November 7, 2017

Nuvve Corporation's Comments on the Vehicle-Grid Integration (VGI) Working Group's October 2017 "Draft Proposal for Next Steps"

Nuvve Corp. appreciates the opportunity to provide these comments on the VGI Working Group's *Draft Proposal for Next Steps*[1] discussed during the working group stakeholder meeting on October 30, 2017.

Nuvve is a San Diego based company[2] operating in the U.S. and internationally whose mission is to lower the cost of electrical vehicle (EV) ownership while supporting the integration of renewable energy sources, such as wind and solar. Nuvve's Grid Integrated Vehicle platform, GIVe™, transforms EVs into grid assets when those vehicles are charging, while guaranteeing the expected level of charge at the time the owner or driver needs it for transportation. The aggregation of thousands of parked and plugged-in EVs into a virtual power plant using the GIVe platform allows Nuvve to provide EV owners with significant benefits, while also participating in electricity markets with a power capacity and capability comparable to traditional generators, using vehicle-to-grid (V2G) technology that is commercially available and viable ***today***.

A significant reduction in fossil fuel emissions, like those captured in California's policy goals such as Assembly Bill (AB) 32, Senate Bill (SB) 350, and Governor Brown's Zero Emission Vehicle objectives requires the safe and reliable integration of energy storage services and renewable (and typically, intermittent) generation sources. EVs are an obvious resource to achieve these goals, especially when they are leveraged under VGI. However, the full value of EVs will only be realized as a grid resource under a full V2G framework that provides benefits beyond those available from V1G (unidirectional managed charging).

V2G provides energy and capacity services similar to stationary battery storage systems, and enables multiple value streams to be captured from the resource by providing ancillary services to the grid such as frequency regulation and voltage control. V2G can provide a full suite of grid services and their associated benefits, all while meeting the needs of drivers, reducing emissions and lowering overall costs for utilities and their customers. VGI is implemented through V2G technology using one of two basic technology frameworks – $V2G_{DC}$ or $V2G_{AC}$.

The following table lists a high-level description of the frameworks for VGI:

[1] http://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=6442455175
[2] Please see http://nuvve.com for additional information about Nuvve, its technology, and projects.

Table 1: Vehicle-Grid Integration Frameworks

VGI Frameworks	Description	Uni- or Bi-directional Power Flow	Potential Grid Services Benefits
V1G	Managed / modulated EV charging load	Unidirectional	Partial
$V2G_{AC}$	Managed EV charging & discharging; AC connection from EV Supply Equipment (EVSE), inverter in vehicle	Bidirectional	Full
$V2G_{DC}$	Managed EV charging & discharging; DC connection from EVSE, inverter in EVSE	Bidirectional	Full

Commitments to V2G technology have been exhibited by several major automotive manufacturers, through their participation in demonstration projects here in California as well as commercial operations in Europe. Those manufacturers include Nissan, Honda, Fiat-Chrysler, Mitsubishi and Groupe PSA. Although some automakers have voiced concern over warranties, those that are actively working on the implementation of V2G have articulated it is no longer a concern as battery technology has improved. For example, Nissan has been cited saying the warranty is no longer a consideration for their V2G plans[3], and one recent university study[4] determined that V2G could *extend* the life of EV batteries.

In the following comments, Nuvve addresses the straw proposal submitted by the VGI Working Group at its October 30, 2017 meeting.

Nuvve agrees with the working group's recommendation to not mandate a single communications protocol for VGI at this time (given the developing VGI market), and with its proposal to gather additional stakeholder feedback on required hardware functionality with the goal of "future proofing" the assets deployed under SB 350. Better understanding the hardware requirements for the various VGI frameworks (V1G, $V2G_{DC}$, and $V2G_{AC}$) will be critical to send a market signal to EVSE manufacturers.

