



CEC Workshop on Vehicle-Grid Integration

Sacramento, CA

October 8, 2013



Workshop Agenda

9:30 a.m. – 9:45 a.m.

Mike Gravely, Deputy Division Chief, Energy Research and Development Division, California Energy Commission

Welcome & Workshop Background from the California Energy Commission

9:45 – 10:00 a.m.

Adam Langton, Energy Regulatory Analyst, Energy Division, California Public Utilities Commission

Update on Related Initiatives from the California Public Utilities Commission

10:00 a.m. – 10:30 a.m.

Heather Sanders, Director, Regulatory Affairs, Distributed Energy Resources, California Independent System Operator

Review of Past Workshops

10:30 a.m. – Noon

Discussion & Feedback on Question 1: Roadmap Outline

Discussion & Feedback on Question 2: Vehicle-Grid Integration Barriers

Stakeholder Discussion

Noon – 1:00 p.m.

LUNCH BREAK

1:00 p.m. – 3:30 p.m.

Discussion & Feedback on Question 2: Vehicle-Grid Integration Barriers Cont'd

Discussion & Feedback on Question 3: Roadmap Activities

Discussion & Feedback on Question 4: Relevant Research, Development or Deployment Efforts

Stakeholder Discussion

3:30 p.m. – 3:45 p.m.

BREAK

3:45 p.m. – 4:15 p.m.

Discussion & Feedback on Question 5: Discussion of Relevant Initiatives

Stakeholder Discussion

4:15 p.m.

Mike Gravely, Deputy Division Chief, Energy Research and Development Division, California Energy Commission

Closing Remarks, Schedule & Next Steps

4:30 p.m.

Adjourn

The Vehicle-Grid Roadmap Fits Within a Larger Context

Four broad goals for state government to advance ZEVs

1. Complete needed infrastructure and planning

2. Expand consumer awareness and demand

3. Expand fleets

4. Grow jobs and investment in the private sector

Develop roadmap to commercialize vehicle to grid (V2G) services provided by PEV batteries. The roadmap will explore economic value of aggregated PEV storage and ancillary services to the California grid, and describe the technology, policy and regulatory environment that must be developed to deploy smart charging and V2G, including CAISO rules to enable energy services market. The roadmap should lay out a pathway for partners to help accelerate development, including research projects and pilot programs.

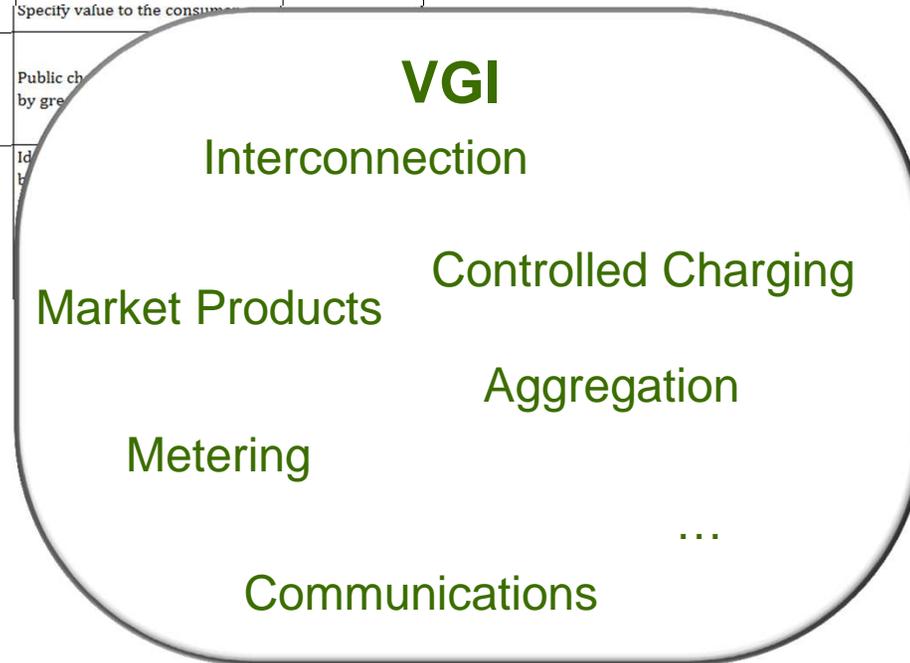
Therefore, the Scope is Focused on the “Integration” Part

