

Discussion Items for Stakeholders Involved in the California Energy Commission Vehicle-Grid Integration Roadmap Stakeholder Workshop

In March 2012, Governor Brown issued an executive order directing state government to help accelerate the market for zero-emission vehicles (ZEVs) in California. Executive Order B-16-2012 establishes milestones on a path toward 1.5 million ZEVs in California by the year 2025. The 2013 ZEV Action Plan is the product of an interagency working group led by the Governor's Office that includes the California Energy Commission and several other state agencies and associated entities. The Action Plan identifies specific strategies and actions that state agencies will take to meet the milestones of the executive order.

As part of the 2013 ZEV Action Plan, the Energy Commission and the California Independent System Operator (California ISO) seek to develop a roadmap to commercialize vehicle-grid integration services provided by Plug-in Electric Vehicle (PEV) batteries. Vehicle-grid integration services involve a suite of managed and smart PEV charging capabilities, including one-way or two-way charging.

In October 2012 and February 2013, the California ISO administered two workshops to solicit feedback from stakeholders for the creation of a Vehicle-Grid Integration Roadmap. In June 2013, the Energy Commission executed a work authorization with DNV KEMA (KEMA, Inc.) to support the completion of the roadmap.

The Energy Commission is hosting this October 8 workshop to:

- gather updates since the previous workshop at the California ISO,
- request input on barriers, research needs, and related activities, and
- solicit stakeholder feedback with regard to a draft vehicle-grid integration roadmap outline.

Please refer to the Workshop Notice posted here <http://www.energy.ca.gov/research/notices/#10082013> for more information.

Before the workshop, stakeholders are invited to provide comments on any of the five discussion items below.

The Public Comment section of the Workshop Notice describes how stakeholders can submit comments before and after the workshop, and the portion of the Public Comment section relating to written comments is also copied at the end of this document.

Discussion Item 1: Draft Vehicle-Grid Integration Roadmap Outline

Below is the proposed outline for the Vehicle-Grid Integration Roadmap.

Are these sections in the proposed outline sufficient for what is necessary to move forward on a Vehicle-Grid Integration roadmap? Though the outline reflects the order of the roadmap, it does not reflect the prioritization.

The intent of the Vehicle-Grid Integration Roadmap is to describe the technology and policy/regulatory environment that must be developed to deploy smart charging. The intent is also to lay out a pathway for partners to help accelerate this development, including research projects and pilot programs.

Draft Vehicle-Grid Integration Roadmap Outline

1. **Abstract**
2. **Executive Summary**
 - a. **Overview**
 - b. **Recommendations & Conclusions**
3. **Introduction & Background**
 - a. **Define Managed charging and Vehicle-Grid Integration**
 - i. Definition of managed charging and Vehicle-Grid Integration – how are they different
 - ii. Introduction to Activities, Stakeholders, Use Cases
 - b. **Barriers to managed charging and Vehicle-Grid Integration**
 - i. Economics
 - ii. Infrastructure
 - iii. Existing market product definitions and requirements
 - iv. Technology
 - v. Consumer awareness
 - vi. Automobile industry awareness and support
 - vii. Utility industry awareness and support
 - viii. PEV adoption and movement from early adopter to mainstream
 - c. **Objectives of this roadmap**
 - i. Issue Statement
Develop roadmap to commercialize managed charging capabilities and Vehicle-Grid Integration services provided by PEV batteries.

The Vehicle-Grid Integration Roadmap will describe the technology and policy/regulatory environment that must be developed to deploy managed charging and Vehicle-Grid Integration, including relevant rules to enable this energy services market. The Roadmap should lay out a pathway for partners to help accelerate this development, including research projects and pilot programs.

- ii. Areas not covered by this roadmap

4. Goals

a. Short-term objectives

b. Long-term objectives

5. Managed charging and Vehicle-Grid Integration Roadmap Activities (include timeframes, stakeholders and barriers)

a. Consumer Awareness

- i. Vehicle-Grid Integration impacts on vehicle performance (e.g., vehicle life, driving range, etc.)
- ii. Understanding demand response, wholesale market products, and the role of EVs
- iii. Economic value to customer
- iv. Relevant research and development efforts underway or completed
 - 1. Research & development
 - 2. Use cases
- v. Relevant demonstrations and pilot projects underway or completed
 - 1. California-specific projects
 - 2. Relevant activity within the U.S.