However, Nuvve does have a concern regarding the following statement in the working group's straw proposal:

> *"The scope of this proposal is for multi-user Level 2 EVSEs supported by SB 350 funds. The working group found that DC fast chargers are not likely to be utilized for VGI due to the need to provide maximum power while in use and that Level 1 or single user EVSEs are unlikely to have a duty cycle that justifies the expense of enabling VGI in the EVSE hardware."*

[3] Nissan, Honda Tease New EVs With Grid Services Capabilities, GreenTech Media, January 6, 2017 https://www.greentechmedia.com/articles/read/nissan-honda-tease-new-evs-with-grid-service-capabilities#gs.2VmTxo8

[4] Uddin K, Jackson T, Widanage WD, Chouchelamane G, Jennings PA, Marco J. On the possibility of extending the lifetime of lithium-ion batteries through optimal V2G facilitated by an integrated vehicle and smart-grid system. Energy 2017. http://www.sciencedirect.com/science/article/pii/S0360544217306825

DC EVSE (also known as "fast chargers") are currently being utilized for VGI in California, in projects such as the CEC-funded demonstration project at the LA Air Force Base[5], where up to 5 vehicles connect to $V2G_{DC}$ EVSEs with up to 50 kW of capacity each. Further, Nuvve and its partners are currently working on efforts in California such as the EV Storage Accelerator[6] (EVSA) and Intelligent Electric Vehicle Integration[7] (INVENT) projects, both of which include $V2G_{DC}$ systems. These demonstration projects have or will show that the value of DC charging is not only for drivers en route to a destination (as implied by the statement quoted above from the draft proposal), but that V2G can provide significant incremental benefits from EVs that are parked and plugged into bi-directional DC EVSE for extended periods of time.

These examples clearly show that the working group's finding that "DC fast chargers are not likely to be utilized for VGI" is in error, as such equipment is being utilized for VGI in California today. Nuvve requests that this be reflected in the next revision of the proposal.

In addition to the three current California projects utilizing $V2G_{DC}$, Nuvve also requests further consideration of how $V2G_{AC}$ will be enabled for deployment. If the Level 2 EVSEs in the working group's proposed scope are limited to AC, their ability to execute (and realize the commensurate benefits of) full $V2G_{AC}$ will be limited in the near-term.

Presently, the limitation of AC EVSEs in executing $V2G_{AC}$ is twofold:

1. $V2G_{AC}$ EVSEs require additional hardware in both the EVSE and the car in order to execute bi-directional flow, thus necessitating in-person field upgrades for existing vehicles and EVSEs that cannot be executed by a simple over-the-air software update.
2. The inverter is on-board the EV. The utilities' Rule 21 standards do not currently provide a path to certify the safety and functionality of the inverter, as vehicles were not anticipated in the last revisions to those rules[8]. Therefore, successfully completing an interconnection with a utility distribution company (and thus allowing the battery in the vehicle to discharge through the EVSE) is not possible at this time, without changes to Rule 21.
    - The current Rule 21 OIR (R.17-07-007) is anticipated to address issues related to V2G through its working groups, but those issues may not be resolved until mid-2019[9].

In contrast, the DC EVSE currently being used for V2G in California have a clear pathway for technical certification and interconnection with California's utility distribution companies based on the current Rule 21 requirements. Therefore, DC EVSE can realize the full suite of V2G services and benefits in the near-term, as compared to AC EVSE which faces barriers.

In conclusion, Nuvve requests the VGI Working Group and its participating stakeholder agencies to:

1. **Include DC EVSE into revised and/or future proposals for functional and/or technical requirements for VGI in California; and to**

[5] http://www.energy.ca.gov/research/energystorage/tour/af_v2g/
[6] http://www.cpuc.ca.gov/WorkArea/DownloadAsset.aspx?id=6442453063
[7] http://www.energy.ca.gov/business_meetings/2017_packets/2017-06-14/Item_13_EPC-16-061.pdf
[8] Rule 21 currently requires certification to the UL 1741 standard, which is not applicable to vehicles given the standard's requirements that were developed for stationary solar inverters.
[9] See R.17-07-007, SCOPING MEMO OF ASSIGNED COMMISSIONER AND ADMINISTRATIVE LAW JUDGE, http://docs.cpuc.ca.gov/PublishedDocs/Efile/G000/M196/K476/196476255.PDF

2. **Explore the upgrades needed on a L2 AC EVSE with minimum functionality to make it V2G capable in the future, and recommend any hardware components that could be included now that would make future upgrades more cost effective.**