# V2G INFRASTRUCTURE

## INTEROPERABILITY ISSUES & SOLUTIONS

### V2G= VEHICLE TO GRID

- Distributed Energy Resource – Reverse Power Flows
- A V2G EV/EVSE may be authorized to export energy to the grid.
- It is interconnected to a utility electrical grid and meets the DER interconnection rules mandated by a PUC.
  - ***For the US, those rules are based on IEEE 1547***
- V2G Systems are interconnected with a DC-AC inverter in the EVSE or the EV itself.

### INTEROPERABILITY ISSUES

- Understanding standards and how to use them – profiles, certifications, interops and more
- Competing immature standards with interoperability issues
- Competing jurisdictions – who is responsible for V2G Interoperability
- Culture clash – utilities vs automakers
- Complexity of V2G vs Other DERs
- Use cases and business models unresolved


### TESLA & RIVIAN

- Potential V2G DERs
- With Utility Interconnection become V2G DERs

A virtual meeting was held Wednesday April 6, 2022, with major automotive leaders, including Tesla Inc Chief Executive Officer Elon Musk and General Motors CEO Mary Barra to discuss electric vehicles and charging.

Ford Motor CEO Jim Farley, Chrysler-parent Stellantis CEO Carlos Tavares, Lucid CEO Peter Rawlinson and Nissan Americas chair Jeremie Papin also joined the call to discuss U.S. funding to "create a national network of 500,000 chargers."

The Biden administration said in a statement "there was broad consensus that charging stations and vehicles need to be interoperable and provide a seamless user experience, no matter what car you drive or where you charge your EV."

Currently multiple standards are in use and they are not interoperable between standards and even between versions of the same standard.

And even products implementing the same standard do not necessarily work together seamlessly – e.g., CharIN Testivals exist because of these interoperability issues.

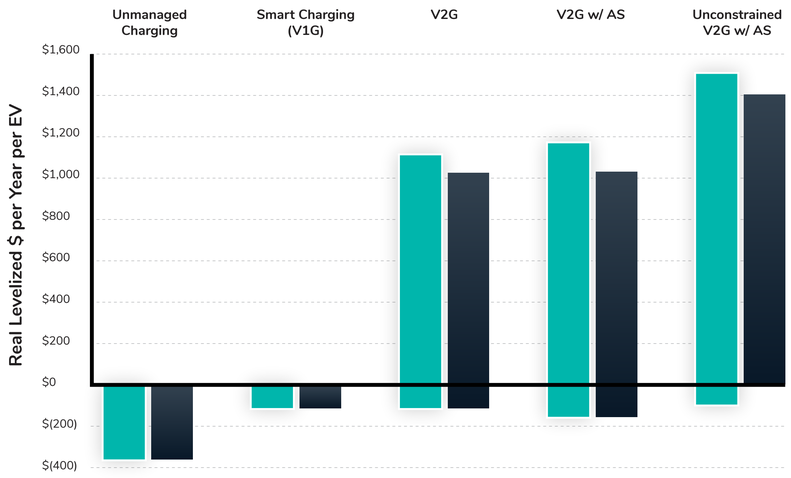
## THE VALUE OF V2G

- Level 1 Charging uses standard 120 Volt connection. Rate of charge comparable to running a dishwasher or microwave – minimal grid impact
- Level 2 charging can create a load 2-5 times greater than a typical household load, potentially causing grid stability issues.
- EV owner charging behaviors show that at least 20% of PEVs charge at peak hours. Combined with Level 2 charging rates, the impact of V1G and V2G applications can be estimated.
- The study modeled only California PEV V1G and V2G scenarios and 3.3-5.0 mil EVs by 2030 (Electric Power Research Institute, ***Vehicle-to-Grid: $1 Billion in Annual Grid Benefits***)

