

U.S. Department of Defense

Plug-In Electric Vehicle Program



DOD Perspectives on Vehicle-to-Grid (V2G)

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What is V2G?

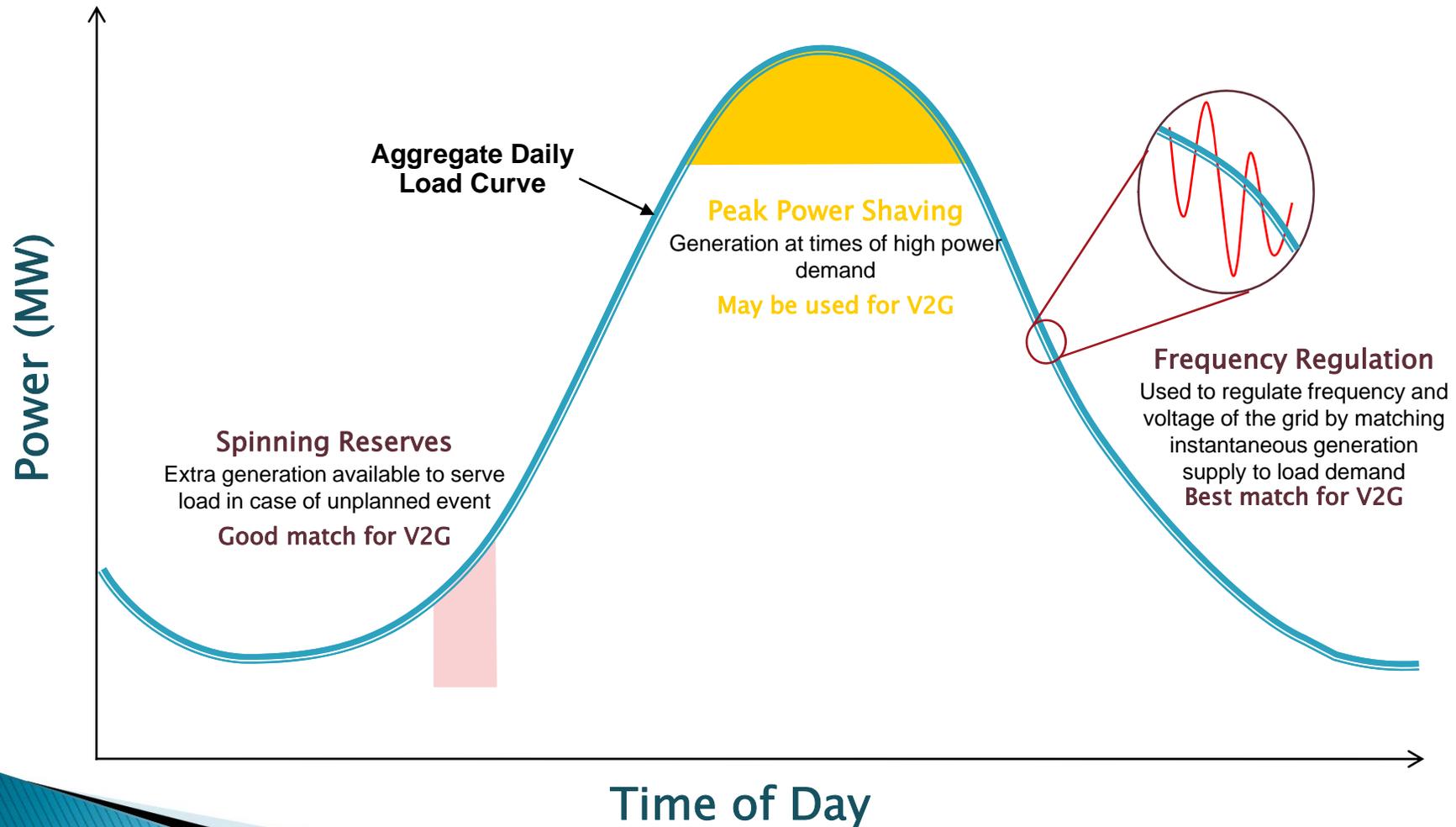
- ▶ Electric vehicle battery power can use bi-directional flow to act as an energy resource when the vehicle is parked and plugged in

- ▶ Vehicle to Grid (V2G) Ancillary Services
 - Peak Power Shaving Capability
 - Frequency Regulation Services
 - Spinning/Non-Spinning Reserve Services

- ▶ Other Energy Uses
 - Energy Storage and Localized Backup Power
 - Integrated within Installation Energy Security Plan
 - Micro-grid integration



