Charger reliability best practices

Implementing solutions that meet EV driver expectations by supporting charger operational goals.

EV charging has a reliability challenge The uncomplicated solution may surprise you

With unprecedented investment in public EV charging infrastructure, we can't afford to waste any time when implementing solutions that meet driver and stakeholder expectations.

For many, the electric vehicle (EV) charging experience is not what it should be, with some charging stations often not working as expected. A charger can be "down" for a number of reasons, including, for example, payment failure, broken cable, software failure, vandalism, or the vehicle and charger not communicating with each other. While some of these issues are attributable to the relative newness of the industry, the solutions have been tested and validated for many years in other industries. We can't afford to waste any time in implementing these solutions and meeting driver and stakeholder expectations.

At ABB, we have been helping critical industries keep their facilities running for decades, from data centers, to hospitals, and water treatment facilities. In these scenarios, reliability and uptime are paramount and are more than aspirational - they are requirements. There are a number of best practices from these industries that can be applied to EV charging operations in order to meet or exceed 97% uptime. We encourage all those in the EV charging industry to consider and implement key best practices while deploying chargers.

Before exploring some of these best practices, it is important to acknowledge that reliability is also heavily impacted by factors beyond just the chargers. For example, high quality networking software and operational plans, based on OCPP are integral; along with ensuring interoperability testing of vehicles, chargers, and OCPP software networks. During the below section on "Beyond the charging hardware," we will explore the impact these types of variables can have on charger reliability.

Keys to charger reliability and uptime

1. **Round the clock connectivity** with remote diagnostics capabilities and monitoring as well as remote updates and upgrades
2. Advanced planning for **preventive maintenance and corrective service** programs to support high uptime
3. **On-call support** from **hardware-OEM trained technicians** within every charging site region
4. **Availability of spare parts** including a warehousing plan for routine and critical parts can support faster service

Best Practices for charger reliability and uptime

- **24/7 Remote monitoring and diagnostics**
  Connectivity, monitoring, and diagnostics are critical to enable uptime by allowing for firmware updates, proactive discovery of failures, remote diagnosis, and in many cases remote repair.

- **Preventive maintenance and corrective services**
  EV chargers are not "set-it-and-forget-it-infrastructure." Preventive maintenance and swift resolution of identified issues are necessary practices to reduce downtime.

- **On-call support from trained technicians**
  Complex infrastructure, like EV chargers, requires that repairs be performed by geographically proximate technicians who have been trained and certified by the original equipment manufacturer.

- **Availability of spare parts**
  Whether it's a consumable part, like a charging cable, or a warrantied item like a control board, uptime can often hinge on the availability of spare parts. Sufficient warehousing of routine and critical spare parts can support improved uptime.

Service Level Agreements: The "great enabler" of reliability and uptime

Service Level Agreements (SLA) are a foundational tool used across many industries to implement these best practices and ensure reliability and uptime. SLAs set a contractually agreed process and procedure between the EV charger manufacturer and the owner or operator of the charger to prevent, address and resolve issues.

SLAs can take many forms to meet a variety of EV charging business models. For example, the charger owner, operator (CPO), or Open Charge Point Protocol (OCPP) network provider could choose to:

1. Become authorized and trained by the charging manufacturer to perform all maintenance and corrective services - and/or -
2. Contract with a third-party service provider that is already authorized and trained by the charging manufacturer to perform all maintenance and corrective services - and/or -
3. Contract directly with the charging manufacturer to perform maintenance and services.

Collaborative service training models

Direct service training
The charger owner/operator is directly trained and authorized by the charger manufacturer to perform maintenance and service.

Third party service training
The charger owner/operator selects a third-party service provider that's trained and authorized by the charger manufacturer.

Contract directly with manufacturer
The charger owner/operator works directly with the charger manufacturer to have experts perform maintenance and service.

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An SLA sets a contractually agreed process and procedure between the EV charger manufacturer and the owner or operator of the charger.

