EV Charging Standards: A Co-op-Centered Guide to Safe, Efficient EVSE Deployments

NRECA Research

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Contents

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Executive Summary

Electric cooperatives across the United States are facing a surge in large, complex load requests—from electric vehicle supply equipment (EVSE) installations to commercial developments and data centers. These projects often come with accelerated timelines, placing new demands on utility workflows that were originally designed for slower, more predictable service applications.
As electric vehicle (EV) adoption grows, rural communities increasingly expect accessible, safe, and efficient charging options. Yet, EVSE deployment can be challenging due to unclear processes, complex interconnection requirements, and incompatible equipment—leading to costly delays and reduced member satisfaction.

To address these challenges, the U.S. Department of Energy **funded** the **REWIRED project** (Rural Electric Vehicle Infrastructure for Workforce, Innovation, Reliability, and Economic Development) in 2024. **Led by NRECA Research**, REWIRED equips co-ops with tools, guidance, and standardized approaches to streamline EVSE deployment, reduce costs, and improve operational efficiency. A central focus of the project is minimizing "soft costs" such as administrative delays, planning missteps, and inspection rework.

Standards are the foundation of safe, reliable, and interoperable EVSE deployment. For co-ops, understanding and applying these standards is essential to avoid stranded assets, ensure member satisfaction, and meet regulatory requirements. The REWIRED project emphasizes early alignment with key standards to streamline deployment and reduce rework. These include:

- **Safety and installation codes** (e.g., NEC Article 625, UL 2594)
- **Charging interface and communication protocols** (e.g., SAE J1772, ISO 15118, OCPP)
- **Grid integration and DER standards** (e.g., IEEE 1547, IEEE 2030.5)

This paper explores how aligning with these and other established EVSE standards can help co-ops reduce project risks, accelerate timelines, and ensure grid compatibility. It serves as a practical guide to leveraging EVSE standards to support safe, efficient, and future-ready electrification in rural America.

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Introduction

When confronted with electric vehicle supply equipment (EVSE) projects, ranging from single public chargers to megawatt-scale fleet depots, co-ops must interpret a dense landscape of technical standards, codes, and protocols. These requirements are not simply regulatory hurdles; they are the foundation for safe, interoperable, and future-ready charging networks.

The challenge for many co-ops is that EVSE standards span multiple domains, safety certification, electrical code compliance, charging interface compatibility, communication protocols, and distributed energy resource (DER) integration. Understanding which standards apply is only the beginning. Co-ops must also grasp how these standards interact, how they influence system design and member experience, and where early alignment can prevent costly redesigns or dissatisfaction. Co-ops face this challenge whether the EVSE is being installed and owned by the cooperative or by a 3rd party. When allowing other entities to connect EVSE to the system, compliance with codes and standards remains essential. A robust inspection program by qualified personnel is essential.

This paper organizes the most relevant EVSE standards into categories that directly map to the decisions co-ops make during each stage of the project lifecycle:

- **Project Planning & Member Coordination** – Select standards that ensure equipment compatibility, interoperability, and readiness for future needs (see *Charging Interface and Communication Standards (SAE)*, p. 4).
- **Design & Engineering** – Apply electrical safety codes and heavy-duty charging specifications to guide transformer sizing, feeder capacity, and site layout (see *Safety and Electrical Standards (UL)* and *Heavy-Duty Fleet Charging Standards*, p. 5 & 4).
- **Procurement & Vendor Engagement** – Reference standards that define safety certification and avoid vendor lock-in (see *Safety and Electrical Standards (UL)* and *Open Protocols*, p. 5 & 6).
- **Installation & Inspection** – Follow applicable codes and safety standards to streamline approvals and ensure compliance (see *Other Codes and Safety Standards (NEC, NFPA, UL)*, p. 7 & 5).
- **Operations & Grid Integration** – Implement communication and DER standards that enable smart charging, demand response, and bidirectional power flow (see *Communication and DER Integration Standards (ISO, IEEE, Open Protocols)*, p. 6).

By framing standards as actionable tools rather than abstract technical requirements, co-ops can more effectively coordinate with contractors, inspectors, and community partners. The result is not only faster and more predictable deployment, but also infrastructure that is safe, interoperable, and adaptable to future needs.

