**WHAT IS VEHICLE-GRID INTEGRATION?**

<table>
<thead>
<tr>
<th>Managed Charging (V1G)</th>
<th>Passive</th>
<th>Active</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>This includes behavioral load control strategies like text messages or time-varying rates.</td>
<td>This includes direct load control strategies where bi-directional or uni-directional commands are exchanged to turn up, turn down, turn on or turn off a charging event, in response to grid/system needs.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vehicle-to-Everything (V2X)*</th>
<th>Active</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Similar to Active V1G but signals include both charging and discharging capabilities between the vehicle battery and either a local grid (building, campus, microgrid) or utility grid. It also includes autonomous functionalities where charge and discharge rate is adjusted based on local voltage or frequency deviations.</td>
</tr>
</tbody>
</table>

*V2X is an emerging technology and the appropriate capabilities and management approaches are developing.  
BENEFITS OF VEHICLE-GRID INTEGRATION

Customer Benefits

- Lower rates
- Bill management
- Demand charge management
- Emergency back-up
- Non-emergency
- Reduced emissions
- Energy arbitrage with export tariffs

Distribution Utility/Bulk Power Operator Benefits

- EV incentives/adoption
- Incent grid-friendly charging
- Peak shaving and shifting
- Absorb excess RE generation
- Avoid new T&D upgrades/repairs/replacements
- Frequency regulation/voltage
- T&D deferral
- Emergency dispatch
- Environmental compliance
- Reactive power support
- Spin/non-spin reserve
- Black start
- Resilience
- T&D capacity
- Generation capacity
- Energy generation


SEPA, A Regulatory Roadmap for Vehicle-Grid Integration, 2020
V2G CAN BALANCE DEMAND LOCALLY

V2G can reduce peak demand, smoothing out load profiles throughout the day.

VGI ENABLEMENT IS COMPLEX
Figure 5: Internal Utility VGI Program Approval Challenges

- Concerns about obtaining regulatory/governance board approval
- Benefit-cost isn't sufficient to make the investment
- Regulatory, statutory, and/or other legal limitations
- Uncertainty around the availability of EVs to manage and customer participation
- Technical issues related to availability and sophistication of VGI equipment and platform offerings
- Technical barriers related to lack of EVSE standardization (e.g., open protocol standards)
- Lack of staffing resources to develop a program
- Limited information about how to design a program
- Other
- No barriers
- Lack of internal support from executive leadership to develop a program

Source: Smart Electric Power Alliance, 2020. N = 115
REGULATORY TOOLS AND APPROACHES FOR VGI

- Comprehensive Stakeholder Process
- Technical Conferences
- Technical Working Groups
- Generic or Rulemaking Proceedings

- Streamlined Approaches for Rapid Review and Approval of Demo/Pilot Projects
- Updated Framework for Benefit Cost Analysis
- Innovation Fund
- Revenue Adjustment Mechanisms and Multi-Year Rate Plans

- Performance-Based Regulation
- Performance Incentive Mechanisms
- Increased Communication Between Legislatures and State Agencies


SEPA, A Regulatory Roadmap for Vehicle-Grid Integration, 2020
USE CASE: ELECTRIC SCHOOL BUS
ELECTRIFYING ALL SCHOOL BUSES IN THE U.S.
FUNDED BY THE BEZOS EARTH FUND

Aggregate demand to drive mass procurement of electric buses (> 100,000 buses), bringing the electric bus industry to a tipping point of mass adoption.

Scale e-bus manufacturing and drive down unit costs.

Develop innovative financing models and support rapid deployment of charging infrastructure.

Influence federal and state policy to unlock public funding and policy support for full electrification of school bus fleet.

Galvanize grassroots community organizations through local and national “Yellow to Green” campaigns to create bottom up pressure/support for school bus electrification.
WHY SCHOOL BUSES

- Our goal is to electrify the entire fleet of 480,000 U.S. school buses by 2030
- Every day school buses transport 26 million students
- Average fleet age is 9.1 years
SCHOOL BUS FACTS

- States with most school buses:
  1. Texas – 47,576
  2. New York – 45,600
  3. Illinois – 26,322
  4. California - 24,213

- In CA, districts with large shares of students relying on the school bus tend to be small, rural, and largely low-income

- Nationally, 60% of low-income students take the school bus, compared to 45% of non-low-income students

- Electrifying the entire school bus fleet can unlock **72 GW** of storage capacity (~22 million homes), enabling utilities to integrate more clean energy on their grids. In CA that could be **3.6 GW** or 1.1 million homes.

1. [https://www.schoolbusfleet.com/download?id=10117405&dl=1](https://www.schoolbusfleet.com/download?id=10117405&dl=1)
2. Storage capacity based on 150kW battery size estimate (BlueBird Type C&D is 155kW)
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