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| VGI Communications Protocol Working Group Deliverable One |
| Map VGI Use Cases and Requirements to Existing Communications Protocols |
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| **8/7/2017** |

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| This is a draft document for review and discussion. Although staff of several California state agencies are leading this working group, this document does not represent the views or opinions of any of the participating state agencies. |

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## 1. Overview of the need for the working group

* 1. Prior policy efforts in Vehicle-Grid Integration

Executive Order B-16-2012 ordered the California Air Resources Board, the California Energy Commission, the Public Utilities Commission, and other agencies to establish benchmarks to help achieve by 2020 infrastructure to support 1 million zero-emission vehicles, including electric vehicle charging that “will be integrated into the electricity grid.” This order, and the subsequent 2013 Zero Emission Vehicle Action Plan[[1]](#footnote-1) serve as the basis for the State’s effort to enable electric vehicles serve as a grid asset, reducing operating costs for facility and vehicle owners, the utilities’ distribution maintenance requirements, and energy prices in the wholesale market. Two related documents have led California’s policy development in vehicle-grid integration (VGI): the California Vehicle-Grid Integration Roadmap , developed collaboratively among the CEC, CPUC, and CAISO and stakeholders through workshops beginning in late 2012, and the CPUC Energy Division’s whitepaper published in the order instituting the Alternative Fuel Vehicles rulemaking R.13-11-007.

The Roadmap identified three tracks to direct the state’s efforts: 1. Determine VGI Value and Potential; 2. Develop Enabling Policies, Regulations, and Business Practices; and 3. Support Enabling Technology Development. Standards play an important role in bridging the tracks. The VGI Roadmap identified activities leading toward “Establishing a Technology Platform” to “increase consistency across technologies to enable interoperability and to provide guidelines for product development, while allowing for variety in VGI products and services.” The Roadmap highlighted the importance of the use of existing, international standards where “a common standards format ensures compatibility among multiple technologies, eases adoption by customers and increases certainty for developers about the access their products will have and about how their technologies can work with others.” [[2]](#footnote-2) The VGI Whitepaper highlighted a concern about the market’s ability to resolve conflicts arising between parties wherein each had the potential to control the VGI resource. The Whitepaper suggested that in order to overcome the fragmentation of the actors objectives that policymakers may need to “define the resource.” In particular, it notes how existing communication standards will be required in order to send messages between the defined resource, aggregators, and utilities.[[3]](#footnote-3)

In September 2016, the assigned commissioner’s ruling in R.13-11-007 stated an intention to overcome barriers that prevent expeditious actions toward effective VGI, particularly as the utilities were ordered to prepare applications for widespread transportation electrification pursuant to SB 350. CPUC Energy Division considered options for the adoption of a VGI communications standard in order to achieve the technology development and system reliability objectives enumerated in the VGI whitepaper, and recommended the use of the International Organization for Standardization and International Electrotechnical Commission’s (ISO/IEC) 15118 Vehicle-to-Grid Communications Protocol. In order to develop additional record needed to inform decisions on this issue, CEC and CPUC held a joint staff workshop on communications standards to discuss ISO/IEC 15118 and its potential conjoint use with IEEE 2030.5 adopted by Utility Electric Rule 21 and the Open Charge Point Protocol. Other means of communications were discussed including a charging or home area networks, an Open Vehicle-Grid Integration Platform, and vehicle telematics. While there was not consensus on the use of ISO/IEC 15118 in the utility programs, the technology is supported by many stakeholders including automakers, charging providers , and industry. Ratepayer advocates also support standardized communications to foster electrification by providing consistent metering, telemetry, and billing across vehicles, charging stations and service territories, and improving security by reducing points of integration, failure, and cyber-attacks. Subsequently, CPUC, CEC, CARB, and CAISO began facilitating an interagency working group of stakeholders to understand whether or not standards within charging equipment are needed to meet the renewable integration goals of SB 350.

