

EV and VGI Research

Reports Database

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Introduction

This document organizes information about ongoing publicly-funded electric vehicle (EV) and vehicle-grid integration (VGI) research, development, and demonstration projects. It was produced to consolidate information collected via the California Public Utilities Commission's [Electric Vehicle Pilot Survey](#), and to expand on that dataset by sorting projects into research areas and adding links to the most current available information, including reports (if available), websites, public presentation slide decks, and news references. The purpose is to help researchers and decisionmakers get up to speed on this rapidly-developing field, avoid duplicative research, and identify research gaps, all ultimately toward the goal of leveraging R&D to support transportation electrification goals.

The document is a novel use of Google Slides inspired by [HyperCard](#). To navigate, simply click the links. The Google platform is not perfect (it is not possible to disable advance-on-click, for example), but was chosen because it is an efficient and flexible sharing service that does not rely on public resources or administration to keep running or to update. It can be curated by anyone in the field willing to volunteer.

The most current version of this document is always available at <http://tiny.cc/vgireports>. To join discussions about this topic, please join the [Vehicle-Grid Integration Network](#) on LinkedIn.

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Grid Impacts of EV Adoption

Examining the extent to which widespread plug-in electric vehicle charging might impact the electric grid.

Publications:

- California Electric Transportation Coalition, [California Transportation Electrification Assessment Phase 2: Grid Impacts](#) (Oct. 2014), [Phase 3 Part A: Commercial and Non-Road Grid Impacts](#) (Jan. 2016)
- National Rural Electric Cooperative Association: Cooperative Research Network, [PEVs and Electric Cooperatives Vol. 2: Managing the Financial and Grid Impacts of Plug-in Electric Vehicles](#) (May 2015)
- European Commission for Transport, Green eMotion Project Reports: 4.3-A1 [EVs' impact on Power Quality related to harmonics](#) (Jan. 2014), -B1 [Parameters for Assessment of EVs Impact on Low Voltage Grid](#) (Nov. 2013), -B2 [Reinforcement Costs in Low-Voltage Grids](#) (Nov. 2013), -B3 [Future Distribution Network Planning Tools: Functional Specifications](#) (Mar. 2014), -C1 [ITRES: Tool for assessing the technical and economic impact of electric vehicles on distribution networks](#) (Mar. 2014), 4.4 [Common findings for the interaction between Electric vehicles and electrical networks](#) (Feb. 2015).
- San Diego Gas & Electric, [Laboratory Testing and Field Measurement of Plug-in Electric Vehicle \(PEV\) Grid Impacts](#) (Mar. 2015)
- U.S. Department of Energy, [Evaluating Electric Vehicle Charging Impacts and Customer Charging Behaviors - Experiences from Six Smart Grid Investment Grant Projects SGIG EV Charging Grid Impacts](#) (Dec. 2014)
- Electric Power Research Institute, [Transportation Electrification: A Technology Overview](#) (July 2011)
- NREL, [Application of Distribution Transformer Thermal Life Models to EV Charging Loads Using Monte-Carlo Method](#) (Nov. 2010)
- ISO/RTO Council, [Assessment of Plug-in Electric Vehicle Integration with ISO/RTO Systems](#) (Mar. 2010)

Purchase Behavior

Examining consumer decisions to purchase, or not to purchase, an electric vehicle.

Ongoing R&D:

- UCLA (funded by the California Air Resources Board Research Division), *Designing Light-Duty Vehicle Incentives for Low- and Moderate-Income Households* ([scope of work](#)) (Feb. 2016)

Publications:

- EPRI, [Plug-in Electric Vehicle Multi-State Market and Charging Survey](#) (Feb. 2016)
- NREL, [Consumer Views on Plug-in Electric Vehicles - National Benchmark Report](#) (Jan. 2016)
- National Research Council, [Overcoming Barriers to Deployment of Plug-in Electric Vehicles](#) (2015)
- California Air Resources Board - U.C. Davis, The dynamics of plug-in electric vehicles in the secondary market and their implications for vehicle demand, durability, and emissions ([website](#)) ([scope of work](#)) (Oct. 2014)
- CA Air Resources Board - UCLA, Examining Factors that Influence ZEV Sales ([scope of work](#)) (June 2013)
- [National Research Council, Transitions to Alternative Vehicles and Fuels](#) (2013)

Charging Behavior

Examining where, when, and how people charge their electric vehicles.