b. Economics

- i. Costs/benefits
 - 1. Vehicle-Grid Integration costs/benefits to owners (fleet and individual)
 - 2. Vehicle-Grid Integration costs/benefits to grid, including distribution
 - a) Storage and ancillary services
 - b) Strengthen connection between ZEV and renewable energy
 - c) Load shaping
 - d) Peak load reduction
 - e) Ancillary services
- ii. Rate impacts
 - 1. Rate base recovery for “infrastructure”
 - 2. Wholesale price benefits from Vehicle-Grid Integration provision of services

- iii. Effects of TOU and Dynamic Pricing
- iv. Relevant research and development efforts underway or completed
 - 1. Research & development
 - 2. Use cases
- v. Relevant demonstrations and pilot projects underway or completed
 - 1. California-specific projects
 - 2. Relevant activity within the U.S.

c. Markets

- i. Market rules / settlement mechanism
 - 1. Enabling new revenue streams for providing grid services
 - a) PEV as Demand Response
 - b) PEV as Another Resource
 - 2. Settlement Processes
 - 3. Certification
- ii. Market size and locational value of Vehicle-Grid Integration
- iii. Relevant research and development efforts underway or completed
 - 1. Research & development
 - 2. Use cases
- iv. Relevant demonstrations and pilot projects underway or completed
 - 1. California-specific projects
 - 2. Relevant activity within the U.S.

d. Policy

- i. Regulations/standards/codes
- ii. Other relevant state and federal policy
- iii. Relevant research and development efforts underway or completed
 - 1. Research & development
 - 2. Use cases
- iv. Relevant demonstrations and pilot projects underway or completed
 - 1. California-specific projects
 - 2. Relevant activity within the U.S.

e. Technology

- i. Technology standards
- ii. Managed charging
 - 1. Controls
 - 2. Communications
 - 3. PEV demand forecasts
- iii. Infrastructure requirement to integrate Vehicle-Grid Integration
 - 1. Grid infrastructure needs
 - 2. Interconnection requirements
 - 3. Metering / billing

- iv. PEV technologies related to managed or smart charging and 2-way energy flow
 - 1. OEM PEV on-board inverter to enable 2-way energy flow
 - 2. PEV warranty to be compatible to Vehicle-Grid Integration
 - 3. Battery degradation from Vehicle-Grid Integration activities
 - 4. Invalidating the warranty of the car due to use for Vehicle-Grid Integration
- v. Relevant research and development efforts underway or completed
 - 1. Research & development
 - 2. Use cases
- vi. Relevant demonstrations and pilot projects underway or completed
 - 1. California-specific projects
 - 2. Relevant activity within the U.S.

6. Completing the Roadmap

- a. **Activity Streams Overview**
- b. **Dependencies & Linkages**
- c. **Sequencing & Coordination**

7. Connections to Related Initiatives

- a. **California**
- b. **National**

8. Conclusions and Recommendations

9. Glossary

10. References

11. Appendices

Discussion Item 2: Barriers

Several barriers were discussed at the California ISO-administered workshops in 2012 and 2013. However, the Energy Commission and the California ISO are seeking feedback to detail and document barriers.

Please describe the barriers you believe should be considered under the Vehicle-Integration Roadmap using the following table.

The table provides categories and specific information request to guide stakeholder response and ensure all relevant information can be included in the roadmap. This information includes a description of the barrier, the context in which the barrier is likely to arise, which stakeholder types are most relevant for resolving the barrier, potential actions to resolve the barrier, methods for taking these actions, and what topics of research, if any, would be needed to overcome the barrier. The intent of defining and detailing barriers to vehicle-grid integration is to assist with confirming roadmap activities. Activities are intended to help overcome barriers and thereby accelerate vehicle-grid integration. Once the full scope of and details about the barriers are captured, activities can then be associated each with a barrier.