... This scope was largely defined via the prior workshops

The following items were collected from the Vehicle-to-Grid roadmap workshop held on October 15th 2012 at the ISO. These items were collected and evaluated to determine whether or not they should be included on the roadmap. Please note that this roadmap does not accomplish the activity, rather the roadmap will include the activity and set a recommended timeframe for activity completions as well as who should complete the activity.

Market & Policy	Include on Roadmap?	Comments	Category
Clarify whether EV aggregators can directly participate in CAISO markets or must they work only with local utilities.	Yes	Clarify who bids and owns aggregated EV resources and how are the settlements done.	customer
Provide “value” of V2G or smart charging to EV customer at time of purchase	Yes	Specify value to the consumer	
Develop a communications program such as “Flex your EV charging healthy grid alert.” E-mail from wind producer/CAISO on best time to charge today (when the wind blows!).	Yes	Public ch by gre	
Identify existing rules that are barriers to V2G implementation. Develop action plans to reduce/eliminate these barriers.	Yes	Id b	

ZEV Planning



Other

- EV Market Adoption
- Charging Infrastructure Deployment & Availability
- Battery Second Life

Discussion Item 1

Vehicle-Grid Integration Roadmap *Outline Content*

Are the sections listed in the proposed Outline Draft sufficient to identify what is necessary to move forward on a Vehicle-Grid Integration Roadmap?

Roadmap Outline & Workshop Purpose

- Identify technology and policy / regulatory environment necessary to support Vehicle-Grid Integration
- Lay out pathway for partners to accelerate development, including R&D efforts and pilot programs

GOAL Finalize outline for Vehicle-Grid Integration Roadmap based on workshop

Outline Topic Summary

Barriers

- Economics
 - Infrastructure
 - Product definitions & req's
 - Technology
 - Consumer awareness
 - Industry awareness & support (Auto & Utility)
 - PEV adoption & tie-in
- *Policy*
 - *Other*

Economics

- Costs/benefits (owners, grid)
- Rates & price impacts
- Effects of alternative rates
- Relevant R&D efforts
- Relevant demo's & pilots

Technology

- Technology standards
- Managed charging
- Infrastructure requirements
- PEV technologies related to managed or smart charging & 2-way energy flow
- Relevant R&D efforts
- Relevant demo's & pilots

Policy

- Regulations / standards / codes
- Other relevant state & federal policy
- Relevant R&D efforts
- Relevant demo's & pilots

Wholesale Market

- Market / settlement rules
- Settlement Processes
- Enabling revenue streams
- Certification
- Market size & locational value
- Relevant R&D efforts
- Relevant demo's & pilots

Awareness

- Vehicle performance impacts
- Service provision awareness
- Economic value
- Relevant R&D efforts
- Relevant demo's & pilots

Discussion Item 2

Vehicle-Grid Integration *Barriers*

Please describe the barriers you believe should be considered under the Vehicle-Integration roadmap.

Barriers Definition Purpose

- Describe barrier
- Describe context in which barrier arises
- Identify stakeholders most relevant to resolving the barrier
- Identify potential actions to resolve the barrier
- Define methods for taking these actions
- Identify relevant research topics or activities

GOAL Define barriers with enough detail to identify activities that could overcome them

Policy Example

Common regulatory/policy framework

The Roadmap needs to “create a common California regulatory and policy frameworks for V2G, e.g., Ease the bureaucratic process for V2G participation, especially at the CAISO, and align the CPUC/CEC/CAISO process related to V2G.”

- **Why** is it a problem?
- **What** potential actions are needed?
- **Who** might be responsible?
- **How** can the actions be implemented?
- **When** does this need to be addressed?