### KEY CONCLUSIONS:

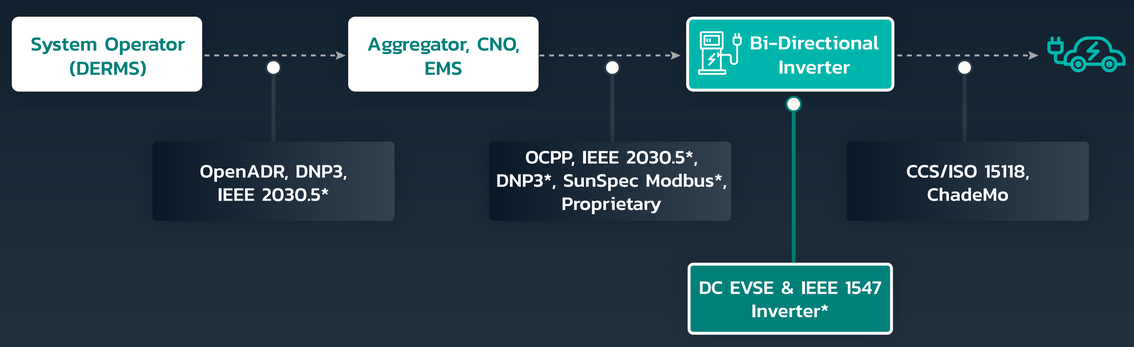
- V1G is valuable only if charging during peak hours.
- For short commutes and once fully charged, V1G services are not available.
- V2G can generate over $670 mil to 1 billion/year in CA Ratepayer benefits in 2030. Significantly more than V1G

**Levelized Costs & Benefits Under High Case**




*Source: Figure 5-15 from the Epri Open Standards Report

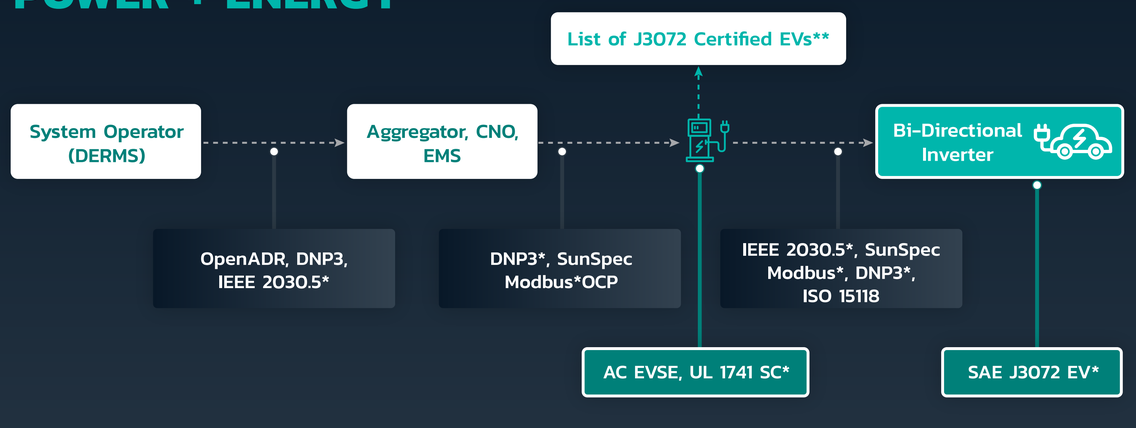
## V2G-DC COMMUNICATIONS PROTOCOLS: POWER + ENERGY




- The EVSE includes a bi-directional inverter with grid support functions
  - ***Interconnected by utility per 1547-2018 (Grid Support) requirements and certifications depending on jurisdiction.***

* For CA IOUs, the DERMS interface will be IEEE 2030.5 as defined by CSIP. The EVSE inverter will need to be certified to UL 1741 SA or SB to be interconnected. For SB, the inverter needs to support one of the three IEEE 1547 Protocols though others may be used if utility agrees.

## V2G-AC COMMUNICATIONS PROTOCOLS: POWER + ENERGY




- Bi-Directional Inverter in EV. Defined by SAE J3072
  - ***Grid support and EVSE/Site settings reside in EVSE; transferred to PEV as part of the authorization process***
  - ***EVSE (Fixed Asset) Interconnected and Registered on DERMS***

* In CA, EVSE presumably to be certified to UL 1741 SC and EV to SAE J3072. (Inclusive of IEEE 2030.5 or SunSpec Modbus for EVSE-PEV comms (Type A1 and B1)). EVSE upstream communications being defined based on IEEE 1547 and 1741 SC. Future ruling by CPUC

**A list of J3072 Certified EVSEs is proposed in the CA Rule 21 Activities to allow and EVSE to check if the attached EV is certified prior to authorizing discharge

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