Charging Interface and Communication Standards (SAE)

EV Charging Standards: A Co-op-Centered Guide to Safe, Efficient EVSE Deployments

The Society of Automotive Engineers (SAE) develops many of the most widely used charging interface and communication standards for electric vehicles (EVs). These standards help ensure EVs connect to charging stations safely, efficiently, and with consistent performance across different makes, models, and charger types. For electric cooperatives, adopting SAE standards supports equipment compatibility, accommodates a range of member vehicles, and anticipates emerging technologies such as wireless charging and megawatt-scale fleet charging. By aligning with established specifications, co-ops may reduce installation and maintenance issues, streamline approvals, and make strategic investments that are prepared for future upgrades. The REWIRED project emphasizes these standards as a foundation for faster deployment, lower costs, and stronger member satisfaction.

Standard	Purpose	Co-op Impact	REWIRED Connection
SAE J1772	Standard plug for Level 1 and Level 2 charging in North America.	Most EVs use this plug, often called the "universal" plug.	Installing this plug type ensures co-op chargers work for most members.
SAE J3400 (NACS)	Tesla's charging standard, now adopted by many new EVs.	Co-ops may need to install stations with both J1772 and J3400 plugs.	Planning for both types avoids future upgrades and extra costs.
SAE J2954	Wireless charging standard: cars can charge by parking over a pad.	Emerging technology, likely to grow quickly in cities and fleets.	Co-ops planning future pilots or smart hubs should consider it early.
SAE J3068	Three-phase AC charging for large vehicles like buses or delivery trucks.	Helps co-ops support schools, city fleets, and large farms.	Knowledge of this standard enables better member guidance.
SAE J3105	Fast DC charging with an automatic connection.	Makes charging safer and faster for heavy-duty fleets.	Helps co-ops plan for large fleet depots.
SAE J3271 – Megawatt Charging for Class 8 Trucks	Designed for fast, high-power charging of large trucks, including long-haul Class 8 freight vehicles; requires megawatt-scale chargers.	Co-ops serving highways, logistics hubs, or rural freight corridors may need stronger substations and upgraded transformers.	Supports REWIRED's goal of future-proofing grid systems; helps forecast needs and avoid costly rework.
SAE J3072 – Vehicle-to-Grid (V2G) Interconnection	Governs how EV inverters connect to the grid for two-way power flow; ensures EVs can safely return electricity to the system during peak times.	Required for safe operation of bidirectional chargers; supports smart charging, demand control, and energy sharing.	Supports grid flexibility and load management; prepares co-ops to use EVs as mobile energy resources. **Note:** IEEE 1547 also applies at the grid point of interconnection for broader safety and performance requirements.
SAE J3105 – Overhead Conductive Charging	Guides planning for municipal and school bus electrification in rural service territories.	Helps co-ops prepare for transit and fleet electrification by understanding infrastructure and clearance requirements for overhead systems.	Supports REWIRED's focus on planning for heavy-duty and transit fleet charging; promotes early consideration of site design, safety, and operational needs

Safety And Electrical Standards (UL)

EV Charging Standards: A Co-op-Centered Guide to Safe, Efficient EVSE Deployments

Underwriters Laboratories (UL) develops safety standards that play a critical role in ensuring EV charging equipment operates reliably and without risk to people, property, or the electric grid. For electric cooperatives, using UL-tested and certified equipment may reduce the risk of installation delays, mitigate exposure, and improve approval timelines by meeting inspection requirements from the start. These standards also help co-ops make consistent, informed procurement decisions and plan for both current and emerging charging technologies. The REWIRED project highlights the following UL standards as especially relevant for safe, efficient, and future-ready EVSE deployment.

Standard	Purpose	Co-op Impact	REWIRED Connection
UL 2202 – DC Fast Charger Safety	Covers the safety rules for DC fast chargers (Level 3), which deliver high power and charge vehicles quickly.	Essential for co-ops installing fast chargers on public roads or busy travel corridors; helps ensure stations are safe and easier to approve.	Supports development of reliable, grant-ready charging sites where speed and safety are priorities.
UL 2251 – EV Connectors and Plugs	Sets the safety rules for plugs, connectors, and receptacles used in EV charging.	Helps co-ops select the right hardware; ensures all components are tested and safe, reducing risk of mismatch or breakage	Simplifies procurement and ensures every component complies with safety regulations.
UL 2750 – Wireless Charging Safety	Addresses safety requirements for wireless EV charging systems that do not require cords or plugs.	Although still emerging, awareness of this standard can inform early planning and reduce risks in pilot or urban deployments.	Supports safe testing of new charging options, allowing co-ops to explore wireless charging within established safety parameters.
UL 9741 – Bidirectional Charging (V2G/V2H)	Sets the safety rules for chargers that send power back to the grid (V2G) or home (V2H).	Required for two-way chargers to ensure energy flows are safe and controlled.	Aligns with support for distributed energy resources (DERs) and prepares co-ops to integrate EVs into innovative grid strategies.