Ongoing R&D:

- SCE, *PEV WorkPlace Charging DR Pilot* ([plan](#)) (report due Q2 2016)
- UC Davis (funded by the California Air Resources Board Research Division), *Advanced PEV Usage and Charging Behavior* ([website](#)) ([scope of work](#) May 2013) ([contract](#) Nov. 2015) (report due Jan. 2018)

Publications:

- Idaho National Lab, [Plug-in Electric Vehicle and Infrastructure Analysis](#) (Sept. 2015) ([summary](#))
- XCEL Energy, [Electric Vehicle Charging Station Pilot Evaluation Report](#) (May 2015)
- SDG&E, [Final Evaluation for SDG&E's PEV TOU Pricing and Technology Study](#) (Feb. 2014)

Rate Design

Examining issues related to designing special rates for electricity used to charge electric vehicles.

Publications:

- CPUC, [California Statewide PEV Submetering Pilot - Phase 1 Report](#) (Apr. 2016)
- NYSERDA, [Electricity Pricing Strategies to Reduce Grid Impacts from Plug-in Electric Vehicle Charging in New York State](#) (June 2015)
- SDG&E, [Final Evaluation for SDG&E's PEV TOU Pricing and Technology Study](#) (Feb. 2014), [EV Project Addendum](#) (Apr. 2015)
- The EV Project, [Lessons Learned: Regulatory Issues and Utility EV Rates](#) (Mar. 2013)
- Kansas Corporation Commission, [Electric Vehicle Rate Issues](#) (Apr. 2012)
- The Brattle Group, [Will Smart Prices Induce Smart Charging of Electric Vehicles?](#) (July 2011)

Current EV rate information (alphabetical by state):

[Alabama Power](#), [Alaska Electric Light & Power](#), [Arizona Public Service](#), [Pacific Gas & Electric](#) (CA), [Southern California Edison](#), [San Diego Gas & Electric](#), [Los Angeles Dept. of Water & Power](#), [Sacramento Municipal Utility District](#), [Georgia Power](#), [Hawaiian Electric](#), [Maui Electric](#), [Hawaii Electric Light](#), [Northern Indiana Public Service Company](#), [Indianapolis Power & Light](#), [Baltimore Gas & Electric](#) (MD), [Consumers Energy](#) (MI), [DTE Energy](#) (MI), [Indiana Michigan Power](#) (MI), [Dakota Electric Association](#) (MN), [Minnesota Power](#), [Otter Tail Power](#) (MN), [NV Energy](#), [Con Edison](#) (NY), [National Grid](#) (NY), [Pacific Power](#) (OR), [Austin Energy](#), [El Paso Electric](#), [Green Mountain Energy](#) (TX), [Dominion Virginia Power](#)

VGI Communications

Developing communications standards, protocols, and software packages that permit secure, reliable, real-time communication between vehicles, charging technologies, and the electric grid.

Ongoing R&D:

- ChargePoint (\$1.5 million funded by California Energy Commission EPIC program), *Next-Gen Grid Communications for Residential PEVs* ([scope of work](#)) (30-home pilot running through Feb. 2018)
- Center for Sustainable Energy (\$1.5 million funded by California Energy Commission EPIC program), *ISO/IEC 15118 Demand Clearing House* ([scope of work](#))
- University of California, Berkeley (\$1.5 million funded by California Energy Commission EPIC Program), *Open Source Platform For Plug-in Electric Vehicle Smart Charging in California* ([scope of work](#))
- Electric Power Research Institute, *Open Vehicle-Grid Integration Platform* (formerly OEM Central Server), [Definition of Use Case Requirement](#) (Dec. 2015) ([presentation Nov. 2014](#)), [Phase 1 Development Update](#) (Dec. 2014), [Status Update](#) (Dec. 2013)

V1G Services (DR)

Examining the potential to utilize VGI communications to effect unidirectional demand response at peak demand periods.

Ongoing R&D:

- PG&E-BMW, *iChargeForward* program ([website](#))
- eMotorWerks, DRAM commitments: ([news](#)). For further information on California's DRAM program, see: [CPUC Rulemaking 13-09-011 CAISO demand response](#) pages, [PG&E](#), [SDG&E](#), and [SCE](#) DRAM pages.
- Lawrence Berkeley National Lab (\$2 million funded by California Energy Commission EPIC program), *Smart Charging of PEV and Driver Engagement for Demand Management and Participation in Electricity Markets* ([scope of work](#)) ([presentation](#))
- SCE, *Augmenting AMI with Broadband: A Smart Charging Pilot Demonstration* ([plan](#)) (demonstrated charge throttling with variety of communications protocols) (report expected release Q2 2016)
- SDG&E, *Managing PEV Charging: Optimization of Pricing & Resource Allocation (OPRA)* (demonstrated participation in CAISO ancillary services markets) (final report estimated June 2016)

Completed demonstration:

- PEPCO, *EV Demand Response Pilot*: ([news](#)) ([presentation](#)) ([FAQ](#)) ([regulatory filing](#)) (paid report: EPRI, [Pepco Demand Management Pilot for Plug-In Vehicle Charging in Maryland: Final Report—Results, Insights, and Customer Metrics](#))

V2G Services

Examining potential to utilize VGI communications and bidirectional charging technologies to provide demand response and ancillary services.