Barrier Categories & Example Themes

- **Consumer Awareness**
 - Vehicle impacts
 - Understanding of market products
 - Economic value to the customer
- **Industry Awareness**
 - Utility industry
 - Automobile industry
- **Economics**
 - Cost/benefits
 - Rate impacts
 - Effects of time of use & dynamic rates
- **Wholesale Market**
 - Market rules & settlement mechanisms
 - Market size & locational value
- **Policy**
 - Regulations, standards & codes
 - Other State & Federal policy
- **Technology**
 - Technology standards
 - Managed charging
 - Infrastructure requirements
 - PEV technologies
- **Other**
 - Transition from early adopter to mainstream
 - Concepts introduced by responses to Discussion Item 1

Additional Examples

Customer Awareness

- Customer willingness & (perceived or actual) inconvenience
- Awareness of total lifetime economic net benefit/cost

Infrastructure Costs & Financing

- Customer: Higher up-front cost; transparency in revenue vs. cost
- System: Division of costs; Funds/approval to cover

Power System Asset Protection

- Implications of modified loads on grid performance (transformer overheating, local power quality impacts, etc.)

Tie-in to Charging Infrastructure

- Influence on revenue from charging levels & charging availability
- Influence, if any, from charger ownership

Discussion Item 3

Vehicle-Grid Integration Roadmap *Activities Identification*

Are the items listed in the Activities List sufficient to move forward with a Vehicle-Grid Integration Roadmap?

Roadmap Activities Definition

- Describe activity details
- Describe barrier category it addresses
- Define impact expectation on barrier
- Identify future activities

GOAL Confirm that significant barriers have activities associated with them

Draft Activities List

I. Objectives, Barriers, Cost / Benefit

- Define Vehicle-Grid Integration Objectives
- Incorporate Information from DOE V2G Roadmap
- Identify Document and Monitor Vehicle-Grid Integration / Managed Charging Barriers
- Develop Managed Charging Value Proposition; Develop Vehicle-Grid Integration Value Proposition
- Perform Managed Charging Cost / Benefit Study; Perform Vehicle-Grid Integration Cost / Benefit Study
- Cost / benefit study of home energy storage appliances (HESA) and battery-to-grid (B2G) to vehicle-to-grid (V2G) systems
- Vehicle-Grid Integration Energy + Ancillary Services Value Analysis

Draft Activities List

II. Policy / Market

- Review demand response markets for PEV participation
- Market construct for long-term resource adequacy
- ISO regulation market including “Pay for Performance”
- CPUC energy storage proceeding
- CPUC alternative fueled vehicles proceeding/ Develop Vehicle-Grid Integration Use Cases
- CPUC Demand Response proceeding (Rule 24)
- DoD Vehicle-Grid Integration Regulation Pilot (ISO)
- Vehicle-Grid Integration Regulation Pilot (PJM)

III. Metering / Billing

- Revise interconnection rules to support Vehicle-Grid Integration
- Develop specification for charging infrastructure to support Vehicle-Grid Integration
- Metering and telemetry options cost / benefit study
- PEV Subtractive Billing EPIC Pilot
- Develop specification for charging infrastructure to support Vehicle-Grid Integration

Draft Activities List

IV. Pilots

- Smart Charging pilot / V2G Pilot
- Develop signal to indicate best charging time
- Fleet Vehicle-Grid Integration EPIC Pilot

V. Distribution Impacts

- Vehicle-Grid Integration Distribution Impact Study
- Impacts of Plug-in Hybrid Electric Vehicles on Distribution Network Reliability
- Plug In Electric Vehicle Load Simulator
- DC Fast Charger performance assessment and grid impact analysis
- Distribution system impact modeling

Draft Activities List

VI. Value Proposition, Role, Other

- Identify stakeholder and roles for Vehicle-Grid Integration
- Vehicle-Grid Integration Utility Perspective Overview
- Vehicle-Grid Integration Participation guide
- Identify / resolve legal issues with V2G
- Car warranty study
- Identification of value, for PEV drivers and all utility customers
- Technical and economic analysis of Vehicle-Grid Integration using real-world PEV charging profiles, uni-directional and bidirectional scenarios.