* 1. Current Proceedings/Dockets

*California Public Utilities Commission*: Public Utilities Code 740.12 , as created under Senate Bill 350 (2015, de León) requires the CPUC to direct the electric investor-owned utilities under its jurisdiction to file applications for programs that accelerate widespread transportation electrification to meet the state’s air quality standards, greenhouse gas reduction goals, and increase access to electric vehicles across the state. In compliance with this requirement, the CPUC in September 2016[[4]](#footnote-4) directed the state’s investor-owned utilities (IOUs)[[5]](#footnote-5) to file applications proposing programs to accelerate transportation electrification. The CPUC is currently reviewing 33 project proposals filed by the IOUs[[6]](#footnote-6) . Eight of those projects would install light-duty electric vehicle charging infrastructure with a combined budget of about $226 million.

In some of the proposed projects, the IOUs would directly purchase and own the electric vehicle service equipment (EVSE), while other proposals would have the IOUs qualify EVSE models that customers receive a rebate for purchasing and installing. If this working group determines there is an existing communications protocol or protocols necessary to enable VGI to be deployed economically and at scale, it would apply to either ownership model currently proposed by the IOUs.

The final recommendation(s) from this working group will be incorporated into one or more of the CPUC’s electric vehicle proceedings[[7]](#footnote-7) to receive further stakeholder feedback. The CPUC will then determine whether to adopt the Working Group’s recommendation.

*California Energy Commission:* CEC is responsible for consulting with the CPUC on charging programs and standards pursuant to Public Utilities Code Sections 740.3 and 740.8. In addition, CEC has authorities under Public Resources Code to adopt standards to avoid energy waste, manage peak load, and develop infrastructure plans for electric vehicles. CEC’s work pursuant to these responsibilities has principally been conducted in research and demonstrations pursuant to the Electric Program Investment Charge Program and statewide and regional charging infrastructure assessments and investments under the Alternative and Renewable Fuel and Vehicle Technology Program.

The EPIC and ARFVTP programs’ contributions to the effort under the ZEV Action Plan and the Transportation Electrification goals under SB 350 are currently being reviewed as part of the 2017 Integrated Energy Policy Report. CEC is reviewing the progress on the technology pilots and actions in support of the VGI Roadmap, considering Transportation Electrification as part of the publicly-owned utilities’ integrated resource plans, and considering how electric vehicles can provide flexible resources to manage increased renewable generation on the grid. In addition, CEC’s participation in the working group will assist its ability to identify and forecast electric vehicle load growth, customers’ responsiveness to advanced rates, and ultimately its impact on the electricity system.

*California Air Resources Board*: CARB has the authority to implement SB 454 the Electric Vehicle Charging Open Access Act. This act details ways in which the customer should be able to access any publicly networked station and receive a standard set of information. One of the requirements set forth by SB 454 is communication of any fees that the consumer will need to pay. Vehicle to Grid Integration can be implemented in many different ways. One of which will require the consumer to interact with either the EVSE or an app. CARB’s participation in the working group will help inform the SB 454 implementation.

## 2. Focus on use cases and actors

Deliverable 1 focuses on identifying potential VGI use cases – but not making any assessments about the costs, benefits, or market readiness of those use cases – and understanding how protocols can enable the use cases. The goal of first focusing on the technological evaluation was to ensure each use case was fully considered as a potentially viable use of VGI and participants did not attempt to rank or exclude any use cases at this initial step in the process.

Each use case has specific actors and communication needs associated with it and can deliver value to customers or provide grid services. The intent of evaluating all potential existing and near-term use cases, regardless of their value, was to identify all communication needs and determine whether a specific communications protocol would facilitate the accomplishment of the use cases as a whole.

The agencies recognize that quantifying the market potential of use cases may help to kick-start the VGI market, because the value will ultimately be what drives investment in VGI technology, but that is beyond the scope of this working group. The final deliverable is expected to identify what, if any, specific communications protocol(s) should be required to be included in ratepayer-funded infrastructure investments currently being proposed by the California IOUs to ensure that infrastructure can support VGI.

