



A convenient, reliable, and seamless charging experience is necessary to bolster consumer confidence in electric vehicles (EVs) and propel the massive market transformation needed to decarbonize our transportation system. As part of EVgo ReNew™, a comprehensive maintenance program designed to improve uptime and enhance the customer experience, EVgo seeks to address not only reliability, but also “One & Done” success rates, or the percentage of time a customer has a successful charging experience on their first try. With data from hundreds

of thousands of charging sessions on the EVgo network each month, EVgo has found that charging attempts can be unsuccessful for a variety of reasons associated with the vehicle, the charger, the driver, or a mix of all three. No matter the reason, an unsuccessful charge attempt is frustrating, and EVgo is committed to resolving all charging issues to ensure drivers have the best charging experience possible.

Solutions to address root causes of reliability and unsuccessful charge events will require the entire ecosystem to work together, including EV charging equipment manufacturers, automakers, and electric vehicle service providers (EVSPs) like EVgo. Based on its decade plus of experience building, owning, operating, and maintaining a nationwide fast charging network, coupled with the technical expertise at its Innovation Lab in El Segundo, CA, EVgo has identified the following best practices to maximize fast charger reliability for the Connect the Watts™ community:

1) Standardize Error Codes Across Both Charging Equipment and Vehicles, 2) Incorporate Vehicle Interoperability Testing with EVSPs Prior to Sale of New EVs, 3) Allow More Time for Charging Session Authentication Before Time Out, 4) Strengthen Safety Standards and Prioritize Compliance, 5) Establish Safety Standards for Charging Adapters, 6) Standardize Vehicle Port Location, 7) Extend Preventative Maintenance to Components, 8) Encourage Suppliers to Prioritize Replacement Part Availability to Support Shorter Repair Timelines, and 9) Build Fault Tolerance and Resilience Into the Charging Process.



Standardize Error Codes Across Both Charging Equipment and Vehicles

✓ Best Practices:

- ▶ Currently, error codes for charging infrastructure vary widely across charging equipment manufacturers, automakers, and subsequently, charging networks. To encourage standardization, EVgo published [recommended](#) minimum required error codes to encourage standardization.
- ▶ Through uniform error codes, that uniquely and correctly identify issues, charging networks will be able to better diagnose problems and institute solutions to enhance customer experience.



Incorporate Vehicle Interoperability Testing with EVSPs Prior to Sale of New EVs

✓ Best Practices:

- ▶ Some charging reliability root causes originate with the vehicle and can only be resolved by close collaboration with automakers to strengthen vehicle and charger interoperability. EVgo invites all automakers to participate in interoperability testing at its full service Innovation Lab before their vehicles go to market. If firmware updates or other changes are needed once vehicles are in operation, automakers should be proactive and contact EVSPs to diagnosis and treat any potential charging issues.
- ▶ Other sample vehicle interoperability best practices include compatibility with both DIN 70121 and ISO 15118-2 charging standards, enabling drivers to utilize Autocharge+, proper inlet locking and unlocking behavior, and more.



Allow More Time for Charging Session Authentication Before Time Out

✓ Best Practices:

- ▶ Standards that apply to both charging equipment and vehicles require a charging session to “time out” if too much time passes between the time when a customer plugs the connector into their vehicle and session initiation. For example, DIN 70121 specifies 150 seconds, and ISO 15118-2 only specifies 60 seconds, which is an insufficient amount of time for an EV driver, especially a new driver, to start a charge. After expiration, the connector must be unplugged and then re-plugged into the vehicle to initiate a charge. Amending these standards to allow customers up to five minutes before timing out would provide EV drivers with the time needed to initiate a session, regardless of their preferred payment method. And, as new EV drivers use public fast charging for the first time, a longer timeout window would contribute to a more positive customer experience.
- ▶ EVgo's Autocharge+ feature, which allows EV drivers to seamlessly initiate a charging session by simply plugging their vehicle into an EVgo fast charger, bypasses the time out issue completely, bolstering charging success rates and streamlining the customer experience by removing separate identification and payment authorization.