VII. Policy / Rate Impacts

- Study potential impact of real time TOU pricing and use of smart meters for Vehicle-Grid Integration services
- PEV Rate and Technology Study
- Electric Vehicle Service Provider (EVSP) Smart Grid Development Project
- ESmart PEV charging demonstration project for time-of-use and demand response with US utility partners.

Draft Activities List

VIII. DR/Homs

- PEV Demand Response
- ZNE Home of the future Pilot
- Vehicle-to-Home (V2H) Demonstration
- DR PEV Pilot
- Flexible Demand Initiative (FDI)

IX. Aggregated Storage

- PEV charging station pilot
- Second Use of PEV Batteries in Stationary Applications
- Vehicle-to-Grid Pilots – stationary battery aggregation and control –DC fast charging stations
- Vehicle-to-Grid Pilots –stationary battery aggregation and control – 3rd party public access charging
- Aggregating the control of several, relatively small energy storage systems into one larger system
- Integrating used batteries from PEVs in a grid-tied energy storage system with bi-directional power flow capability

Draft Activities List

X. Technology

- Develop Forecasting for charging load and visibility
- R&D for Vehicle-Grid Integration enabling technology
- Seamless mechanized charging interface for PEV/PHEV
- Vehicle-Grid Integration Standards Development
- Vehicle-Grid Integration Testing Lab
- Cloud computing platform for smart home with PEV charging, home energy storage and renewable energy generation.
- Cloud-based PEV communication Pilot

Discussion Item 4

Vehicle-Grid Integration Roadmap *Current Relevant R&D*

What are relevant research, development or deployment efforts *directly related* to Vehicle-Grid Integration?

R&D Activity Definition

- Describe activity details
- Describe barrier category it addresses
- Define impact expectation on barrier
- Identify future activities

GOAL Identify the current state of R&D efforts to determine future needs

R&D Activity Example

Category	Activity Type	Activity Description	Activity Goals	Relevant Stakeholders	Activity Milestones & Dates
Wholesale Market	DOD VG pilot projects	Aggregated EV wholesale participation in the ISO market for Energy and Ancillary Services capable of bi-directional power flow.	The goals of this project are for the ISO to develop an understanding of how EVs could participate in the ISO wholesale energy market and assist in the efforts of integrating additional amounts of variable and intermittent renewable resources while maintaining grid reliability.	DOD; EVSE Services Suppliers; EV Charging Station Developers; EVSE OEMs; CPUC; CEC; SCE, SDG&E, PG&E	Pilot efforts began in 2011
	EVSE services based pilots				Market Simulation exercises in 2012/13
	EV charging station based pilots	Aggregated EV wholesale participation in the ISO market as a demand side load resource.	Specifically, the goals are to: <ul style="list-style-type: none"> • Determine grid integration requirements to enable EV participation in the wholesale energy market • Develop an aggregated vehicle resource configuration between the EV & the ISO which meets ISO requirements for providing regulation services interconnection, telemetry, metering • Demonstrate VGI capability from an aggregated fleet of EVs providing regulation services under the NGR LESR/REM and PDR Models • Document gaps or potential changes to ISO market products or operational systems which may be required to enable EV integration 		Market participation expected to begin late 2013 into 2014 as each pilot reaches the ability to participate
	<i>Confirmation of whether this activity is active, planned or completed is requested.</i>				See CPUC Resolution E-4595 <i>Updated schedules or additional details on milestones are requested.</i>

Discussion Item 5

Vehicle-Grid Integration Roadmap *Other Initiatives*

What are other initiatives *not directly related* to Vehicle-Grid Integration, but that the roadmap should be aware of?