Category	Example Themes	Barrier Description <i>Describe the barrier in detail</i>	Barrier Context <i>Identify conditions under which barrier may arise</i>	Relevant Stakeholder Type <i>Identify stakeholders types relevant to this barrier (e.g., to fix it)</i>	Potential Actions <i>Identify actions that might resolve this barrier</i>	Method to Act <i>Describe possible ways to take action (working groups, proceedings, etc.)</i>	Additional Research <i>Describe related research needs, if any.</i>
Consumer Awareness	<ul style="list-style-type: none"> •Vehicle impacts •Understanding of market products •Economic value to the customer 						
Industry Awareness	<ul style="list-style-type: none"> •Utility industry •Automobile industry 						
Economics	<ul style="list-style-type: none"> •Cost/benefits •Rate impacts •Effects of TOU & dynamic rates 						
Wholesale Market	<ul style="list-style-type: none"> •Market rules & settlement mechanisms •Market size & locational value 						

Policy	<ul style="list-style-type: none"> • <i>Regulations, standards & codes</i> • <i>Other State & Federal policy</i> 						
Technology	<ul style="list-style-type: none"> • <i>Technology standards</i> • <i>Managed charging</i> • <i>Infrastructure requirements</i> • <i>PEV technologies</i> 						
Other	<ul style="list-style-type: none"> • <i>Transition from early adopter to mainstream</i> • <i>Concepts introduced by responses to Q1</i> 						

Discussion Item 3: Draft Vehicle-Grid Integration Activities

Based on workshops to date, the following activities have been identified as potential elements of a vehicle-grid integration roadmap. **Please comment on whether these activities are sufficient to move forward on vehicle-grid integration.** The number does not reflect the prioritization.

Draft Vehicle-Grid Integration Activities

I. Objectives, Barriers, Cost / Benefit

- I-1. Define Vehicle-Grid Integration Objectives
- I-2. Incorporate Information from DOE V2G Roadmap
- I-3. Identify Document and Monitor Vehicle-Grid Integration / Managed Charging Barriers
- I-4. Develop Managed Charging Value Proposition; Develop Vehicle-Grid Integration Value Proposition
- I-5. Perform Managed Charging Cost / Benefit Study; Perform Vehicle-Grid Integration Cost / Benefit Study
- I-6. Cost / benefit study of home energy storage appliances (HESA) and battery-to-grid (B2G) to vehicle-to-grid (V2G) systems
- I-7. Vehicle-Grid Integration Energy + Ancillary Services Value Analysis

II. Policy / Market

- II-1. Review demand response markets for PEV participation
- II-2. Market construct for long-term resource adequacy
- II-3. ISO regulation market including "Pay for Performance"
- II-4. CPUC energy storage proceeding
- II-5. CPUC alternative fueled vehicles proceeding/ Develop Vehicle-Grid Integration Use Cases
- II-6. CPUC Demand Response proceeding (Rule 24)
- II-7. DoD Vehicle-Grid Integration Regulation Pilot (ISO)
- II-8. Vehicle-Grid Integration Regulation Pilot (PJM)

III. Metering / Billing

- III-1. Revise interconnection rules to support Vehicle-Grid Integration
- III-2. Develop specification for charging infrastructure to support Vehicle-Grid Integration
- III-3. Metering and telemetry options cost / benefit study
- III-4. PEV Subtractive Billing EPIC Pilot

- III-5. Develop specification for charging infrastructure to support Vehicle-Grid Integration

IV. Pilots

- IV-1. Smart Charging pilot / V2G Pilot
- IV-2. Develop signal to indicate best charging time
- IV-3. Fleet Vehicle-Grid Integration EPIC Pilot

V. Distribution Impacts

- V-1. Vehicle-Grid Integration Distribution Impact Study
- V-2. Impacts of Plug-in Hybrid Electric Vehicles on Distribution Network Reliability
- V-3. Plug In Electric Vehicle Load Simulator
- V-4. DC Fast Charger performance assessment and grid impact analysis
- V-5. Distribution system impact modeling

VI. Value Proposition, Role, Other

- VI-1. Identify stakeholder and roles for Vehicle-Grid Integration
- VI-2. Vehicle-Grid Integration Utility Perspective Overview
- VI-3. Vehicle-Grid Integration Participation guide
- VI-4. Identify / resolve legal issues with V2G
- VI-5. Car warranty study
- VI-6. Identification of value, for PEV drivers and all utility customers
- VI-7. Technical and economic analysis of Vehicle-Grid Integration using real-world PEV charging profiles, uni-directional and bidirectional scenarios.

VII. Policy / Rate Impacts

- VII-1. Study potential impact of real time TOU pricing and use of smart meters for Vehicle-Grid Integration services
- VII-2. PEV Rate and Technology Study
- VII-3. Electric Vehicle Service Provider (EVSP) Smart Grid Development Project
- VII-4. Smart PEV charging demonstration project for time-of-use and demand response with US utility partners.

