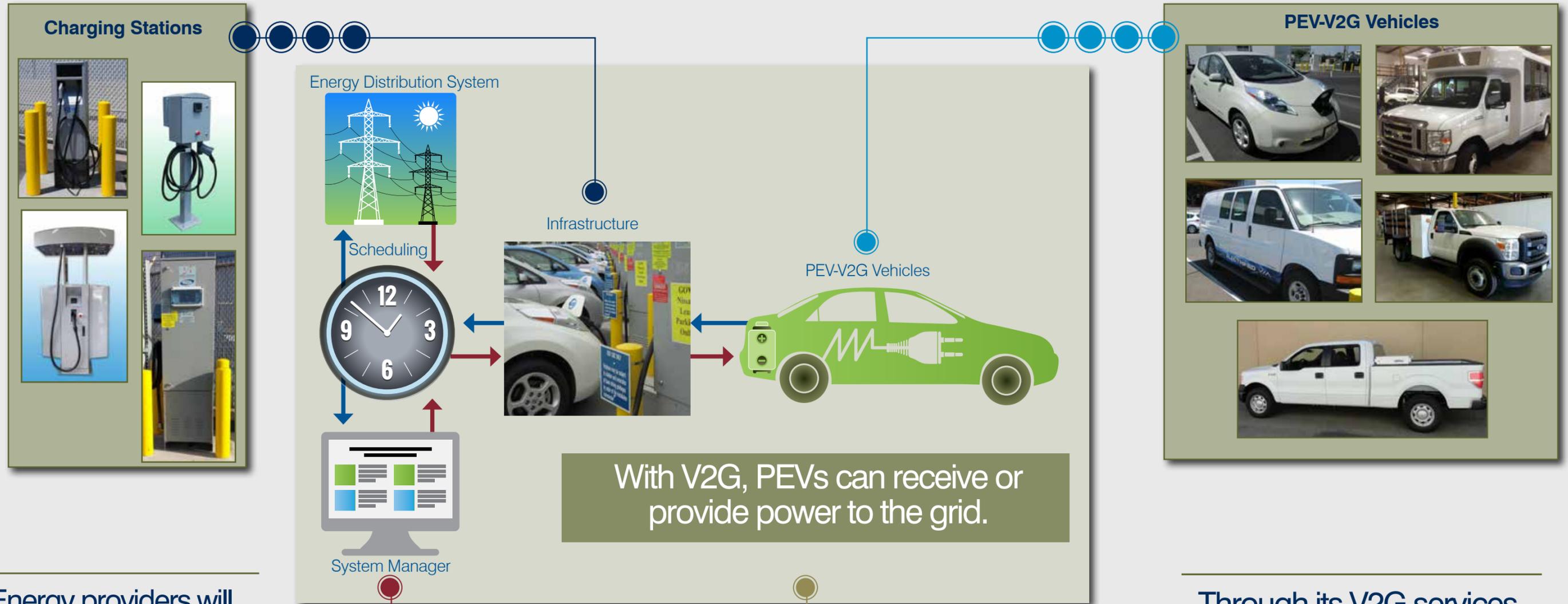


What is Plug-in Electric Vehicle – Vehicle to Grid (PEV-V2G)?



Charging Stations



PEV-V2G Vehicles



With V2G, PEVs can receive or provide power to the grid.

Energy providers will **PAY** for V2G services – vehicle batteries provide an energy source to stabilize the grid.

Software Capabilities

- Fleet Management System
- Charge Control
- Grid Scheduling
- EV Asset Coordination
- Grid Interface

Sites

- Los Angeles Air Force Base (LAAFB), California
- Fort Hood, Texas
- Joint Base (JB) Andrews, Maryland
- JB McGuire-Dix-Lakehurst (MDL), New Jersey

Through its V2G services, a military base **REDUCES** its energy costs and greenhouse gas emissions.





What Plug-In Electric Vehicles (PEVs) and Plug-In Hybrid Electric Vehicles (PHEVs) are in the V2G fleet?



