ELECTRIC SCHOOL BUS CHARGING 101

Electric School Bus Charging 101

Here's a quick overview of the types of electric school bus (ESB) chargers and considerations for selecting the right option for your fleet.

Charger Types: There are three levels of chargers (also commonly referred to as "Electric Vehicle Charging Equipment", "EVSE", or "chargers") available on the market: Level 1, Level 2 and DC fast charging. The main difference is how quickly they can charge your bus, and their power requirements at your facility.

Level 1 charger are compatible with standard electrical outlets, but are not suitable for ESBs because of their slow charging speeds. Many ESBs can be effectively charged by either a high-power Level 2 chargers (19 kW, 240 volts Alternating Current (AC)) or a medium-power direct current (DC) chargers (commonly 25 kW, 480 volts DC). Many ESBs may also charge at high-power DC fast chargers (commonly 50-150 kW, 480 volts DC).

Level 1 Charging 120V	**Level 2 Charging** 240V	**DC Fast Charging** 480V
		
Residential Not suitable for ESBs	Residential or Commercial Up to 20 kW 5 - 13 hours charge time	Commercial 25 - 150 kW 1 - 4.5 hours charge time

While DC fast chargers are more expensive compared to high-power Level 2 AC units, they operate more efficiently. Also, some electric bus models only accept DC charging, and others may offer discounts on a bus if they don't need to provide onboard Level 2 charging hardware.

Some chargers come equipped with more than one port, or plug, which allows it to connect to more than one ESB at a time. A charger equipped with multiple ports will still only deliver it's maximum power rating, either split simultaneously between multiple ports or through a single port. For example, a 125 kW charger with 2 ports could deliver 62.5 kW through each port simultaneously, or 125 kW through one port (other configurations that add to 125 kW might also be possible, depending on the specific charger's capabilities).

Costs: High-power Level 2 chargers typically cost between $2,000 and $5,000 for the equipment, and $1,000 to over $10,000 for installation (depending on the complexity). Medium-power DC fast chargers are more expensive ($10,000-$15,000 for more basic equipment to more than $40,000 for larger, more powerful stations, and typically $50,000 or greater for High-power DC fast chargers). They also require a three-phase power supply, so installation costs are typically higher as well – ranging from $4,000 to $15,000 on the lower end to over $50,000 for larger and more complex projects.

The cost of installing one or more chargers can vary widely depending on site characteristics, quantity, and type of charging equipment. That said, there are two primary considerations that drive the cost of installation:

1. **The distance from the power source to the charger.** Costs associated with connecting a charger to the power source can account for 40% or more of the installation cost. If possible, minimize your installation costs by installing the station as close as possible to an existing power source that has sufficient capacity to avoid service upgrades. Longer distances between the charger location and power source increase costs by requiring more electric circuit components and conduit-runs, as well as trenching or linear drilling costs for underground conduit.
2. **Whether the charger is mounted to an existing wall or installed as a free-standing unit.** Wall-mounted chargers are generally less expensive because they don't require a free-standing pedestal (or a concrete pad) or trenching to connect them to a power source. Whether wall-mount units can work for a school bus depends on the location and position of bus parking relative to the building. Note that High-power DC fast chargers typically require freestanding installation due to their size.

Charging Time: A typical Type C ESB with a 150kWh battery pack will be able to charge in 6 to 8 hours overnight using High-power Level 2 chargers. A Medium-power DC fast charger will be able to provide a slightly faster charge (4-6 hours). Some fleets with more-powerful DC fast chargers (50 kW or more) may be able to recharge the same bus in as little as 2 hours. Fleets should evaluate whether they may need midday charging, how much charging time they will have between morning and afternoon shifts, and how much range they will need to recover during that time, as each factor will influence charger type selection.

Networked Chargers: Some chargers are connected on a network so they can be monitored and managed collectively using an online software platform. For school fleets, networked chargers can enable managed charging (see below) and provide real-time charging status for your buses and alerts if there are any charger malfunctions. Networked chargers are typically more expensive than simpler, non-networked chargers, and often require ongoing monthly fees.

Managed Charging: EV charging can increase electricity demand - sometimes significantly in the case of DC fast chargers and/or during midday charging. However, the resulting impact on your electricity demand charges can be minimized if EV charging is managed to occur while other loads are low (such as overnight). Managed charging includes any strategy to control when charging occurs or the amount of charging done at any given time. Generally, managed charging aims to minimize both costs (such as demand charges) and strain on the electric grid, and typically uses software to coordinate charging schedules among multiple networked chargers.

Vehicle-to-Grid (V2G) or Vehicle-to-Building (V2B): Electric utilities are interested in vehicle-to-grid/building configurations of ESBs. V2G/V2B enables a parked ESB to help absorb excess power or supply power in peak power demand times. The ESB accomplishes this by charging or partially discharging its battery at specific times while connected to a specially equipped EVSE. Strategic timing of battery discharge could save money for the utility and still allow for a fully charged vehicle when needed, while potentially providing utility financial incentives to the fleet to help offset the cost of the electric bus. These technologies are still very new, however, and until more trials have been completed school bus operators should not plan on extra cost savings from V2G/V2B (unless these savings are guaranteed through a service contract from a 3rd-party "turnkey" ESB fleet administrator).