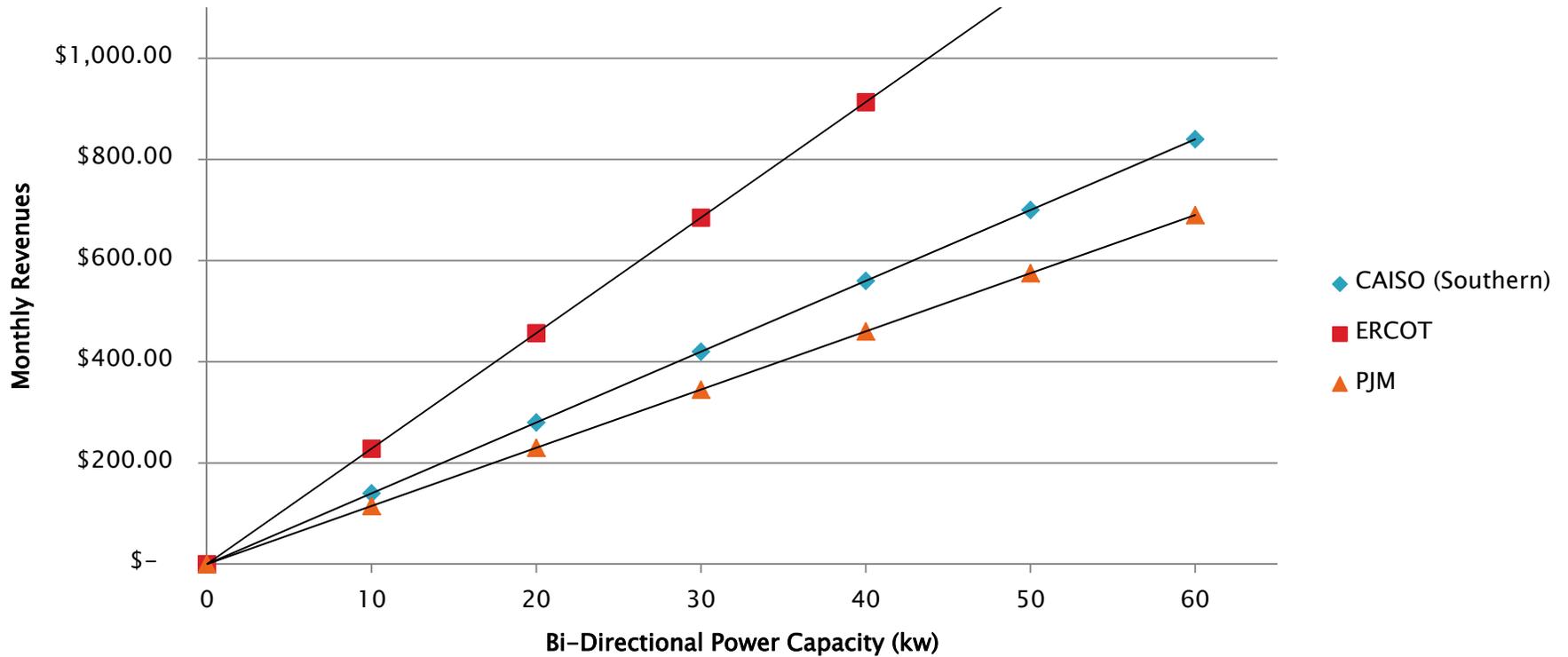
V2G Ancillary Services



Value of Frequency Regulation



CY 2011 Monthly Frequency Regulation Revenues





V2G Case Study

- ▶ Case Study: EV Fleet Sedan in Southern California
 - Assumptions:
 - Lease Price: \$290/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: \$290/month Operating cost (\$.06/mile): \$60/month V2G value: \$150/mo
Net Cost: \$319/month	Net Cost: \$200/month
Net Savings for V2G: \$119/month	



Other V2G Financial Considerations

- ▶ Infrastructure costs are significantly higher for V2G systems than conventional charging systems
 - Costs scale roughly proportional with power capacity (i.e. a 15kw system costs about twice as much as a 7.5kw system per station)
 - V2G requires that there is one charging station per PEV
- ▶ Frequency regulation is a highly variable market
 - A collapse in revenues is unlikely but possible
- ▶ Value of frequency regulation is stable in most markets when “normal business hours” are omitted
- ▶ Market saturation is possible but would require tens of thousands of V2G vehicles in a given RTO/ISO region
- ▶ Additional work is underway to identify new V2G activities that can draw financial value



Broader Implications of V2G

- ▶ A few hundred V2G vehicles on DOD bases can reduce costs and enhance mission capabilities
- ▶ What would happen if 100,000 V2G vehicles were placed in California?
 - At 15kw per vehicle, that's 1.5GW of bi-direction power
 - Current ancillary service markets would be saturated
 - Financial value would have to be drawn from other demand response activities
 - At that point, we would hope that PEV prices are closer to ICE vehicles anyway.
 - Ancillary service market structures could be built around statistical models for driving patterns
- ▶ Electrical and transportation infrastructure would be effectively merged



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
- ▶ Implementation of a V2G fleet will require a fundamental change in the manner in which fleet vehicles are organized and operated
- ▶ DOD is committed to exploring avenues that will bring V2G technologies to bear



DISCUSSION