U.S. ARMY



U.S. AIR FORCE



Nissan LEAF Sedan



Ford F-Series Trucks with EVAOS PHEV kits



VIA Motors VTRUX Van



Electric Vehicle International (EVI) Range Extended Electric Vehicle (REEV)



Phoenix Motorcars Electric Shuttle

Range Description



PEV
electric range: 75 miles
fuel efficiency: 99 MPGe

PHEV
electric range: N/A
fuel efficiency: 45 MPG**

PHEV*
electric range: 31 miles
fuel efficiency: 38 MPG**

PHEV*
electric range: 40 miles
fuel efficiency: 43 MPG**

PEV
electric range: 100 miles
fuel efficiency: 32 MPGe

General Purpose Fleet Role



23.6 cubic feet cargo capacity

1500 to 2800 lbs payload

2650 lbs payload (cargo van only)

5300 lbs payload

116 cubic feet cargo capacity



5 seats

3 seat standard cab
6 seats crew cab

2 seat cargo
12 seat passenger

2 seats

visitor transport:
12 passengers + driver

Battery Capacity



24 kWh

27 kWh

21 kWh

54 kWh

102 kWh

at Locations



LAAFB
Fort Hood
JB Andrews
JB MDL

13

8

8

5

14

5

8

11

4

1

Miles per gallon (MPG), Miles per gallon equivalent (MPGe), Kilowatt-hours (kWh)
Los Angeles Air Force Base (LAAFB), Joint Base Andrews (JB Andrews), Joint Base McGuire-Dix-Lakehurst (JB MDL)

*Fuel used only when electric range exceeded
**Averaged over 60 miles

How is the V2G infrastructure controlled?

Introduction

A V2G system is comprised of plug-in electric vehicles (PEVs), bi-directional charging stations, and software controls that enable an installation to compete in utility ancillary services markets. Customized for each base, the OB-EVI provides the communication and software controls needed for all aspects of V2G.

Goal

Meet utility system operator's charge and discharge requirements

- Fulfill base fleet mission requirements
- Maximize ancillary services revenues
- Minimize non-conformance penalties



Performance Reporting
OB-EVI includes a dashboard and detailed reports that provide system status, V2G participation and financial performance information.

On Base-Electric Vehicle Infrastructure (OB-EVI)

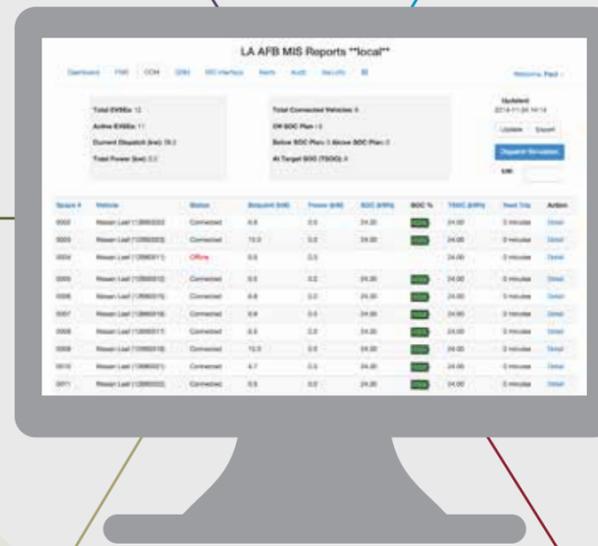
PEV Fleet Reservations
Base personnel reserve cars/trucks in advance of use. OB-EVI ensures V2G participation does not prevent the fleet from meeting mission requirements.



Vehicle to Grid
OB-EVI supplies power stored in vehicle batteries to the grid according to the award signal.



Power Sent from Battery to Grid



Charge Management
OB-EVI develops an optimal charge schedule to ensure mission readiness and maximize financial benefit of V2G participation. OB-EVI controls EVSE charge/discharge according to schedule.



Charge Vehicle Battery Discharge Vehicle Battery

Managing fleets & participation in the ancillary services market

Award Signal
Utility system operator responds to submitted bid with award signal.