Ongoing R&D:

- Electric Power Research Institute (\$1.5 million funded by California Energy Commission EPIC program), *Distribution System Aware Vehicle to Grid (V2G) Services for Improved Grid Stability and Reliability* ([scope of work](#)) ([presentation](#)) (4-vehicle testing through June 2018)
- University of California Los Angeles (\$2 million funded by California Energy Commission EPIC program), *Demonstration of PEV Smart Charging and Storage Supporting Grid Objectives* ([scope of work](#))
- Andromeda Power LLC (\$700,000 funded by California Energy Commission EPIC program), *InCISIVE - Grid Communication Interface for Smart Electric Vehicle Services* ([scope of work](#)) (Feb. 2016)
- NRG EVgo, *Storage Accelerator* ([presentation](#)) ([settlement annual report](#))
- U.S. Dept. of Defense, LA Air Force Base V2G Pilot ([presentation](#) May 2016) ([presentation](#) Dec. 2015) ([presentation](#) Nov. 2014) ([plan](#))
- U.S. Dept. of Defense, China Lake Naval Air Weapons Station V2G demonstration ([rate schedule](#))
- U.S. Dept. of Defense, 63rd Regional Support Command (Moffett Field) demonstration ([presentation](#) Nov. 2014 (after LAAFB))
- U.S. Dept. of Defense, Fort Carson pilot ([assessment report](#)) ([presentation](#))
- University of Delaware

Publications:

- NREL, [Interim Test Procedures for Evaluating Electrical Performance and Grid Integration of Vehicle-to-Grid Applications](#) (June 2011)

Wireless Charging

Examining potential to utilize wireless charging technologies.

[COMING SOON - WORK IN PROGRESS]

Publications:

- NREL, [Dynamic Wireless Power Transfer Grid Impacts Analysis](#) (Nov. 2015)

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Residential Charging

[COMING SOON - IN PROGRESS]

Examining special problems related to installation and operation of electric vehicle charging equipment in residences.

- Alternative and Renewables Fueled Vehicle Technology Program, Charging Grants: Residential Deployment ([presentation](#))

Workplace Charging

Examining special problems related to installation and operation of electric vehicle charging equipment in workplaces.

Ongoing R&D:

- California Dept. of General Services, Electric Vehicle Charging Infrastructure program ([presentation](#))

Publications:

- U.S. Dept. of Energy, [Workplace Charging: Charging Up University Campuses](#) (Mar. 2016) (earlier [presentation](#))
- PEVC, [Plugging in at Work: How to Effectively Install, Share and Manage Electric Vehicle Charging Stations](#) (Nov. 2015) (earlier [presentation](#))
- U.S. Dept. of Energy, [Costs Associated with Non-Residential Electric Vehicle Supply Equipment](#) (Nov. 2015)
- U.S. Dept. of Energy, [EV Everywhere Workplace Charging Challenge: Mid-Program Review: Employees Plug In](#) (2015)
- CALSTART, [Best Practices for Workplace Charging](#) (2013)

Public Charging

Examining special problems related to installation and operation of electric vehicle charging equipment in publicly accessible locations.

Ongoing R&D:

- PG&E, DCFC Siting project (report due 4/15/2016)
- Alternative & Renewable Fueled Vehicle Technology Program, Public Charging Grants: CEC overview ([presentation](#)), Redwood Coast ([presentation](#)), SMUD DCFC ([presentation](#)), Adopt-a-Charger ([presentation](#)), ChargePoint public-private ([presentation](#))

Publications:

- NREL, [California Statewide Plug-in Electric Vehicle Infrastructure Assessment](#) (May 2014)

Integrated Renewables/Storage

Projects demonstrating integration of renewable energy generation or energy storage technologies with electric vehicle charging technologies.

Existing demonstrations:

- Greencharge Networks ([presentation](#)), Solar Tree ([presentation](#))
- SDG&E San Diego Zoo ([presentation](#))
- SCE, [Irvine Smart Grid Demonstration, a Regional Smart Grid Demonstration Project: Technology Performance Report #1](#) (Feb. 2014), [Technology Performance Report #2](#) (Oct. 2014)
- Oak Ridge National Lab, [Solar-Assisted Vehicle Charging Stations: Interim Report](#) (Sep. 2011).

Publications:

- Simpson (NREL), [Plug-in Electric Vehicle Fast Charge Station Operational Analysis with Integrated Renewables](#) (May 2012) ([presentation](#))

Battery Recycling/Disposal

Examining recycling and disposal of electric vehicle batteries at the end of useful operating life.

