



## Los Angeles Air Force Base Vehicle to Grid and Building Integration Project

**objective:** Electrification of non-tactical vehicle fleets represents a key efficiency and energy security objective for the U.S. Department of Defense (DoD). Among other planned demonstrations, a mixed purpose and duty 40-vehicle 100% plug-in electrical vehicle (PEV) pilot test fleet will be deployed at the Los Angeles Air Force base (L.A. AFB). Procurement of the fleet and the necessary charging stations (mostly bidirectional at the Level 2 power level) and other infrastructure, as well as basic logistics, will be provided by the DoD. But several key additional capabilities will be added by this project to demonstrate the full capabilities and requirements of cost effective all-electric fleets. First, the PEVs will be given additional fleet management capabilities. Second, optimization capability will ensure that the highly complex task of scheduling charging and discharging of vehicles can be achieved such that energy costs are minimized and the benefits from participation in grid demand response and ancillary services (DR+AS) markets are all jointly considered and the best overall bids submitted and scheduling implemented. Third, receipt and fast response to grid instructions as well as settlement of revenues from grid service provision will be enabled through use of the OpenADR protocol. And finally, the integration of PEVs into the wider base energy system will be analyzed to examine their potential role in base microgrids, which bridges this project to another key DoD security objective.

**technology description:** This project aims to fill the necessary requirements listed above for the L.A. AFB demonstration as follows.

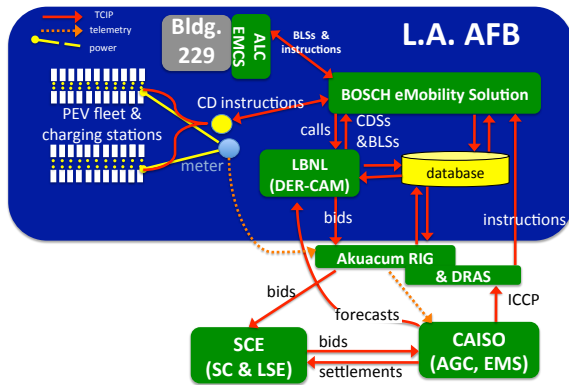
1. Bosch's *eMobility Solution* will provide the necessary additional front-end PEV fleet management and charging services tools. This software will reside on a base server and talk to the charging stations to control charging and discharging, as well as schedules and organizes itineraries.
2. Optimization capability based on Berkeley Lab's *Distributed Energy Resources Customer Adoption Model (DER-CAM)* will be extended to deliver optimal scheduling for the fleet. eMobility will request these schedules and implement them when received. DER-CAM will additionally collect other necessary input data, such as weather forecasts, for optimal scheduling.
3. *OpenADR* capable hardware will be installed on base by Akuacom allowing participation in DR+AS markets. Specifically, capability will be installed to permit participation in several markets, especially the California Independent System Operator (CAISO) Regulation Up and Down (Reg.U-D) markets.
4. Building 229 will be monitored and control of its loads simulated to evaluate the potential of PEVs to contribute to overall base energy efficiency goals.

This entire system, must meet the security requirements of the L.A. AFB.

**expected benefits:** The overall security and environmental benefits of reducing fossil-fuel powered non-tactical military vehicle fleets are clear; however, wisely managing PEV fleets will pose a base operations challenge. PEVs can create both costs and non-transportation benefits. Vehicle charging can be costly if not scheduled well relative to the prevailing utility tariff and other constraints, while the fast responding energy storage capability of vehicle batteries can provide valuable services to help satisfy building and

local base energy requirements. Further, while vehicles individually are not large electricity loads or sources, when aggregated or when integrated with the buildings at which they are interconnected, they can become a controlled entity able to ameliorate the effects of variable local resources and loads, and provide DR+AS service to the local utility and the wider power system around it.

**system architecture:** The proposed project communications flows are shown below.



The blue area represents the part on-base. Bosch’s eMobility software is installed on a server on the base together with DER-CAM, but outside the firewall. eMobility provides fleet management capabilities to base dispatchers and directly controls charging and discharging of the approximately 40-vehicle fleet. Akuacom uses an existing secure remote Demand Response Automation Server (DRAS) to deliver CAISO instructions using OpenADR, a widely used protocol for delivering grid signals to controlled loads. Actually bidding and settlement with CAISO can only be

executed by an approved Scheduling Coordinator (SC), in this case Southern California Edison (SCE), which is also the local distribution company serving the L.A. AFB. DER-CAM forecasts available battery capacity as well as available charge-discharge (CD) capability and develops AS bids into the Reg.U-D market. Note that the scheduling has two components. First, the purchase of energy for the vehicles should be achieved at minimum cost. Second, the ability of batteries to rapidly charge or discharge can be sold to CAISO to assist with its grid control. Vehicle charge-discharge schedules are implemented accordingly, providing necessary information to drivers and fleet managers. Instructions from ISOs are in the Inter Control Center Protocol (ICCP), which is being promoted as a worldwide standard. Participation in the Reg.U-D requires fast (4 seconds) response to signals, so passage of data to eMobility is continuous.

**funding sources:** This project is funded in three parts. DoD will provide the bulk of the vehicle fleet and the necessary charging and other physical facilities at the Base, with approximately 2 M\$ of funding. The Environmental Security Technology Certification Program (ESTCP) is providing funding of 1.75 M\$ to a team led by Berkeley Lab that will provide the fleet management software, the communications, optimization and other structures necessary for participation in CAISO AS markets. Finally, the California Energy Commission is providing an additional 1 M\$ under the AB-118 effort to convert the state’s fleet to alternative fuels. These funds will provide some vehicles and support the integration of the fleet with Bldg. 229.

*glossary:*

AB-118	California Assembly Bill 118, 2007, which established the CEC's Alternative and Renewable Fuel and Vehicle Technology Program
AGC	Automated Generation Control
ALC	Automated Logics Corp.
BLS	building load schedule
CAISO	California Independent System Operator
CD/S	charge-discharge instructions/schedule
CEC	California Energy Commission
DER-CAM	Distributed Energy Resources Customer Adoption Model
DoD	U.S. Department of Defense
DRAS	Demand Response Automated Server
DR+AS	demand response and ancillary services
EMCS	building energy management and control system
EMS	CAISO's Energy Management System
ESTCP	Environmental Security Technology Certification Program
ICCP	Inter Control Center Protocol
L.A. AFB	Los Angeles Air Force Base
LSE	load serving entity (usually a local distribution electricity utility)
PEV	plug-in electric vehicles
Reg.U-D	CAISO Regulation Up and Regulation Down AS market
RIG	Remote Intelligent Gateway
SC	Scheduling Coordinator
V2G	vehicle to grid