VIII. DR/Homs

- VIII-1. PEV Demand Response
- VIII-2. ZNE Home of the future Pilot
- VIII-3. Vehicle-to-Home (V2H) Demonstration
- VIII-4. DR PEV Pilot
- VIII-5. Flexible Demand Initiative (FDI)

IX. Aggregated Storage

- IX-1. PEV charging station pilot
- IX-2. Second Use of PEV Batteries in Stationary Applications
- IX-3. Vehicle-to-Grid Pilots – stationary battery aggregation and control –DC fast charging stations
- IX-4. Vehicle-to-Grid Pilots –stationary battery aggregation and control – 3rd party public access charging
- IX-5. Aggregating the control of several, relatively small energy storage systems into one larger system
- IX-6. Integrating used batteries from PEVs in a grid-tied energy storage system with bi-directional power flow capability

X. Technology

- X-1. Develop Forecasting for charging load and visibility
- X-2. R&D for Vehicle-Grid Integration enabling technology
- X-3. Seamless mechanized charging interface for PEV/PHEV
- X-4. Vehicle-Grid Integration Standards Development
- X-5. Vehicle-Grid Integration Testing Lab
- X-6. Cloud computing platform for smart home with PEV charging, home energy storage and renewable energy generation.
- X-7. Cloud-based PEV communication pilot

Discussion Item 4: Current Activities

Please list current research, development or deployment efforts directly related to vehicle-grid integration (e.g. managed or smart charging) using the table below.

Provide a description of the activity and identify whether the activity is a research, development, or deployment initiative; whether the project is current, past or planned; what the project goals are; who the relevant stakeholders are; and what the project milestones and timeline is, was or will be. Please use the table below.

A separate document posted on the workshop website here <http://www.energy.ca.gov/research/notices/#10082013> provides an example to use as reference.

Category	Example Themes	Activity Type <i>Research, Development or Deployment? Past, current or planned?</i>	Activity Description <i>Describe activity</i>	Activity Goals <i>Describe activity goals</i>	Relevant Stakeholders <i>Describe relevant stakeholders involved in the activity</i>	Activity Milestones & Dates <i>Identify known activity timeline and milestones</i>
Consumer Awareness	<ul style="list-style-type: none"> •Vehicle impacts •Understanding of market products •Economic value to the customer 					
Industry Awareness	<ul style="list-style-type: none"> •Utility industry •Automobile industry 					
Economics	<ul style="list-style-type: none"> •Cost/benefits •Rate impacts •Effects of TOU & dynamic rates 					
Wholesale Market	<ul style="list-style-type: none"> •Market rules & settlement mechanisms •Market size & locational value 					

Policy	<ul style="list-style-type: none"> • <i>Regulations, standards & codes</i> • <i>Other State & Federal policy</i> 					
Technology	<ul style="list-style-type: none"> • <i>Technology standards</i> • <i>Managed charging</i> • <i>Infrastructure requirements</i> • <i>PEV technologies</i> 					
Other	<ul style="list-style-type: none"> • <i>Transition from early adopter to mainstream</i> • <i>Concepts introduced by responses to Q1</i> 					

Discussion Item 5: Other Initiatives

Please describe other initiatives not directly related to the Vehicle-Grid Integration Roadmap but that the roadmap stakeholders should be aware of.

These activities could include those that are pre-requisites for vehicle-grid integration or those that depend on activities within the roadmap. Please describe initiative content, milestones and stakeholders.

Public Comment

Written comments:

Written comments are highly encouraged before the workshop, and may be incorporated into the agenda to facilitate discussions during the workshop. Comments are also accepted after the workshop and should be submitted by 4:00 p.m. on October 15, 2013. Please e-mail your comments to Kiel Pratt at kpratt@energy.ca.gov

In your comment e-mails, please include the following:

- the phrase "Vehicle-Grid Integration Workshop" in the e-mail subject line
- a short title or subject label for your comment, e.g. "Discussion Item 2: Barriers"
- your comment, either as text in the e-mail or as a Microsoft® Word or Adobe® .pdf document
- your name
- your organization if applicable.

Written comments may be posted to the Energy Commission's website before and/or after the workshop. Please note that your written and oral comments, attachments, and associated contact information (e.g. your address, phone, email, etc.) become part of the viewable public record. However, comments submitted by e-mail will be stripped of contact information prior to being incorporated into any posted document or workshop presentation, unless the sender requests otherwise.