MICROGRIDS

L.A. AFB V2G PILOT PROJECT

Chris Marnay

Ernest Orlando Lawrence Berkeley National Laboratory

ChrisMarnay@LBL.gov - *http://microgrid.lbl.gov/*

Santiago 2013 Symposium on Microgrids

Santiago, Chile - Wednesday 11 Sep 2013

BERKELEY LAB

BOSCH
Invented for life

Akuacom

Outline

PROJECT OVERVIEW & RELEVANCY

CAISO ANCILLARY SERVICES PROCUREMENT

SOFTWARE DEVELOPMENT

INSTALLATION AT LOS ANGELES AIR FORCE BASE

EXAMPLE FLEET RESULTS

BIDIRECTIONAL PLUG-IN ELECTRIC VEHICLE TECHNOLOGY

PROJECT CHALLENGES

Project Overview

- 6 DoD bases with 500 PEVs announced, including China Lake CA
  - third phase will be 1000 additional vehicles of total non-tactical fleet of ~200,000
    - (mostly low usage medium duty vehicles)
- about half L.A. AFB fleet will bid into CAISO Regulation (Aug 2013)
- Three L.A. funding sources:
  - DOD ~2+ M$ for vehicles, charging stations, and construction
  - ESTCP ~1.75 M$ for fleet management, communications, & optimization
  - CEC ~1 M$ for 10-15 sedans and building integration capability
- first vehicles + EVSEs by Aug 2013
- hoping for a full year of data collection through mid-2014
- key research questions:
  - can an all-electric fleet meet mission requirements
  - can regulation market revenue close PEV cost gap

Why Relevant?

- between PEV-microgrid interaction a likely key component
- PEV batteries valuable storage
- PEV charging-discharging controllable and fast responding
- vehicle to grid (V2G) a precursor
  to microgrid to megagrid (m-μ2MG)
- controlled microgrids will be participants in ISO markets
- function at scales consistent with current grid practice

CAISO Ancillary Services

Regulation

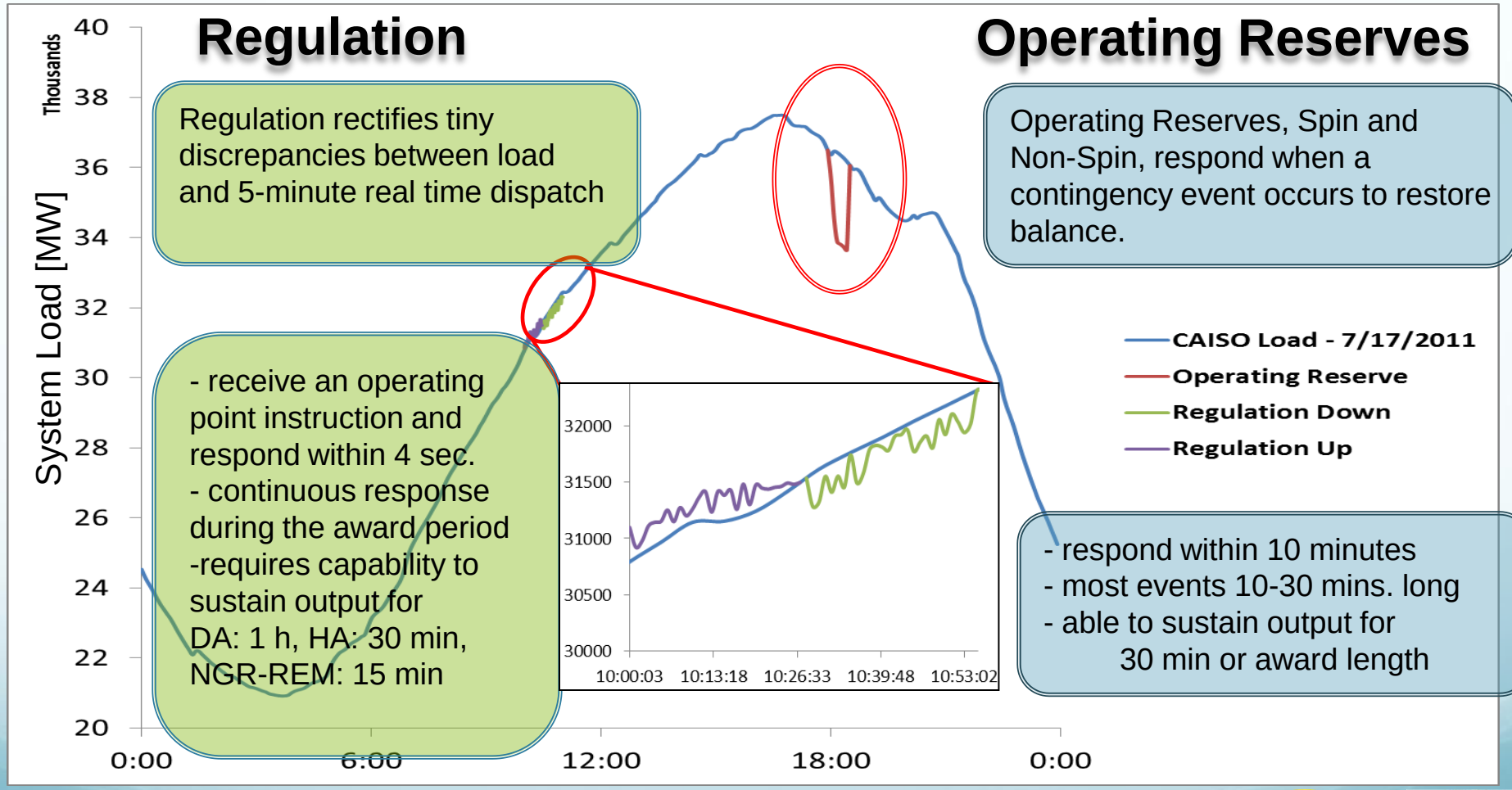
Regulation rectifies tiny discrepancies between load and 5-minute real time dispatch