Ongoing R&D:

Lawrence Berkeley National Lab (PIER funded), *Strategies for Sustainable and Cost-effective Scale-up of Second-Life, Recycling, and Disposal Pathways for PEV Battery Packs* (expected June 2015)

Publications:

- Electricore, [Market Impact of Standardized Design in PEV Battery Pack Purchase and Disposal](#) (March 2015)
- Farasis, [Direct Recycling Technology for CA's PEV Li-ion Battery Packs](#) (March 2015)
- NREL, [Identifying and Overcoming Critical Barriers to Widespread Second Use of PEV Batteries](#) (Feb. 2015).

Medium- and Heavy-Duty Vehicles

Ongoing R&D:

- NREL, Miami-Dade hydraulic hybrid refuse vehicles evaluation ([fact sheet](#))

Publications:

- NREL, [Medium-Duty Plug-in Electric Delivery Truck Fleet Evaluation](#) (June 2016)
- EPRI, [Plug-in Hybrid Medium-Duty Truck Demonstration and Evaluation](#) (2015)
- NREL, [Statistical Characterization of Medium-Duty Electric Vehicle Drive Cycles](#) (May 2015)
- NREL, [Characterization of In-Use Medium Duty Electric Vehicle Driving and Charging Behavior](#) (Dec. 2014)

School Buses

[COMING SOON - WORK IN PROGRESS]

Clinton Global Initiative V2G School Buses ([presentation](#)) ([website](#))

Mass. Dept. of Energy, Electric School Bus Project (presentation requested)

Public Transportation

Electrified transit bus demonstrations, renewable energy for electric trains.

Publications:

- NREL, [Fast Charge Battery Electric Transit Bus In-Use Fleet Evaluation](#) (June 2016) ([fact sheet](#))
- NREL, [Foothill Transit Battery Electric Bus Demonstration Results](#) (Jan. 2016)
- Bruzzone & Ferry, [Making BART Run with the Warm California Sun](#) (Nov. 2015) ([presentation](#))

Transit agency electric bus pages:

[San Joaquin RTD](#), [Stanford Marguerite Shuttle](#), [Mountain View Community Shuttle](#), [Antelope Valley Transportation Authority](#), [Santa Barbara MTD](#), [Los Angeles DOT](#), [Los Angeles County MTA](#), [Long Beach Transit](#), [Gardena Municipal Bus Lines](#), [Foothill Transit](#), [Washington State DOT](#), [RTC Southern Nevada](#), [TriMet \(Portland\)](#), [King County Metro \(WA\)](#), [Link Transit \(Wenatchee WA\)](#), [Ben Franklin Transit \(WA Tri-Cities\)](#), [Utah Transit Authority](#), [VIA Metro Transit \(San Antonio TX\)](#), [Metro Transit \(Houston TX\)](#), [Chicago Transit Authority](#), [IndyGo \(Indianapolis IN\)](#), [TARC \(Louisville KY\)](#), [CARTA \(Chattanooga TN\)](#), [Nashville MTA](#), [StarMetro \(Tallahassee FL\)](#)

Utility Regulation

ZEV Program Implementation Task Force, [Regulation of Electric Vehicle Charging Equipment by Public Utility Commissions: Recommended Practices](#) (Oct. 2015)

Western States

[Oregon](#)

Washington

Utility Regulation: Oregon

[EO 08-24](#). Created AFV Infrastructure Working Group ([Final Report](#))

OPUC [Docket UM 1461](#) (opened Dec. 2009). Investigating EV rate structures and utility role in EVSE development. ([staff request](#) Dec. 2009) ([staff straw proposal](#) July 2010). Final Order: [Order 12-013](#) (Jan. 2012).

Freeway Corridor Pilot: PGE [AL 12-05](#) (Mar. 2012) (approved); PGE [AL 13-21](#) (Oct. 2013) (approved); PGE [Schedule 344](#).

[SB 1547](#) (Mar. 2016) §§ 20, 21, 29. OPUC [Docket 599](#) (opened Apr. 2016) [Staff Proposal](#) on application requirements, plus proposed schedule. Proposed rule coming soon.

Utility Regulation: Washington

EV Pilot Survey Results

The Electric Vehicle Pilot Survey is designed to collect baseline information on EV and VGI research, development, and demonstration projects in California and beyond. See <http://tiny.cc/evpilotsurvey> for further information.

Information from the survey is curated and compiled into a single spreadsheet, for reference. The most recent version is:

[2016.05.16 EVPS Response Master](#)

Change Log

2016.05.16. Started change log. Cleaned up formatting. Added subtitles. Added introduction page. Added NREL documents.

2016.05.20 migrated to dedicated account

2016.06.30 began compiling State Commission Proceedings