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Maintaining a strong connection between the charger manufacturer and the teams overseeing the day-to-day function of the charger is critical to maximizing charger reliability.

The consistent theme among these models is that maintaining a strong connection between the charging manufacturer and the teams overseeing the day-to-day function of the charger is critical to maximizing charger reliability. SLAs can serve as the foundation for this connection and should include, at minimum, the best practices mentioned here.

24/7 connectivity
24/7 connectivity can deliver remote diagnostics, monitoring, user access control, robust data delivery, and upgrades. These services are key for monitoring and maintaining reliability. To minimize downtime, operators should have access to real-time status information and usage statistics for their network of chargers. So, if something does go wrong, they can take quick action.

The most reliable charging programs will have remote services that include remote software updates as well as diagnostics and troubleshooting. With robust remote solutions, charging operators can have up to 90% of their service cases diagnosed remotely and over 75% of the cases resolved without an on-site visit, substantially reducing downtime and costs. Additionally, remote update capabilities also help operators stay up to date with the latest charging protocols that support vehicle-side and network-side interoperability.

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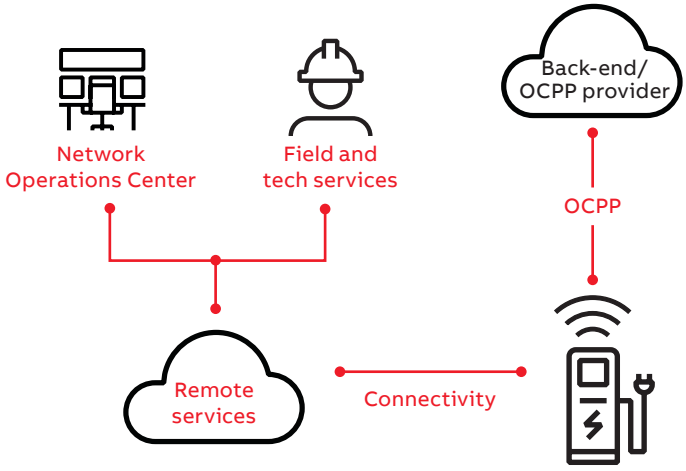
Preventive Maintenance and Corrective Services
There are three main components of a preventative and corrective service program. First, preventive maintenance should be scheduled at regular intervals beginning with the commissioning date of every charger. To maximize uptime, this work should be completed by a service technician authorized by the charging manufacturer according to product maintenance schedules. This service should include at a minimum, a visual inspection of internal and external components, an air filter change and unit testing. A trained service technician will also advise on necessary or recommended repairs to help avoid major issues that could lead to long periods of downtime.

Connected services support remote services



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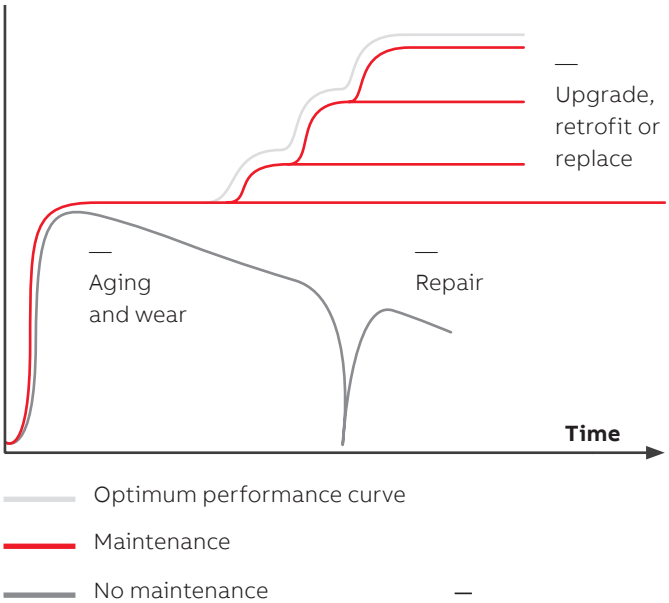
Connected Services
ABB E-mobility connectivity solutions link EV chargers to back-end systems as well as robust service tools.