- receive an operating point instruction and respond within 4 sec.
- continuous response during the award period
-requires capability to sustain output for
DA: 1 h, HA: 30 min,
NGR-REM: 15 min

Operating Reserves

Operating Reserves, Spin and Non-Spin, respond when a contingency event occurs to restore balance.

- respond within 10 minutes
- most events 10-30 mins. long
- able to sustain output for
30 min or award length



CAISO RegU+D Prices

(Apr 2009 – Mar 2012)

	Avg [$/MW-h]	Std Dev [$/MW-h]	Min [$/MW-h]	Max [$/MW-h]
Regulation Up	9.13	9.63	0.00	545.27
Regulation Down	6.91	5.63	0.00	79.55
Spinning Reserve	6.61	8.02	0.00	440.92
Non-Spinning reserve	0.97	4.34	0.00	416.33

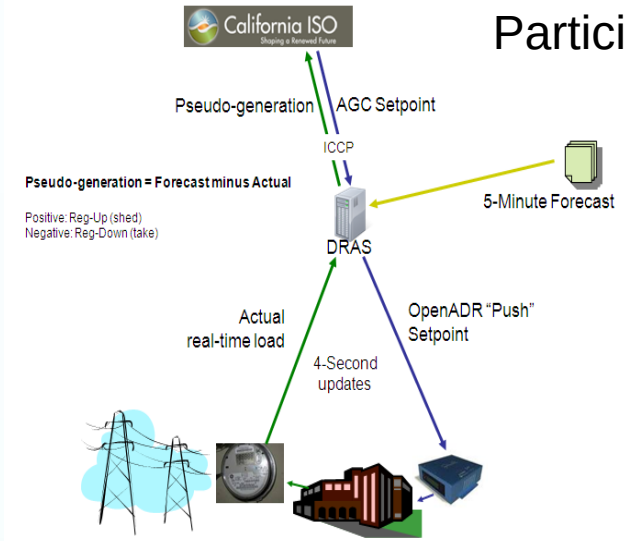
- A symmetric combined regulation award has an average value of $16.04/MW-h.
- On average Regulation is about 2.5 times more valuable than Spinning Reserve, and approximately 16 times more valuable than Non-Spinning Reserve.
- MW-h is the unit used for ancillary awards. It is defined as one MW of power capacity held in reserve for one hour (it is not a unit of energy)
- 10-15 k-vehicles could provide all of SoCal's regulation requirement