Other Initiatives Definition

- Identify purpose of initiative
- Determine relevance to Vehicle-Grid Integration
- Identify milestones and timeline
- Identify relevant stakeholders

GOAL Identify outside initiatives that may relate to Vehicle-Grid Integration Roadmap

PHEV Research Roadmap

- Roadmap for 2011 to 2017 and beyond
- Stakeholders are CEC, UC Davis PHEV Research Center
- Topics addressed:
 - Plug-in hybrid vehicle architectures and control systems
 - Plug-in hybrid batteries
 - Plug-in hybrid infrastructure impacts
 - Plug-in hybrid consumer behaviors
 - Plug-in hybrid codes and standards
 - Plug-in hybrid environmental benefits and lifetime costs
- Goals
 - Developed roadmap to find out if and how plug-in hybrid electric vehicles can help California reach its energy and environmental goals

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Back-up Slides

Consumer Awareness Research

- Status (active, planned, completed)
- Any changes in scope since the public filing
- Schedule updates, milestones
- Preliminary results?
- Which VGI barrier does it address?

SCE Pilot (2012-2014)

- Stakeholders are CPUC, SCE, and customers
- Description
 - 233 PEV charging stations
 - Measure user load at each charging station
 - Fees charged using vendor-supplied billing service
 - Aggregate load monitoring
 - Communications controlled via Open ADR 2.0 messaging
- Goals
 - Examine effects of workplace charging on power systems
 - Determine how to minimize impact of PEV charging patterns without adversely affecting PEV owners

Economics Research

- *Status (active, planned, completed)*
- *Any changes in scope since the public filing?*
- *Schedule updates, milestones*
- *Preliminary results?*
- *Which VGI barrier does it address?*

SDG&E TOU Rate Pilots (2011-2013)

- Stakeholders are CPUC, SDG&E, and customers
- Description
 - 3 different TOU rates
 - SDG&E customers with EVs randomly assigned TOU rate
 - Charging behavior analyzed
- Goals
 - Examine impact of EV on electric infrastructure
 - Identify methods to mitigate grid impact

Wholesale Market Research

- *Status (active, planned, completed)*
- *Need more details on project description*
- *Schedule updates, milestones*
- *Preliminary results?*
- *Which VGI barrier does it address?*

DOD VG, EVSE services pilot projects (2011-14)

- Stakeholders are CEC, CPUC, DOD, EVSE OEMs/Service Suppliers, PG&E, SCE, and SDG&E
- Description
 - Energy and ancillary services markets
 - Aggregated EV wholesale participation in ISO market as Capable of bidirectional flow
- Goals
 - Determine grid integration requirement
 - Develop aggregated vehicle resource configuration
 - Demonstrate VGI capability to provide regulation services
 - Document gaps or potential changes to ISO market products

Wholesale Market Research

- *Status (active, planned, completed)*
- *Schedule updates, milestones*
- *Preliminary results?*
- *Which VGI barrier does it address?*

L.A. Air Force base VGI demonstration (2012-16)

- Stakeholders are CAISO, CEC, CPUC, SCE, LADWP and DOD
- Description
 - Integration of 13 Nissan LEAF's with VGI capabilities
 - Enhance revenue generating capability through ancillary services consistent with AB 118
- Goals
 - Accelerate adoption of heavy EVs
 - Demonstrate use as base level grid management system

Technology Deployment

- *Status (active, planned, completed)*
- *Any changes in scope since public filing?*
- *Schedule updates, milestones*
- *Preliminary results?*
- *Which VGI barrier does it address?*

NRG Energy Settlement (2013+)

- Stakeholder is NRG
- Description
 - NRG to install 200 fast charging “Freedom Stations” in L.A., San Francisco, San Joaquin Valley, and San Diego.
 - Charging stations will be free to use
 - 20% will be in low income areas
- Goals
 - Promote deployment of EV charging infrastructure in California

Technology Research

- *Status (active, planned, completed)*
- *Schedule updates, milestones*
- *Results?*

EU RD&D Gap Study (2013)

- Stakeholders are EU gov't agencies, car companies, and universities
- Description
 - Collect information on 320 EV & PHEV RD&D projects that received EU or national public funding >\$1M Euros
 - Studies included vehicle controls capabilities and needs, power grid communications, battery life effects of usage
- Goals
 - Assess which barriers are addressed by RD&D efforts
 - Identify RD&D landscape gaps