Communication and DER Integration Standards (ISO, IEEE, Open Protocols)

Communication and distributed energy resource (DER) integration standards establish how EV charging equipment interacts with both the electric grid and management systems, including bidirectional V2G applications. These protocols define authentication, data exchange, control signals, and interoperability, ensuring that chargers can connect securely and respond effectively to utility or market needs. For electric cooperatives, these standards may improve member experience, enable demand response, and support grid stability—especially as EVSE deployment expands in rural areas. The REWIRED project highlights the following standards as key to building flexible, future-ready charging networks.

Standard	Issued By	Purpose	Co-op Impact	REWIRED Connection
ISO 15118	International Organization for Standardization (ISO)	Enables "plug and charge," allowing EV drivers to connect and begin charging without cards or apps.	Simplifies the charging process for members and improves convenience.	Supports improved public access to EV charging in rural areas.
IEEE 1547	Institute of Electrical and Electronics Engineers (IEEE)	Establishes how DERs, including bidirectional EVSE, connect to the grid.	Allows EVSE to assist with grid load balancing.	Supports intelligent load control and managed charging goals in V2x applications where the EV battery is supplying power back to the grid
IEEE 2030.5	—	Enables secure two-way communication between EV chargers and the grid.	Provides real-time control and grid updates.	Helps co-ops develop responsive and adaptable systems.
Open Charge Point Protocol (OCPP)	Open Charge Alliance	Open-source communication language linking EVSE to network management platforms.	Enables vendor choice and helps manage costs.	Prevents vendor lock-in and supports EVSE data collection.
OpenADR	—	Sends pricing or load control signals during high-demand periods.	Supports demand flexibility	Assists in managing grid stress through EVSE coordination.

Other Codes and Safety Standards (NEC, NFPA, UL)

EV Charging Standards: A Co-op-Centered Guide to Safe, Efficient EVSE Deployments

Depending on your state, certain codes and safety standards may be required for EVSE installation and operation. These requirements, developed by the National Fire Protection Association (NFPA) and Underwriters Laboratories (UL), set the baseline for safe, code-compliant charging equipment. While UL listing ensures equipment meets safety benchmarks, installation must follow both the manufacturer's listing instructions and applicable code requirements to maintain compliance and safety. It is also important to note that the NEC governs customer-side installations, while the NESC applies to utility-side infrastructure. Coordination between utility engineers and local inspectors is essential to ensure compliance across both domains. For electric cooperatives, following these standards may improve safety, speed inspections, mitigate risk, and ensure projects meet regulatory and insurance requirements. When EVSE is owned by a third party, insurance coverage and liability responsibilities should be clearly defined to protect both the co-op and the provider. The REWIRED project emphasizes these standards as essential for consistent, safe, and grant-ready EVSE deployment across co-op territories.

Standard	Issued By	Purpose	Co-op Impact	REWIRED Connection
NEC Article 625	National Fire Protection Association (NFPA)	Governs the installation of EVSE, including wiring methods, load calculation, branch circuits, and overcurrent protection.	Foundational electrical code for all EVSE including bidirectional V2G applications; compliance ensures safety and mitigates risk.	Standardizing to NEC 625 may reduce inspection delays and rework during EVSE deployment.
UL 2594	Underwriters Laboratories (UL)	Defines the safety requirements for EV charging stations.	UL-listed EVSE meets national safety benchmarks, reduces risk, speeds approvals, and builds member trust.	Supports consistent procurement processes across co-ops.
UL 2231	Underwriters Laboratories (UL)	Provides personnel protection requirements for EVSE to prevent electric shock.	Critical for public charging installations, especially in unattended locations.	Helps co-ops select systems that meet public-use safety expectations.
UL 3141	Underwriters Laboratories (UL)	. Ensures power control systems often used in EVSE and other DER applications operate safely, reliably, and efficiently.	Supports system stability during high-use periods, reducing outages and improving energy flow.	Aligns with REWIRED's goal of developing flexible systems that adapt to changing loads and maintain power reliability.

International and Global Equipment Standards (IEC)

International standards provide a common technical language and framework for EVSE design, installation, and performance. They are especially valuable when sourcing equipment from multiple vendors, coordinating with international manufacturers, or planning for technologies that are still emerging in the global market. For electric cooperatives, these standards may support compatibility, improve long-term planning, and enhance system reliability. The REWIRED project highlights the following standards for their relevance in building resilient, flexible, and globally compatible charging infrastructure.

