

DoD Plug-In Electric Vehicle Program



The DOD V2G Pilot Project Overview

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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

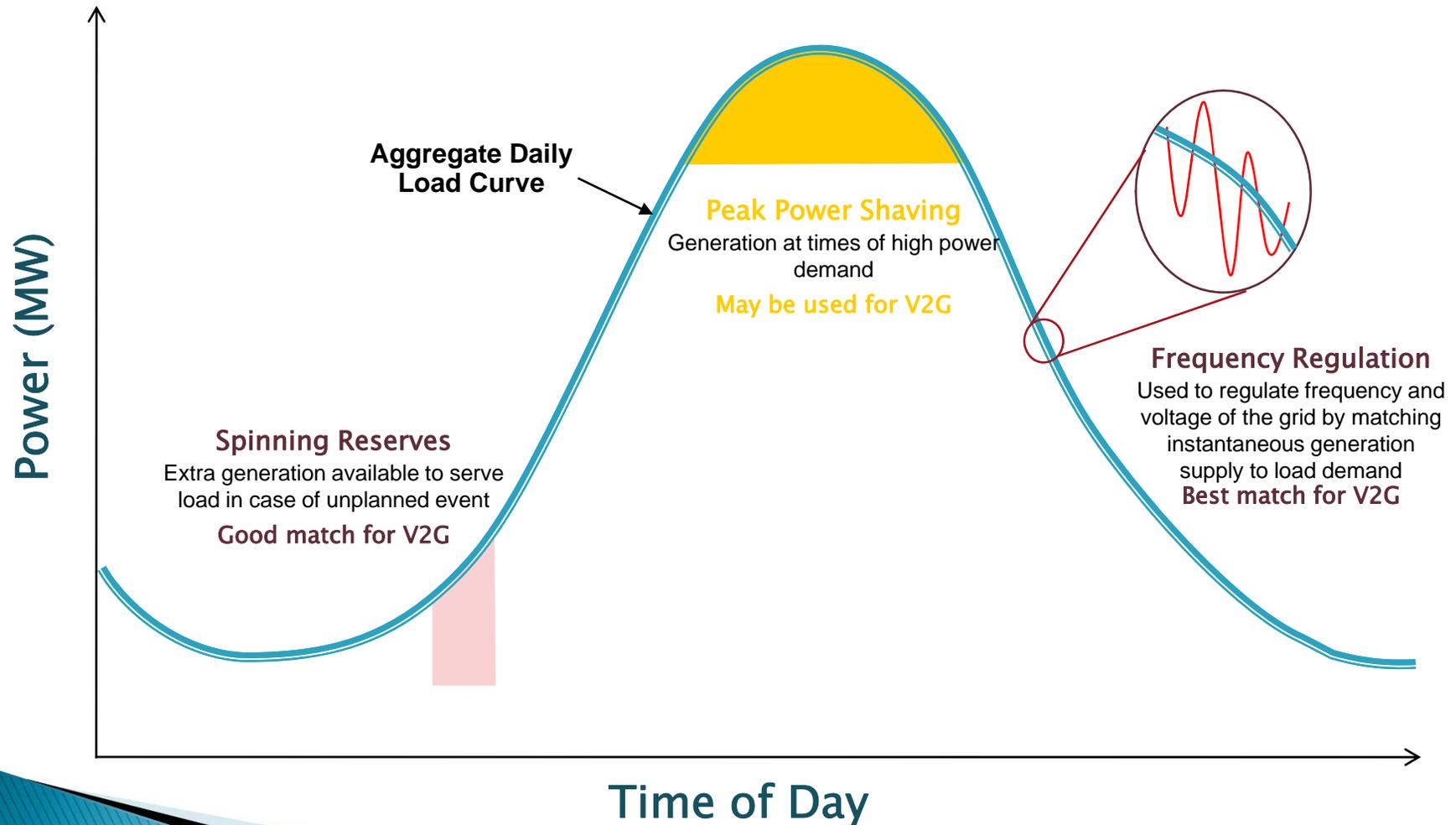


Activities Completed to Date

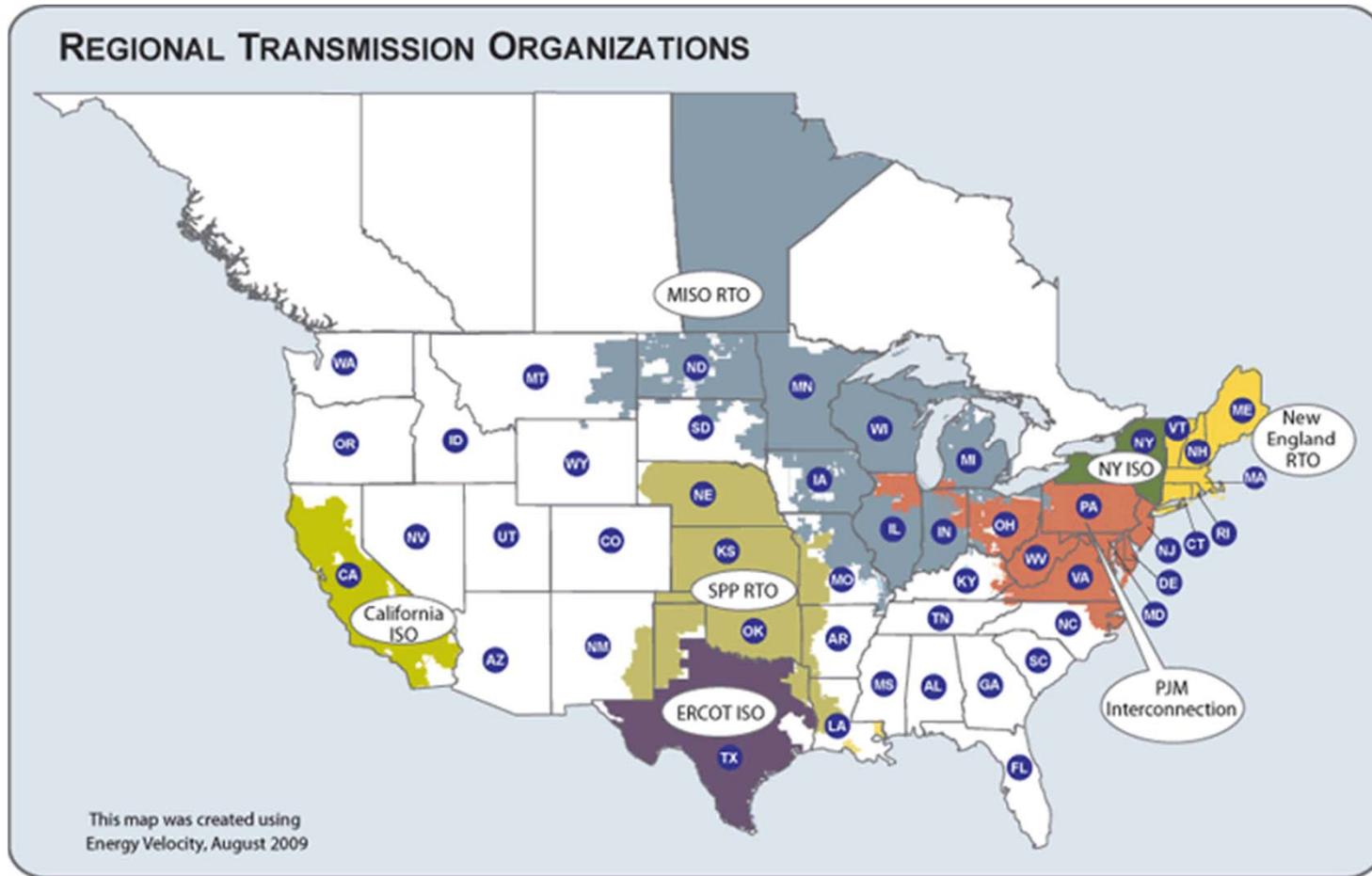
- ▶ Worked with GSA to develop PEV residual value and lifecycle cost model
- ▶ Implemented detailed PEV charging infrastructure analyses at 16 DOD installations, including cost-benefit analysis for V2G
- ▶ Initiated effort to make Los Angeles AFB the first federal facility to convert its entire general 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



Where is frequency regulation valuable?





V2G Case Study

- ▶ 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?

| ICE Sedan | V2G Sedan |
|--|--|
| GSA lease price: \$174/month Operating cost (\$.145/mile): \$145/month | Base lease price: \$200/month Operating cost (\$.06/mile): \$60/month V2G value: \$150/mo |
| Net Cost: \$319/month | Net Cost: \$110/month |
| Net Savings for V2G: \$209/month | |



Impact of V2G Activities on Batteries

| Truck | | | | |
|---------------------------|--------|-----------|------|----------------------------|
| Truck Total Energy Cycles | | | | |
| Energy cycles per year | | | | |
| Driving | 240 | cycles at | 39% | % SOC/day |
| Peak-shaving | 72 | cycles at | 60% | DOD/day |
| Frequency Regulation | 61,020 | cycles at | 2.1% | Ave. change in SOC% /cycle |
| Other | 24 | cycles at | 60% | DOD/day |