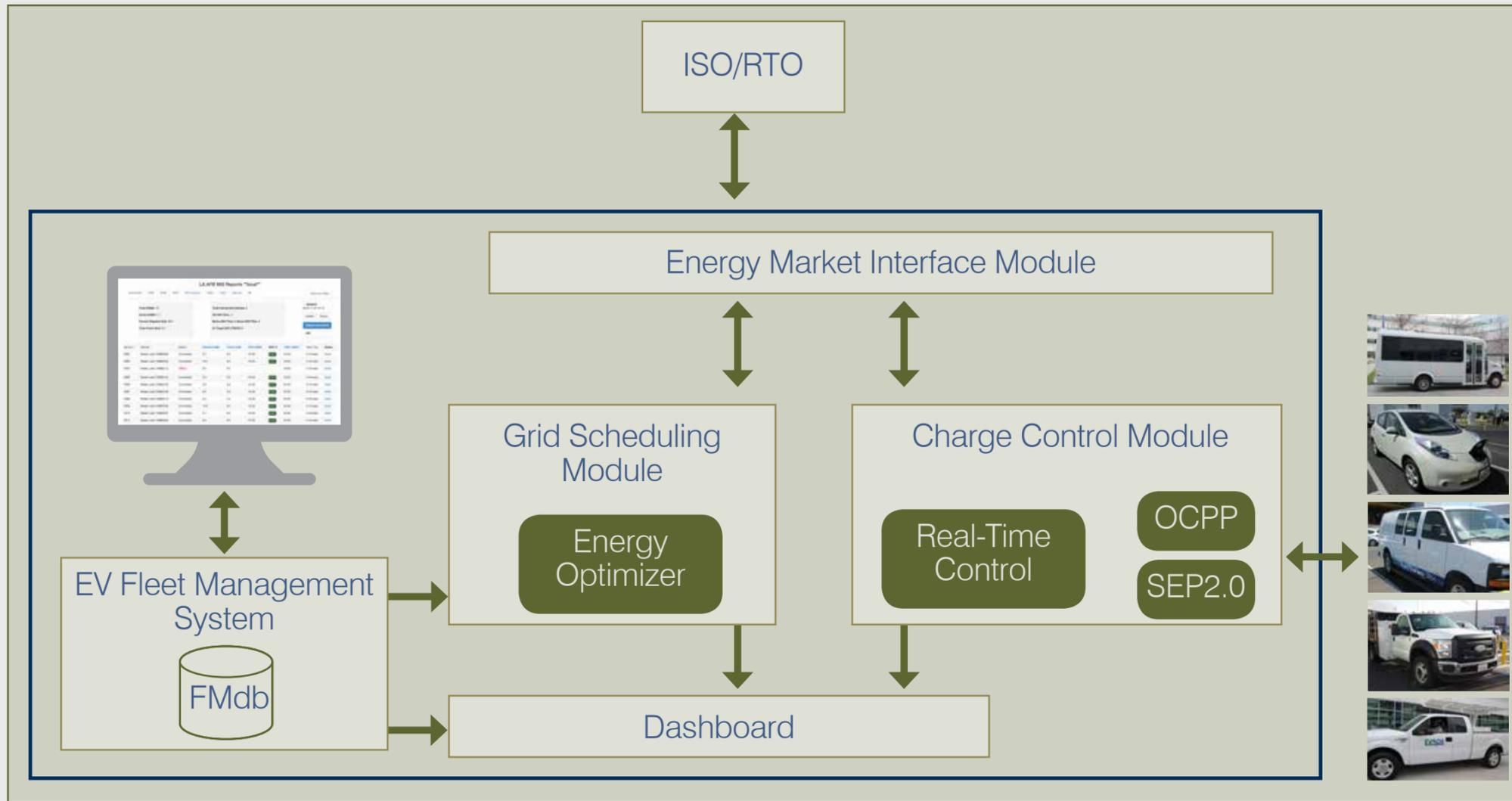
Bid Submission
OB-EVI prepares a detailed next day bid using planned vehicle availability information and submits to utility system operator.





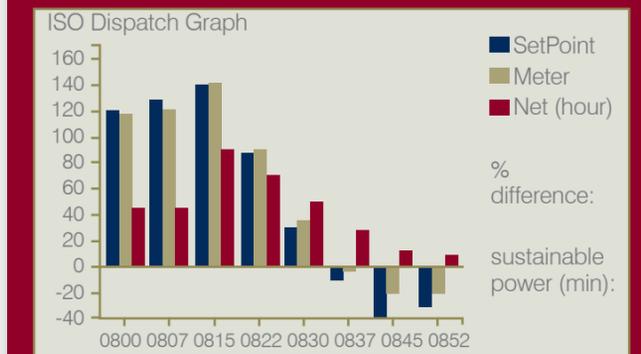
On Base-Electric Vehicle Infrastructure (OB-EVI)