Standard	Issued By	Purpose	Co-op Impact	REWIRED Connection
IEC 61851	International Electrotechnical Commission (IEC)	Defines EV charging modes, connector types, cable specifications, and installation requirements.	Provides a global standard that aids in working with international vendors and supports planning for future upgrades.	Helps co-ops source equipment internationally and collaborate with vendors outside the U.S.
ISO 15118	International Organization for Standardization (ISO)	Enables “plug and charge,” allowing EV drivers to connect and begin charging without cards or apps.	Simplifies the charging process for members and improves convenience.	Supports improved public access to EV charging in rural areas.

How Standards Reduce Soft Costs and Deployment Days

Applying the right EVSE standards from the start may streamline every stage of a project, helping co-ops avoid delays, reduce rework, and lower overall costs. Clear standards provide a common framework for engineers, contractors, inspectors, and vendors—allowing projects to move from design to operation with fewer interruptions.

During the interconnection and grid approval phases, standards such as NEC 625 and IEEE set expectations for safe wiring, load calculations, and DER integration where bidirectional charging is utilized. If the plans meet these requirements from the start, utility reviewers and inspectors may speed approvals and minimize back-and-forth with utility reviewers and inspectors, avoiding costly redesigns.

In equipment procurement, UL safety standards (e.g., UL 2594, UL 2231, UL 2202, UL 2251) and SAE charging interface standards (e.g., SAE J1772, SAE J3400) ensure chargers meet national safety benchmarks and work with the majority of EVs on the market. SAE charging standards make sure that EV plugs and systems match common vehicle models. This avoids buying hardware that doesn't work or is complex to install.

Load planning and infrastructure sizing benefit from standards like SAE J3068 and SAE J3105, which address medium- and heavy-duty vehicle charging. These specifications help co-ops accurately size transformers, feeders, and substations, avoiding overload issues or unplanned upgrades.

For communication and control, protocols like ISO 15118, OCPP, IEEE 2030.5 and OpenADR define secure, interoperable data exchange between chargers, grid operators, and management platforms. They enable load control, pricing signals, and remote monitoring. This is especially helpful when co-ops want to offer smart charging or manage grid stress during peak hours.

Safety reviews and inspections may proceed more smoothly when installers use UL-approved equipment with labels like UL 2594, UL 2231, UL 3141, and UL 2202. Inspectors check for these labels. If everything is certified, the inspection may pass without delay. This also builds trust with members who want to know the EVSE equipment is safe.

Even member education and engagement can be simpler when co-ops follow SAE J1772 or NACS plug standards. These are common plugs that most drivers know. People are more likely to use a charger when it feels familiar and easy.

For basic EVSE installations, where the charger only supplies power to the vehicle, standards like NEC 625 provide essential guidance on safety and installation requirements. However, when bidirectional power flow is introduced through V2G applications, additional complexity arises. These systems require more rigorous study and coordination, as they involve energy flowing from the vehicle back to the grid.

In V2G scenarios, standards such as IEEE 2030.5, SAE J3072, and UL 9741 support communication protocols and safety requirements for bidirectional operation. IEEE 1547 specifically applies to the point of interconnection with the grid and is only relevant when the EVSE supports V2G functionality.

When co-ops integrate these standards early in the process, each phase, from design through operation, may require fewer site visits, involve fewer change orders, and receive better vendor support. This approach aligns with the REWIRED project's mission to help co-ops deliver EVSE projects faster, more cost-effectively, and with greater reliability. Inspection by qualified personnel prior to interconnection is essential whether the EVSE is owned and maintained by the cooperative or by a third party.

REWIRED A DOE Initiative

REWIRED (Rural Electric Workflow Improvements for Rapid EVSE Deployment) is a three-year, $2-million initiative funded by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (June 2024–May 2027) to help rural electric cooperatives streamline EV charging station deployment by reducing soft costs—the hidden, non-hardware expenses that arise during planning, interconnection, permitting, and inspections.

A central strategy is early and consistent use of established EVSE standards to prevent rework, shorten approval timelines, and ensure safety, interoperability, and grid readiness. These include codes like NEC Article 625 and UL safety certifications (UL 2594, UL 2231, UL 2202) that inspectors and insurers require; connector and interface standards from SAE (J1772, J3400, J3068, J3105, J3271) that ensure compatibility across vehicle types; and communication protocols such as ISO 15118, OCPP, IEEE 2030.5, and OpenADR that enable secure, flexible, and utility-integrated charging.