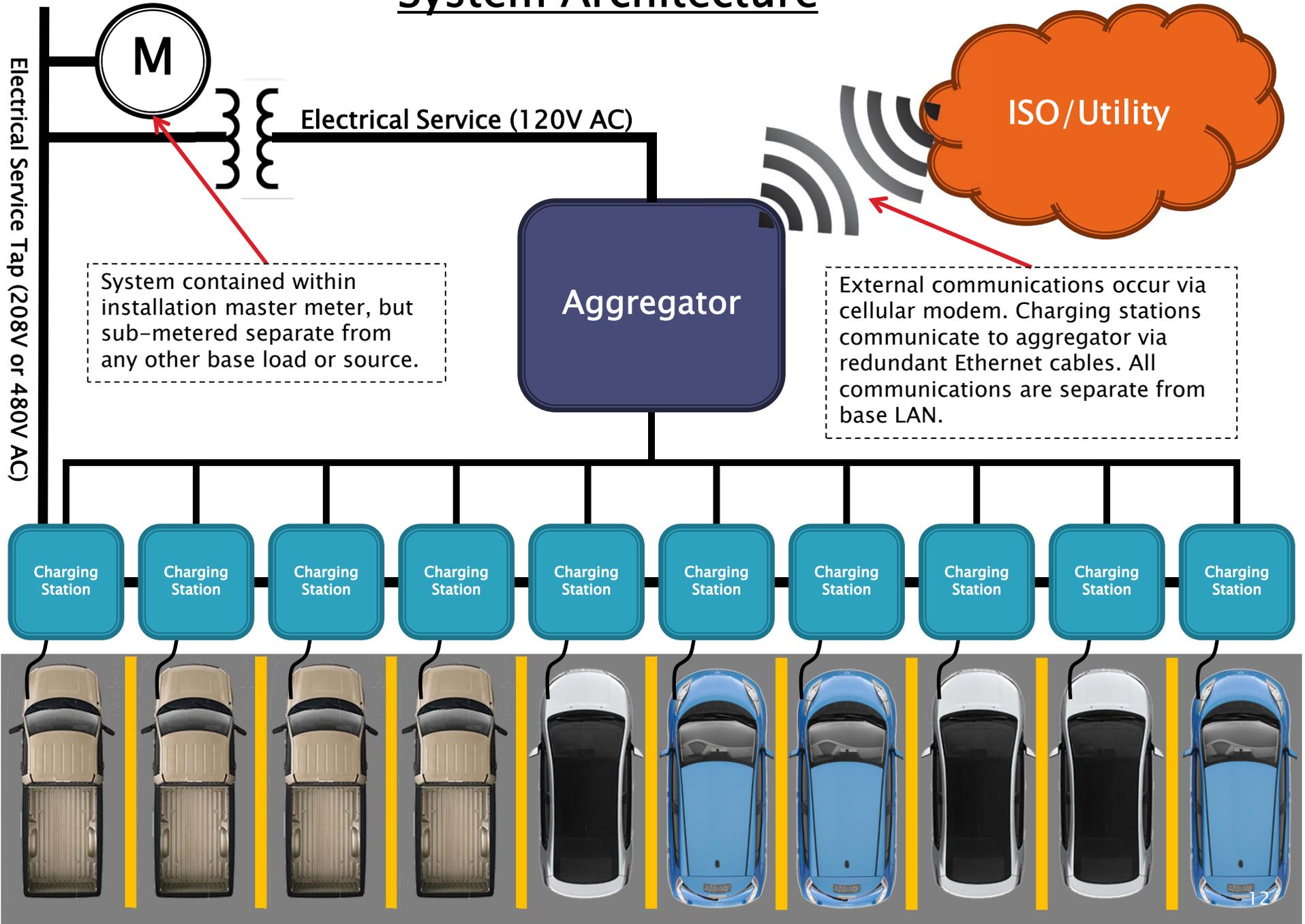
| Auto | | | | |
|--------------------------|--------|-----------|------|----------------------------|
| Auto Total Energy Cycles | | | | |
| Energy cycles per year | | | | |
| Driving | 240 | cycles at | 50% | % SOC/day |
| Peak-shaving | 72 | cycles at | 60% | DOD/day |
| Frequency Regulation | 61,020 | cycles at | 2.1% | Ave. change in SOC% /cycle |
| Other | 24 | cycles at | 60% | DOD/day |



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





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