Source: Ventyx Velocity Suite

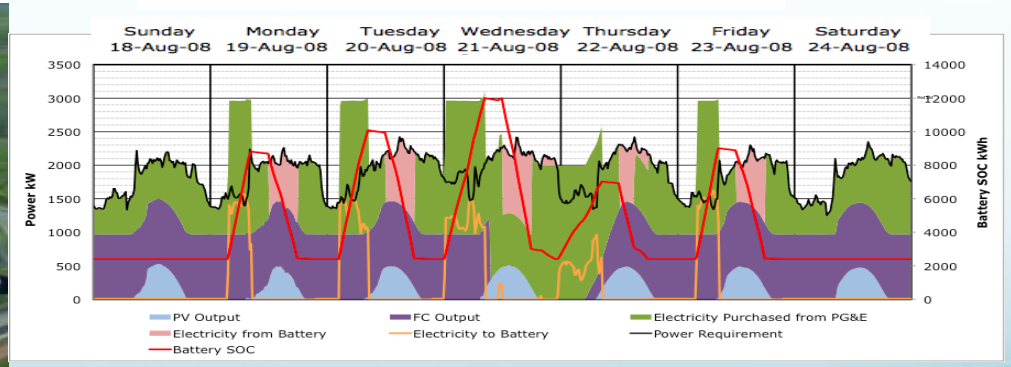
3 Required Technologies

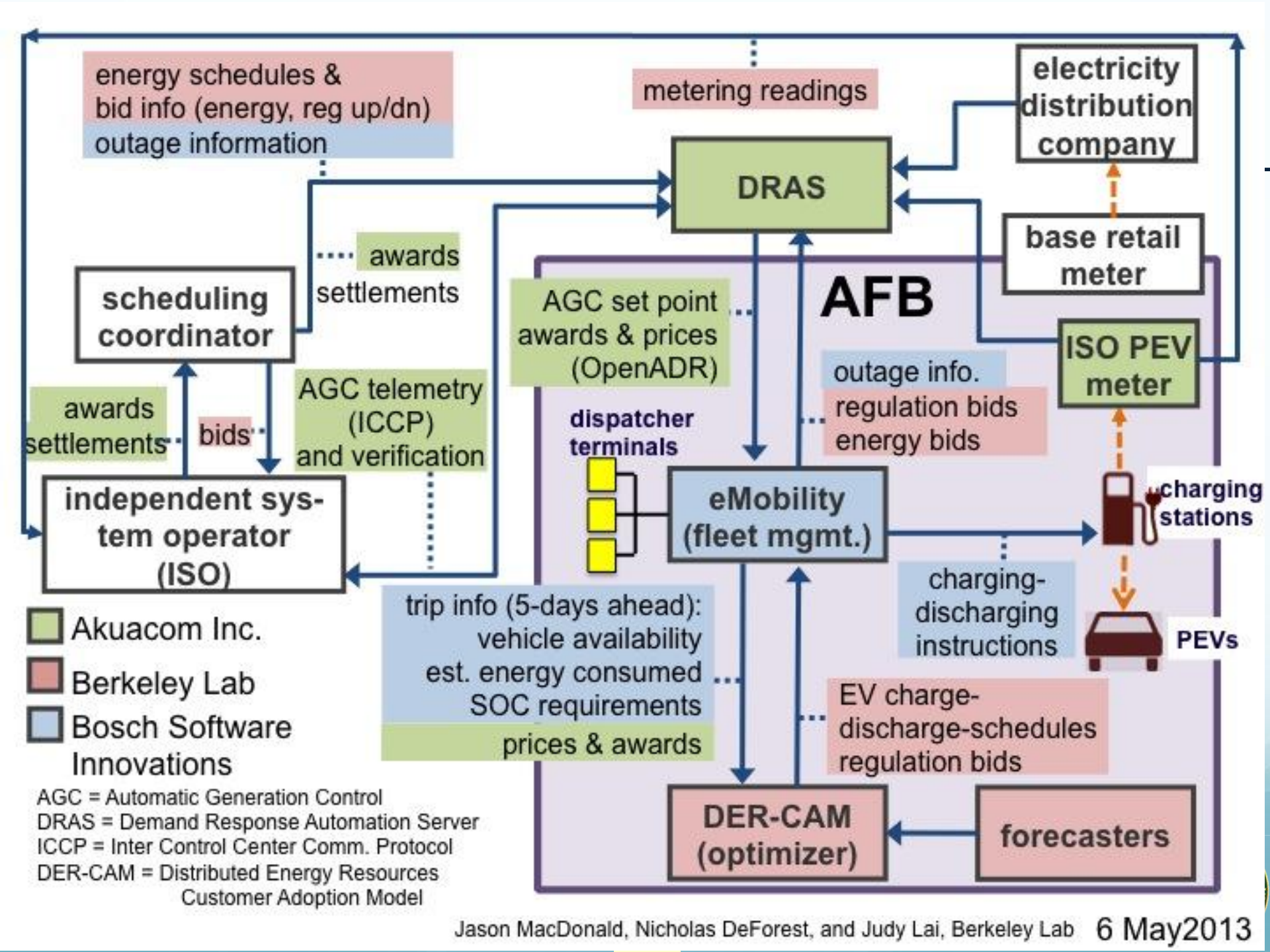
Singapore

Santa Rita Jail



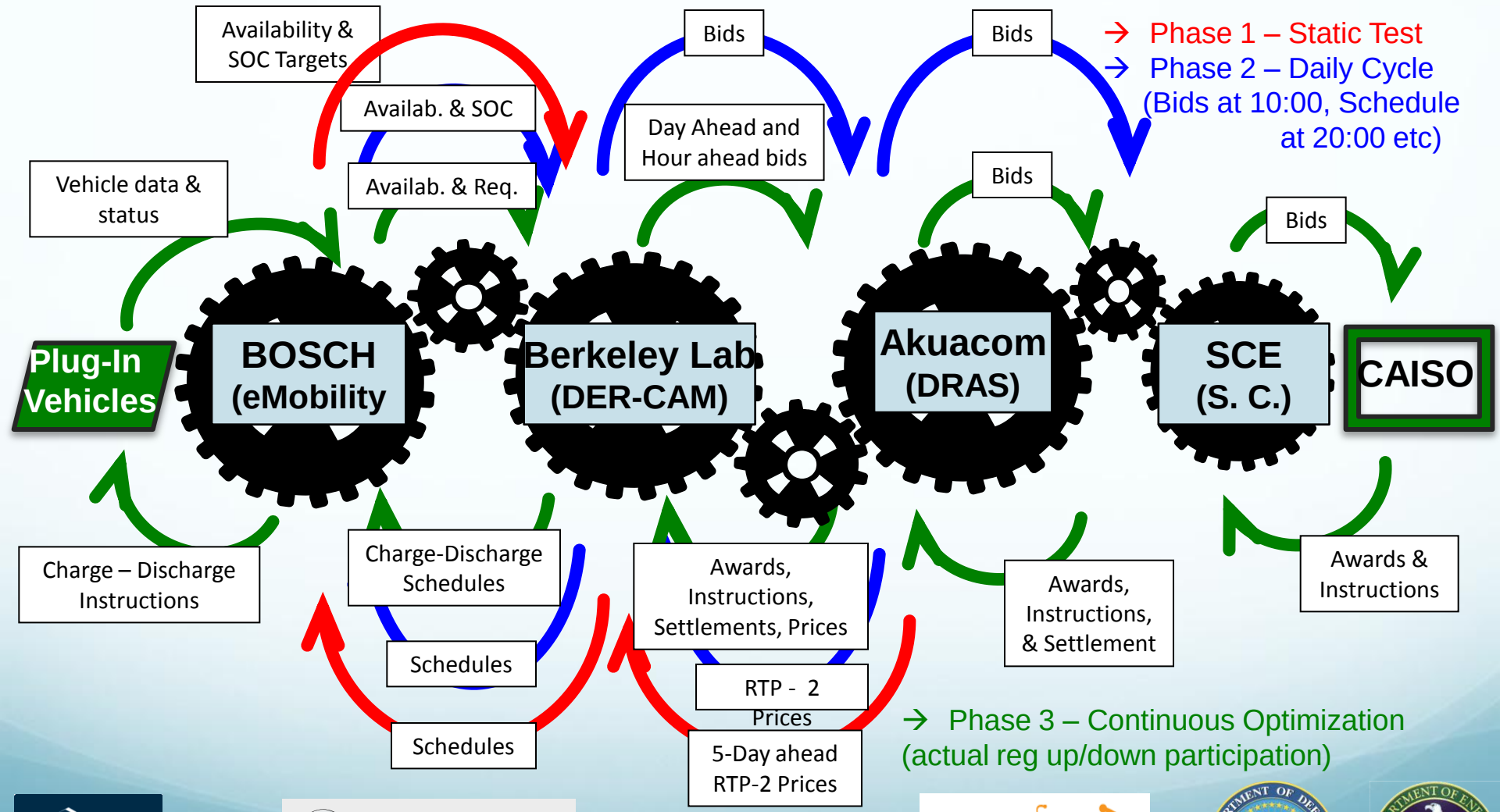
Participating Load Pilot





Jason MacDonald, Nicholas DeForest, and Judy Lai, Berkeley Lab 6 May2013

Data Machinery

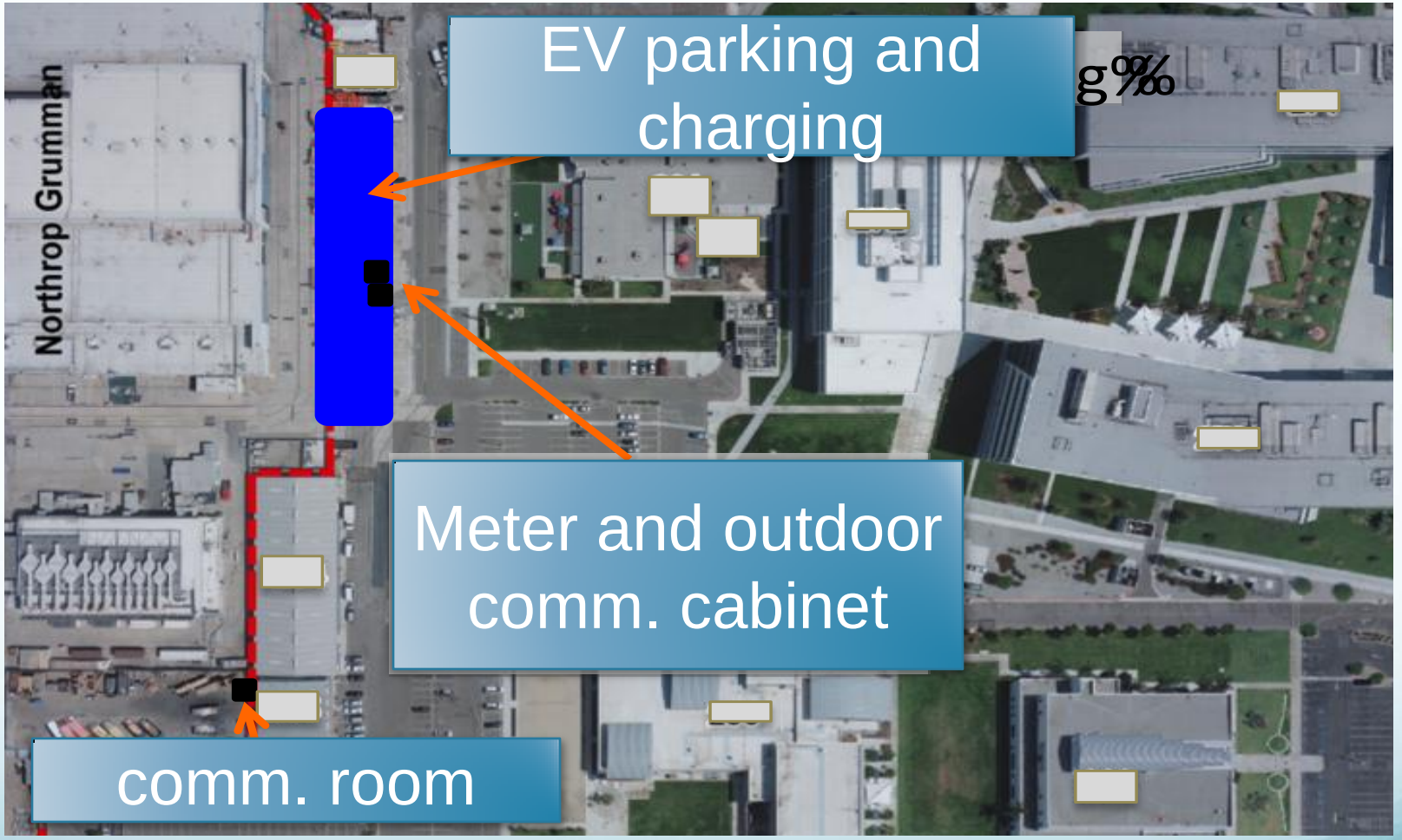


BERKELEY LAB

BOSCH
Invented for life

Akuacom

Aerial View of L.A. AFB



L.A. AFB Views

18 Vehicle Test Fleet