The software that enables V2G integration



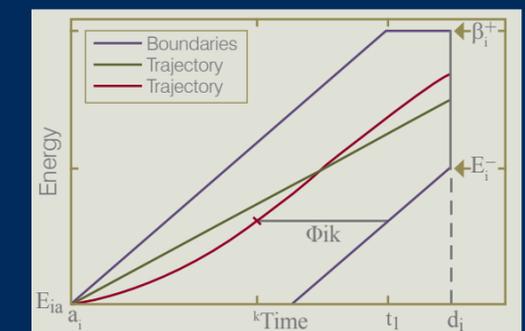
Energy Market Interface Module

- Supporting CAISO, PJM, ERCOT
- Bid-Award in Ancillary Services Energy Market
- Demand Response Market to Frequency Regulation Market Support



Charge Control Module

- Calculate optimal charging and discharging trajectories for both operational requirements and market participation
- Manage the aggregated state of charge across the entire fleet (Virtual Battery)
- Controls the EV Charging Station (EVSE) through industry standard protocols



EV Fleet Management System

- Support for base vehicle fleet
- Vehicle management to accomplish operational mission
- Assigns available vehicles to energy market participation

Grid Scheduling Module

- Day ahead and real-time bidding into energy markets
- Continuous monitoring and re-optimization based on actual vehicle status
- Complies with FERC-ISO rules in each energy market

Dashboard

- Tracks revenue generation in the energy markets
- Management tool for system monitoring and control
- Detailed views of vehicle usage, energy trading history, forthcoming schedules, audits, alerts, and dispatches

Who are the Public-Private Consortium members deploying V2G technology?



V2G integration is complex and technically challenging. Success is a reflection of collaborative communication by all parties to develop solutions and overcome obstacles.

Consortium PEV-V2G Achievements

- Accelerating the nation's adoption of electric vehicles
- Advancing the state of electric vehicles and charging stations
- Advancing the state of engineering and software applications
- Providing installations with a means to lower energy and fleet vehicle costs
- Providing utility operators with an alternative energy solution for electric distribution system stability
- Promoting energy surety across the nation

Department of Defense Organizations

- Air Force Civil Engineer Center (AFCEC)
- Air Force Research Laboratory – Advanced Power Technologies Office (AFRL - APTO)
- Air Force Vehicle and Equipment Management Support Office (VEMSO)
- Army Engineer Research and Development Center-Construction Engineering Research Laboratory (ERDC-CERL)
- Army Tank Automotive Research, Development, and Engineering Center (TARDEC)
- Fort Carson (SPIDERS)
- Fort Hood
- General Services Administration (GSA)
- Joint Base Andrews
- Joint Base McGuire-Dix-Lakehurst (JB MDL)
- Los Angeles Air Force Base (LAAFB)
- Office of the Secretary of Defense (OSD)
- Secretary of the Air Force Installations, Environment, and Logistics (SAF I/E)
- Secretary of the Army Installations, Energy & Environment (ASA [IE&E])

State Government and National Laboratories

- California Energy Commission (CEC)
- Lawrence Berkeley National Laboratory (LBNL)
- Massachusetts Institute of Technology Lincoln Laboratory (MIT LL)