Strengthen Safety Standards and Prioritize Compliance

✓ Best Practices:

- ▶ All chargers deployed by EVgo are UL certified and must pass rigorous safety, interoperability and reliability testing at the EVgo Innovation Lab before installation.
- ▶ While public funding programs commonly require chargers to be certified by a United States Occupational Health and Safety Administration's Nationally Recognized Testing Laboratory (OSHA NRTL) like UL, enforcement is not as common and should be a priority, as some charging equipment in the field today operates outside of compliance with existing standards, which impacts reliability and could pose a safety risk.
- ▶ Safety standards should be expanded to be more comprehensive. For example, the UL standard requires a latch to ensure the connector remains locked in the car's charging port but does not require redundant safety features beyond the latch. Because the latch is a common point of failure, this may create a safety risk for drivers if those features are not added voluntarily.
- ▶ Additionally, these standards will need to be extended to cover North American Charging Standard (NACS) connectors for charging equipment.



Establish Safety Standards for Charging Adapters

✓ Best Practices:

- ▶ Adapters that enable access to both CCS and NACS chargers are likely to become more common as automakers adopt the NACS for non-Tesla vehicles. California's Advanced Clean Cars II rule, adopted by a myriad of other states, soon will require that non-CCS vehicles be equipped with a CCS adapter off the lot.
- ▶ As adapters become more common, regulations are needed to ensure that adapters meet safety standards, and to prevent the usage of unverified third-party adapters, which may create safety risk for EV drivers and their vehicles as well as impact charging session success rates. Organizations like UL, SAE and IEC should develop more robust safety standards for charging adapters that can be applied by third-party labs.



Standardize Vehicle Port Location

✓ Best Practices:

- ▶ Charging stations today must be designed to meet the needs of five different charging port locations on various vehicle models and sizes, meaning charging cables need to be longer—and therefore heavier—to meet all vehicles' charging needs.
- ▶ Heavier and longer cables are more likely to be dropped and damaged by EV drivers, increasing the need for repairs. They also require more materials, making them a target for vandalism and decreasing efficiency of charging. Greater standardization of port location across vehicle models, similar to internal gasoline fuel inlets, can simplify station design and improve customer experience, especially for drivers with disabilities.



Extend Preventative Maintenance to Components

✓ Best Practices:

- ▶ At a minimum, EVSPs should comply with the manufacturer's requested preventative maintenance schedule to ensure the resilience of their respective networks. However, manufacturer-provided preventative maintenance should be expanded to include specific components, such as cables, connectors, or retractors. The maintenance schedule should also closely align with the actual failure rates in the field for these components to ensure that they are proactively remedied.



Encourage Suppliers to Prioritize Replacement Part Availability to Support Shorter Repair Timelines

✓ Best Practices:

- ▶ The time needed to repair a charger depends greatly on whether any new parts are required, and subsequent inventory management to ensure such parts are available. Tracking the failure rates of parts helps to bolster the resilience of a network so that charging network providers and charging equipment manufacturers may predict how often a part might fail and stock inventory accordingly.
- ▶ In recent years, inventory management has been impacted by supply chain constraints and resulted in longer lead times for replacement parts. Manufacturers should focus on ramping up production to meet the growing demand.



Build Fault Tolerance and Resilience Into the Charging Process

✓ Best Practices:

- ▶ Today, there are multiple factors that can lead to unsuccessful first attempt charging sessions, and more will be discovered in the future of this complex process. Thus, it is best to monitor the process at the micro level to detect where issues arise, and whenever possible, correct them system wide. At a minimum, EVSPs should provide drivers with reasons for charging session initiation issues and steps to correct the error where possible.
- ▶ Examples of built-in fault tolerance and resilience include better detection of protocol timeouts or payment failures and development of auto-retry techniques to correct the issues without driver intervention.