In working to complete Deliverable 1, working group participants have identified all of the functional and non-functional communications requirements and any other requirements necessary to achieve all of the use cases under consideration and the communications pathway(s) needed to meet those requirements. Participants have also identified any alternative ways to achieve the use case requirements that do not require any communications protocols. Deliverable 1 summarizes these results and identifies which communications protocol(s) must or can be used to achieve each use case.

## 3. Definitions Sub-Working Group

The working group decided that it would be important for all participants to use the same terminology when discussing VGI concepts to ensure participants could communicate clearly and precisely. The working group is comprised of participants from a variety of sectors and may use slightly different nomenclature in their respective work.

More than 12 participants contributed to the terms and definitions. The sub-working group used a variety of source materials to develop terms and definitions from:

* California State Agencies – CPUC, CEC, CAISO
* Federal Agencies – US Department of Energy, The Federal Energy Regulatory Commission
* Research/Private Sector

The sub-working group identified xx terms and definitions, which are provided in Appendix XX of this document. They are grouped into the following sections:

* VGI Groupings of benefits
* General terms and definitions
* EV charging industry terms and definitions
* Utility industry terms and definitions
* Charging communication terms and definitions
* Standards

## 4. Discussion of Use Cases

Working group participants were asked to submit use cases and tag them with categories as identified in the [California Vehicle-Grid Integration Roadmap](https://www.caiso.com/Documents/Vehicle-GridIntegrationRoadmap.pdf). The category tags were:

1. V1G: Use cases where charge only flows into the vehicle.
2. V2G: Use cases that allow charge into the electric vehicle battery system as well as discharge of electricity from the electric vehicle battery system.
3. Aggregated: Use cases in which an entity manages more than one load such as over an open vehicle-grid integration platform (OVGIP), Demand Clearing House (DCH) or an EVSE Service Provider.
4. Non-aggregated: Use cases in which an entity manages only one load.
5. Fragmented: Use cases in which the actors involved are owned or controlled by different entities.
6. Unified: Use cases in which the actors involved are controlled or owned by the same entity.
7. Other: Use cases that do not fit into any of the above categories.

Each submitter presented and explained their use case to the Use Case sub-working group, which held 12 meetings and reviewed 77 use case submissions. On average, 26 participants attended each sub-working group meeting.

The sub-working group participants were given time to ask use case submitters questions, which in some instances led to an action or correction and re-submission of the use case. Once all of the reviewing participants came to a consensus about each use case, they also tagged it by consensus using the tags detailed above. Some use cases fit into more than one category.

Due to the large influx of use cases, we will discuss them here in more general categories rather than individually.

1. Price Programs: These use cases influence drivers’ charging habits by changing the price of electricity.
2. Demand Mitigation: These use cases attempt to curtail peak demand use from commercial accounts and general service customers by encouraging those customers to charge during off-peak times.
3. Direct Current Flow: These use cases focus on public DC charging infrastructure, and could include situations where there are one-way or two-way flows of electricity.
4. Vehicle Two Way Flow: These use cases can influence charging behavior and also allow EV drivers and business owners to use electricity from a car battery.
5. VGI Services: These use cases allow actors to access VGI services through the use of telematics, building management systems, network service providers and other pathways.

The 77 use cases considered are detailed in Appendix XXX and were broken down into tags as follows:

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| **Tag** | **Number of Use Cases** |
| V1G | 45 |
| V2G | 13 |
| Aggregated | 49 |
| Non-Aggregated | 44 |
| Fragmented | 48 |
| Unified | 45 |
| Other | 4 |

## 5. Discussion of Requirements

a. Discuss communication pathways, why each are important and what they can accomplish

In order to tag each use case, the Use Case Sub-Working group identified the requirements needed to achieve the use case and the communications pathways that must or can be used to successfully achieve each use case.