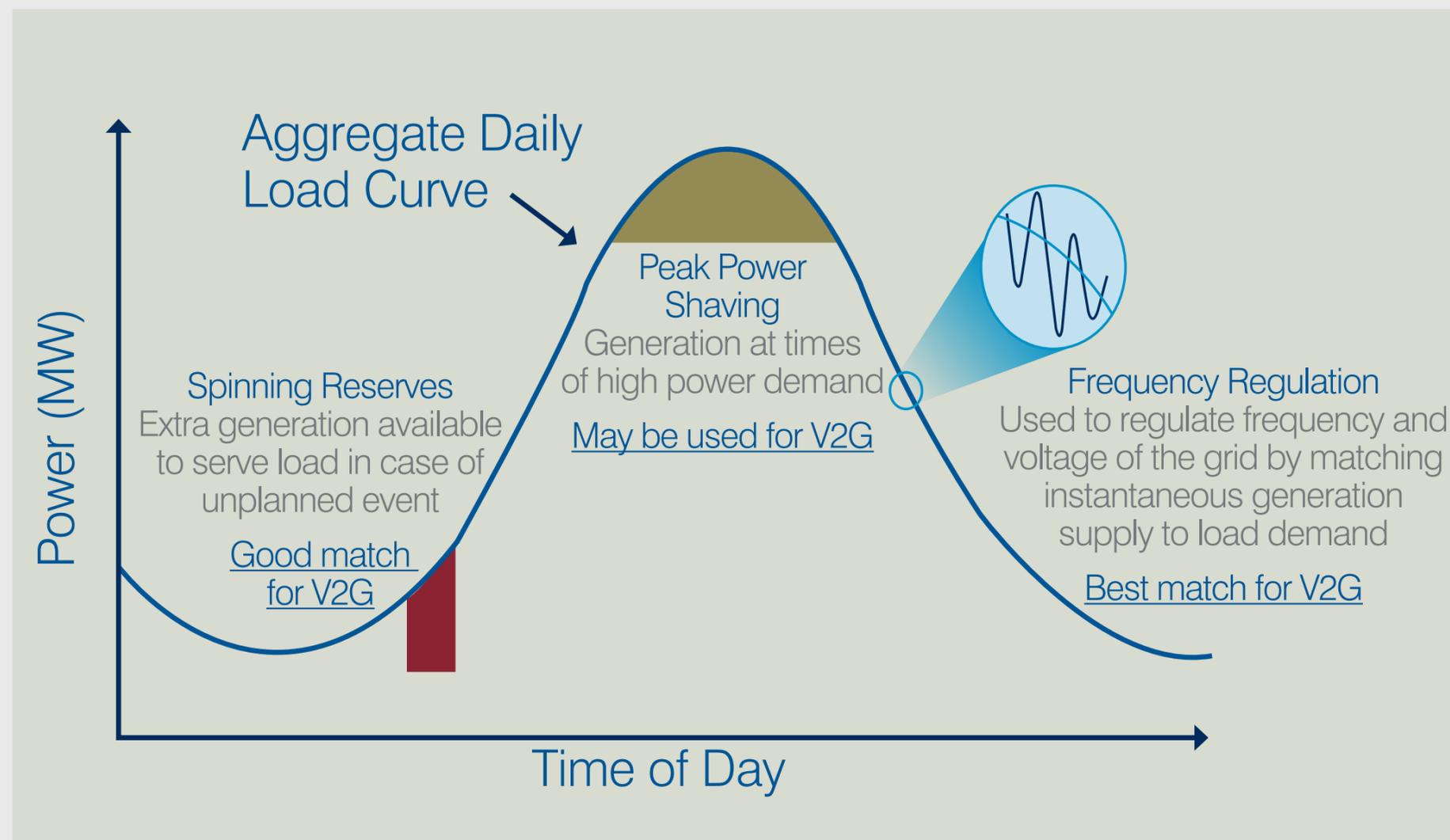
Private Industry

- ACDD
- Akuacom, Inc.
- Bel Fuse Inc.
- Clean Wave Technologies, Inc
- Concurrent Technologies Corporation (CTC)
- Coritech Services, Inc.
- Eaton Corporation
- Electric Vehicle Add-On Systems, Inc (EVAOS)
- Electric Vehicles International LLC (EVI)
- Electricore, Inc.
- Ford® Motor Company
- Kisensum, Inc.
- Nissan® Motor Corporation
- Phoenix Motorcars, LLC
- Princeton Power Systems, Inc. (PPS)
- VIA Motors Inc.

Energy Providers and Regulators

- California Independent System Operator (CAISO)
- California Public Utilities Commission (CPUC)
- Electric Reliability Council of Texas (ERCOT)
- Oncor Electric Delivery Company (Oncor)
- Pepco
- PJM Interconnection LLC (PJM)
- Southern California Edison (SCE)
- Viridity Energy Inc

What benefits will the DoD obtain from future large-scale V2G implementation?



Cuts Installation Electricity Costs

- Earns energy revenue to offset installation utility expenses
- Increases penetration of energy storage systems
- Encourages use of lower cost, off-peak electricity

Increases Resiliency & Reliability

- Overcomes natural disasters and intentional threats with on-site power support
- Serves as backup power to mission critical facilities during outages

Aids Energy System Stabilization

- Reduces failure and degradation of system's electrical devices with bi-directional power flow
- Increases power distribution efficiency with on-demand reserve supplies
- Supports ancillary services market that provides grid operators with real-time adjustment capabilities
- Cuts electrical generation operational costs

Provides a Positive Environmental Impact

- Promotes use of renewable energy
- Supports the national goal of reducing fossil fuel and energy consumption
- Reduces dependence on foreign energy sources
- Reduces greenhouse gas emissions

Frequency regulation is a continuous adjustment of power generation or electrical demand to maintain the grid frequency at or near the nominal 60 hertz standard.