	EV1-EV6	EV7-EV12	EV13-EV18
			
Model	**Nissan LEAF**	**Auto Port Van**	**Smith Electric Truck**
Number	6	6	6
Energy Capacity	24 kWh	35 kWh	120 kWh
Max Charge Power	15 kW	15 kW	60 kW
Max Discharge Power	15 kW	15 kW	60 kW

Total Energy Capacity	1074 kWh
Total Charge Power	540 kW
Total Discharge Power	540 kW

Minimum Resource Size	500 kW
Minimum Bid	100 kW
Minimum Bid Increment	10 kW

BERKELEY LAB

BOSCH
Invented for life

Akuacom

Bidirectional Power

1. Nissan LEAF using CHAdeMO

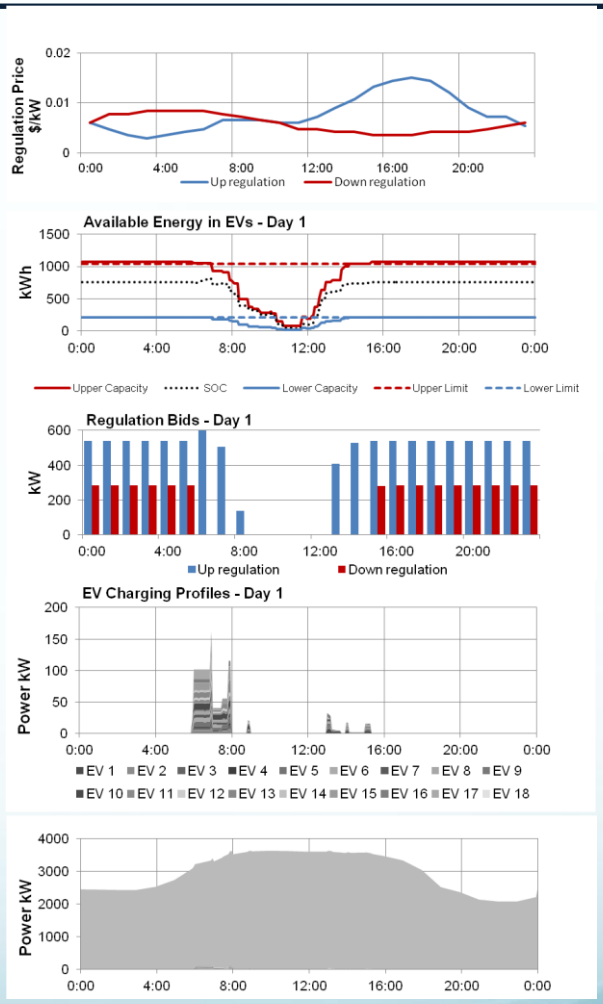
Leading, Environmentally friendly, Affordable, Family car

2. AC propulsion technology

3. J1772 combo connector

EV Results Summary

Energy Costs ($)			22.65
Power Costs ($)			0
Reg Revenue ($)	Up	D1	83.01
	Dn	D1	24.53
	Up	D2	85.37
	Dn	D2	24.55
Energy limit (kWh)	High	D1	1039
	Low	D1	214.8
	High	D2	1039
	Low	D2	214.8



Project Challenges

- regulatory barriers
  - need special tariff approval (hybrid wholesale-retail)
  - CAISO NGR rules under development
- equipment availability and cost
  - bidirectional vehicles and specialized charging stations
  - OCPP & CHAdeMO
- security
  - cyber security approval
  - physical security of vehicles

  +++++++++
- CAISO minimums
  - > additional vehicles
  - > charging-discharging control
- diversity of equipment
- CHAdeMO & OCPP support – TARDEC requirements
- cyber security
- general contracting issues, e.g. CEC title, 14th LEAF, etc.
- . . .. THIS IS AN R&D PROJECT

Thank you!

http://microgrid.lbl.gov/