The program's two core tools—a standardized guidebook and an interactive dashboard—help co-ops integrate these standards into every project phase, from application and design through installation and operation. A Cooperative Advisory Board with representatives from all 10 NRECA regions ensures that these tools reflect real-world co-op needs and lessons learned.

By aligning processes with recognized standards, REWIRED enables faster, safer, and more cost-effective EVSE deployment, improves member satisfaction, and positions rural co-ops to meet future charging demands—from residential Level 2 stations to megawatt-scale fleet depots—without costly retrofits or operational setbacks.

Conclusion

Electric vehicle growth is reshaping transportation across the country. Rural electric cooperatives are now expected to support this shift by providing reliable and accessible charging options. The process, however, involves more than placing chargers on the ground. It requires careful planning, strong technical understanding, and coordination with utility systems. Mistakes in early planning may lead to delays, safety issues, and higher project costs.

The REWIRED project, supported by the U.S. Department of Energy, was designed to guide co-ops through this process. It helps reduce soft costs and avoid common problems by promoting the use of proven standards. These include safety codes, electrical design rules, charging connector types, and communication protocols. Each standard serves a purpose—some protect people and equipment; others ensure future grid integration or support large fleet charging. Using these standards early in the process helps avoid unnecessary rework, makes inspections faster, and supports better vendor choices. It also builds the public trust by ensuring the final product is safe and reliable. For more information on the standards discussed, see Appendix A: Additional Resources

APPENDIX A: Additional Resources

To support deeper technical understanding, members and co-op engineers can explore the following organizations' sites. These sources provide code access, working group updates, and implementation guides.

IEEE 1547 – IEEE Standards Association – https://standards.ieee.org/standard/1547-2018.html
IEEE 2030.5 – IEEE Standards Association – https://standards.ieee.org/standard/2030_5-2018.html
IEEE Standards Association – standards.ieee.org
ISO 15118 – International Organization for Standardization – https://www.iso.org/standard/55366.html
NEC Article 625 (NFPA) – https://www.nfpa.org/news-blogs-and-articles/blogs/2024/05/13/importance-of-using-the-latest-nec-for-ev-charger-installations
NFPA (National Fire Protection Association) – www.nfpa.org
OCPP – Open Charge Alliance – https://openchargealliance.org/my-oca/ocpp/
Open Charge Alliance (OCPP) – www.openchargealliance.org
SAE International – www.sae.org
SAE J1772 – SAE International – https://www.sae.org/sae-j1772-electric-vehicle-adapter-and-plug-standard
SAE J2954 – SAE International – https://www.sae.org/standards/content/j2954_202010/
SAE J3068 – SAE International – https://www.sae.org/standards/content/j3068_201804/
SAE J3105 – SAE International: https://www.sae.org/standards/content/j3105_202001/
UL 2594 – UL Solutions – https://standardscatalog.ul.com/standards/en/standard_2594
UL Standards – www.ul.com

Appendix B: Glossary of Acronyms

Acronym	Meaning
AC	Alternating Current
Acronym	Meaning
DC	Direct Current
DER	Distributed Energy Resources
DOE	U.S. Department of Energy
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment
IEC	International Electro Technical Commission
IEEE	Institute of Electrical and Electronics Engineers
ISO	International Organization for Standardization
J1772	SAE Standard for Level 1 and Level 2 EV charging plugs
J3068	SAE Standard for 3-phase AC charging
J3072	SAE Standard for bidirectional EV-grid interconnection
J3105	SAE Standard for automated DC fast charging
J3271	SAE Standard for megawatt charging of Class 8 trucks
NACS	North American Charging Standard (also known as SAE J3400)
NEC	National Electrical Code
NFPA	National Fire Protection Association
NRECA	National Rural Electric Cooperative Association
OCPP	Open Charge Point Protocol
OpenADR	Open Automated Demand Response
REWIRED	Rural Electric Workflow Improvements for Rapid Electric Vehicle Supply Equipment Deployment
SAE	Society of Automotive Engineers
UL	Underwriters Laboratories
V2G	Vehicle-to-Grid
V2H	Vehicle-to-Home

APPENDIX C: REWIRED Annotated Bibliography

REWIRED. “Rural Electric Workflow Improvements for Rapid Electric Vehicle Supply Equipment Deployment.” Cooperative.Com, July 3, 2024. https://www.cooperative.com/programs-services/bts/research/rewired/Pages/default.aspx.