>24</td>
<td>cycles at</td>
<td>60%</td>
<td>DOD/day</td>
</tr>
</tbody>
</table>
V2G Project Scope

- Initiate large-scale testing and evaluation program for PEVs on 6 installations (DOD-wide) in four regions, with the following features:
  - 100-500 PEVs with V2G capability
    - LD pick-up trucks
    - LD cargo/passenger vans
    - MD/HD trucks and vans
    - Buses
  - One V2G-capable charging station per PEV
  - Specialized software to manage PEV fleet with V2G capability
  - Training for multiple DOD constituencies
  - Sustainment for PEVs, infrastructure, and software
  - Program management and systems integration
- Demonstrate financial and operational benefits of a V2G fleet
- Option to expand up to 1,500 PEVs on up to 30 installations
System Architecture

- Electrical Service Tap (208V or 480V AC)
- Electrical Service (120V AC)

- System contained within installation master meter, but sub-metered separate from any other base load or source.

- Aggregator

- External communications occur via cellular modem. Charging stations communicate to aggregator via redundant Ethernet cables. All communications are separate from base LAN.
V2G Fleet Management

- Software system is central to execution
- Fleet management tool is primary user interface
  - User tells system when each vehicle will be used and where it will be travelling
  - Statistical planning eventually feasible
- System projects charge state of battery upon return and produces charging schedule for next use
  - Charging schedule optimized for cost
- On top of charging schedule, system bids into relevant energy/power markets
- System dispatches relevant signal from utility/ISO/facility to charging stations
V2G Operational Considerations

- Mission requirements are always top priority
  - V2G activities may be superseded at any time, regardless of financial loss
  - DOD may restrict market participation to mitigate risk of non-compliance

- Human factors will likely pose greatest challenge
  - Car not “returned” until it’s parked in a designated location and plugged in
  - Requires a much greater level of planning than conventional fleet management

- V2G may create opportunities to enhance mission capabilities that would otherwise be unattainable
Conclusion

- There is a pathway for fleets to procure PEV’s at total cost of ownership parity (or better) with conventional vehicles
- V2G is an essential element to satisfy financial constraints on DOD’s fleet electrification efforts
- Additional operational and tactical benefits occur with the implementation of V2G technologies
- Bureaucratic barriers are more substantial than technical barriers to actualization of V2G program
- DOD is committed to exploring avenues that will bring V2G technologies to bear