Vehicle to Grid -
A Control Area Operators Perspective

David Hawkins
California Independent System Operator
December 13, 2001
Figure 4
Existing System
Total Capacity in MW as of 1/1/00
Generation = 158,889
Trans Path = 87,934
Key ISO Roles

- Frequency Monitoring & Time Error Control
- Scheduling of Power Transfers
- Grid Planning
- Real-Time Dispatch
- Financial Settlements
- Ancillary Services Management
- Transmission Congestion Management
- Outage scheduling - Trans. & Generation
INFO: Schedules from Generators
1. Bilateral
2. Markets (Day-ahead, Hour-ahead)
3. Real-Time Instructions
   - Every 10 minutes
   - Stamped

INFO: Schedules from Loads
1. Consumption
   - Read Meter Every 30 days
   - A) Profile
   - B) Interval meters
Daily Load Curve - Dec. 12th
Control Area Operation - ACE

- **ACE = Area Control Error = Zero (Ideal)**
- **ACE = Change in Generation (DG) - Change in Load (DL)**
How Balancing Energy Works

Balancing Energy Purchased in 10-minute increments as needed in Real Time

Preferred Operation Point

Hour Ending 07:00           Hour Ending 08:00           Hour Ending 09:00

........................ = Typical morning energy ramp-up by hour
........................ = Typical balancing energy needed to fill-in energy needs during morning ramp-up
Real Time Use of Ancillary Services and Supplemental Energy

**Regulation** → **AGC Control**

**Spinning**

**Non-Spinning**

**Replacement**

**Supplemental Energy***

**Energy Bids** → **Imbalance Energy Merit Order Stack**

$$/\text{MWh}$

Inc

Dec
Regulation via Load vs. Generators

**Advantages**
- Fast response to AGC signals - improved freq. control
- Reduces wear & tear on generators
- Could also provide Freq. Response Service & Line Overload Relief

**Disadvantages & ?**
- Impact on Distribution systems
- Lack of visibility to EMS computer system
- Lack of experience in dealing with Distributed Resources
Grid Regulation with Electric Vehicles

Grid Operator

Power Command

Internet

Aggregator

Wireless Provider

Driver Usage Profile and Preferences

GPS

Power Response

GPS
New Wind Generation

The State would like to encourage construction of new wind generation facilities

• Primary objective is to encourage the building of 2000-3000 MW of additional Wind and Solar Generation

• State needs alternatives to gas fired plants

• Wind Generation tends to peak between 10PM and 2AM when the loads are low and CA doesn’t need the power

• EV Load would be an ideal complement to Wind Generation power production
Future Directions

• Continue testing and validation of the concept of sending dispatch notices to Electric Vehicles and evolve the model for services provided by loads.

• Identify software / infrastructure requirements

• Investigate the potential for Frequency Response Services

• Evaluate impact on Distribution Systems and deployment limitations