Grid Integration for Electric Buses & Trucks
*Opportunities, Challenges & Recommendations*

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CALSTART, Inc.
CALSTART’s 150+ Member Companies and Organizations
(Partial Listing)
Almost Twenty ZEB Products Across Nine Bus Makers and Up-fitters
One E-Truck or E-Bus provides substantial environmental benefits compared to one light-duty EV.
Utility load planning will be easier for E-Trucks & Buses as they will be concentrated in fewer areas
Charging has to support vehicle operation and unlike light-duty EVs cannot easily be shifted.
Demand charges can be prohibitively costly for early E-Bus & Truck deployments

**Assumptions:**
Each bus drives 40,000 miles per year. The diesel bus has a fuel economy of 4 MPG and diesel is priced at $4.00 per gallon. The CNG bus has a fuel economy of 3.5 MPDGE and CNG is priced at $2.00 per DGE. The electric transit buses have an efficiency of 2.5 AC kWh/mile and electricity is priced at $0.10/kWh. One electric bus charging on-route draws 150 kW from the grid, 4 draw 280 kW, 6 draw 330 kW and 8 draw 380 kW. The electric bus charging overnight draws 40 kW from the grid.
E-Truck & Bus charging infrastructure is a limiting factor for further vehicle adoption

Fleet cost estimates per one charger installation

<table>
<thead>
<tr>
<th></th>
<th>EVSE</th>
<th>EVSE Installation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Low</td>
<td>High</td>
</tr>
<tr>
<td>16.5kW (220V / 75A)</td>
<td>$1,000 - $3,000</td>
<td>$17,000 - $32,000</td>
</tr>
<tr>
<td>70kW (208VAC 3Ø / 200A)</td>
<td>$5,000 - $10,000</td>
<td>$20,000 - $75,000</td>
</tr>
<tr>
<td>450kW (480VAC 3Ø / 640A)</td>
<td>$350,000</td>
<td>$150,000 - $200,000</td>
</tr>
</tbody>
</table>
E-Truck & Bus charging, if unmanaged, can have significant impacts on the grid.

Assumptions: the Chevy Volt charging rate is 3.3 kW, the medium-duty E-Truck charging rate is 15 kW and the E-Bus charging rate is 60 kW. The peak load for the Transamerica Pyramid building is from [26].
Storage – Distributed Generation – Intelligent Management

- Energy Storage System
- Battery Swapping
- Distributed Generator
- Load Management System

**ABB TOSA bus charging system with ultracapacitors**

<table>
<thead>
<tr>
<th></th>
<th>Grid to Charger</th>
<th>Charger to Bus</th>
</tr>
</thead>
<tbody>
<tr>
<td>Maximum charging power</td>
<td>40 kW</td>
<td>400 kW</td>
</tr>
<tr>
<td>Charging duration</td>
<td>2.5 minutes</td>
<td>15 seconds</td>
</tr>
<tr>
<td>Energy transferred</td>
<td>1.7 kWh</td>
<td>1.7 kWh</td>
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</tbody>
</table>

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E-Trucks & Buses could provide additional benefits to the electric grid
Electrifying the truck & bus market requires innovative utility rates

![Charge Ready How It Works](image)

**Utility Rates Table**

<table>
<thead>
<tr>
<th>Rate Schedule</th>
<th>TOU-EV-3</th>
<th>TOU-EV-4</th>
<th>TOU-EV-6*</th>
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</thead>
<tbody>
<tr>
<td>Maximum Demand</td>
<td>&lt;20kW</td>
<td>&gt;20kW</td>
<td>&gt;500kW</td>
</tr>
<tr>
<td>&lt;500kW</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**EV Submetering**

- Required

**Energy Charge**

- Max. $0.36/kWh
- Min. $0.06/kWh

- Max. $0.29/kWh
- Min. $0.06/kWh

- Max. $0.39/kWh
- Min. $0.07/kWh

**Demand Charge**

- A - $0.00/kW
- B - $7.23/kW

- $13.20/kW
- $10.93/kW

**Notes**

- No EV demand charges if EV account demand does not exceed General Service account demand of associated facility.

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Commercial Electric Vehicle Working Group

Shared understanding of common issues, costs, impacts, and opportunities

- Utility
- Transit Agency
- Truck Fleet
- Vehicle OEM
- Tech Provider
### Overview of Participating Fleets

#### Summary of Stated Challenges

**Infrastructure**
- Infrastructure costs (in-depot and on-route)
- Power upgrades for 50+ vehicles
- Need for off-street property to accommodate on-route chargers
- Delays from utility during construction
- Inter-city coordination

**Rates**
- Electricity rates
- Demand charges / peak pricing

**Other (Cross-Cutting)**
- Regulatory uncertainty
- Inadequate funding levels
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