There are different types of requirements needed to achieve each use case. These include:

1. Functional requirements define specific inputs, behaviors, outputs or other functions needed to accomplish each use case. These include functions such as authentication, authorization, certification, reporting, and data collection.
2. Non-Functional requirements define criteria about the use case’s operation, rather than specific functions. These include attributes such as scalability, response time, reliability, data integrity, and interoperability.
3. Customer requirements ensure the customer has control over accepting or rejecting VGI services. These requirements can include interaction with the EV charging equipment, a smartphone or computer app, a building management system or some other digital interface.

Requirements can be met through communications pathways. In some cases, communications pathways are necessary to meet a requirement. In other instances, certain communications pathways can improve or enhance a use case’s outcome, or make it easier to achieve. Participants were asked to consider both situations in identifying what communications pathways apply to each use case.

In order to identify the necessary or optional communications pathways that could achieve certain requirement, participants had to consider the actors involved in accomplishing each use case. Actors are any entity that will need to send, receive or request information, including companies or persons who will be starting and stopping the flow of electricity. Identifying the actors also helps determine who will control the power flow during the use case, and how it will be controlled. This is influenced by whether the power flow is controlled at the EVSE or within the EV itself.

The communications pathways considered include:

1. Network Service Provider (NSP) to Building Management System (BMS)
2. NSP to EVSE
3. NSP to Electric Vehicle (EV)
4. NSP to Customer
5. BMS to EVSE
6. BMS to EV
7. BMS to Customer
8. EVSE to EV
9. EVSE to Customer
10. EV to Customer

Participants also identified some alternative ways to achieve use cases without the use of a communications pathway. Once the requirements, communications pathways, and alternatives were identified, a small group of volunteers worked to map those requirements to existing network architectures. The working group as a whole at its July 10, 2017 meeting, identified the current standards that are available as:

1. Institute of Electrical and Electronic Engineers (IEEE) 2030.5/ Smart Energy Profile (SEP) 2.0
2. Telematics
3. Open Automated Demand Response (OpenADR) v2.0b
4. International Organization for Standardization (ISO) 15118 v1
5. CHAdeMO[[8]](#footnote-8) (IEEE 2030-1-1)
6. Charging Network Management Protocol (CNMP) IEEE 2690
7. SAE[[9]](#footnote-9) J3072, J2847, J2931, J1772
8. Open Charge Point Protocol (OCPP) v1.6

## 6. Summary of Deliverable 1

Summary of which communications protocols or alternatives must or can be used to achieve each use case

1. The ZEV Action Plan was updated in 2016. <https://www.gov.ca.gov/docs/2016_ZEV_Action_Plan.pdf> [↑](#footnote-ref-1)
2. VGI Roadmap at 11 <http://www.caiso.com/documents/vehicle-gridintegrationroadmap.pdf> [↑](#footnote-ref-2)
3. VGI Whitepaper at 30 and 34 http://docs.cpuc.ca.gov/PublishedDocs/Published/G000/M080/K775/80775679.pdf. [↑](#footnote-ref-3)
4. [Assigned Commissioner’s Ruling](http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M167/K099/167099725.PDF) in R.13-11-007 [↑](#footnote-ref-4)
5. There are six electric IOUs in the state: San Diego Gas & Electric, Southern California Edison, Pacific Gas and Electric, PacifiCorp, Liberty, and Bear Valley. [↑](#footnote-ref-5)
6. The SB 350 Transportation Electrification proceedings are A.17-01-020, et al., A.17-06-031, A.17-06-033, and A.17-06-034 [↑](#footnote-ref-6)
7. R.13-11-007, A.17-01-020, et al., A.17-06-031, A.17-06-033, and A.17-06-034 [↑](#footnote-ref-7)
8. CHAdeMO, an abbreviation of Charge de Move, is the trade name for [a protocol](https://www.chademo.com/about-us/what-is-chademo/) for fast charging EV batteries. [↑](#footnote-ref-8)
9. SAE International is a global association of engineers and technical experts in the aerospace, automotive and commercial-vehicle industries. [↑](#footnote-ref-9)