Preventive maintenance and charger life cycle performance



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Life cycle performance
Preventive maintenance programs are designed to provide reliability and optimum performance, as represented by the horizontal red line.

If preventive maintenance is neglected, performance and reliability deteriorate mainly through component aging and wear, as shown by the downward gray line.

— 24/7 REMOTE SERVICES

— TRAINING AND CERTIFICATION

— PREVENTIVE MAINTENANCE

— SERVICE LEVEL AGREEMENTS

— PARTS & STOCK AVAILABILITY

Second, when issues are identified, or an unexpected problem occurs, one should have an established service ticketing, escalation and tracking system for effective communications between teams. As charging networks continue to expand, the ability to clearly track open issues and ongoing maintenance activity is of increasing importance. This should be complemented with detailed documentation and procedures to troubleshoot and repair chargers to ensure actions are consistent across entire networks and varied service technicians.

Third, in the rare case that a broader-scale issue is identified, having the capability to execute detailed service campaigns hand-in-hand between owner, operator and manufacturer across an entire network can be the difference between extended periods of downtime and consistent reliability. As charging infrastructure continues to rapidly evolve and installation timelines quicken, charging owners and operators should strongly consider their hardware partner's ability to quickly respond and resolve large scale challenges.

On-call support from trained technicians
The first line of defense against downtime is a 24/7/365 service call center, to support remote service or repair requests.

Once the request to service a charger is received, the priority shifts to ensuring knowledgeable technicians trained on the correct make and model of the charger are dispatched. Different charging manufacturers use different technology architectures making generic training insufficient. Trained technicians can prevent significant problems down the road and ensure chargers are repaired in compliance with manufacturer requirements, upholding warranty.

Training delivered by the charging manufacturer helps achieve maximum performance by ensuring that charger design, safety, and service knowledge is shared with all personnel responsible for maintaining the chargers. Training should be customizable to meet the needs and experience of different charging owners, operators and OCPP networks.

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Spare parts, storage and availability
Sufficient warehousing of spare parts is required for charging operators to provide a reliable charging experience. An SLA will determine what parts will be stocked by the manufacturer versus what should be stocked by the owners and operators. To ensure the highest uptime and availability of chargers, operators should stock routine and critical wear and tear parts, as well as those with long lead times. In addition to local stock and warehousing, strong logistical infrastructure is required to get the needed parts quickly and economically to the charger location.

Beyond the charging hardware
Many non-charging hardware variables can impact operational performance as well as the overall driver experience. For example:

- **Experienced and qualified installers**
  Selecting a qualified installer with electricians who are trained and certified to work on high power industrial electrical equipment may affect ongoing quality of operations.
- **Experienced Network Software Provider (OCPP)**
  Selecting a network software provider that has a proven track record with payment integration across various hardware providers and a commitment to network interoperability across authentication modes, financial layers and other protocols.
- **Well thought out site design**
  The quality of experience for EV charging infrastructure users begins early in site discussions about parking space placement to accommodates all vehicle types and charging port locations. Site reliability can also be better supported through comfort and safety strategies such as shelter, lighting, and cameras which are attractive to drivers while discouraging acts of vandalism over time.
- **Connectivity at sites**
  Sites need to be assessed for their ability to facilitate cellular communications and evaluate whether repeaters or other digital communications strategies need to be considered.
- **Hardware and network Interoperability**
  Open charging standards provide a blueprint for the entire EV industry to grow at scale and build successful infrastructure business models. The driver experience at charging sites is more reliable when vehicle makers, charging hardware companies, OCPP networks and charging operators work collaboratively early in their developmental planning to support every EV with charging systems that work together seamlessly.

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Recommendations
For charging infrastructure stakeholders

For government agencies and policy makers
Unprecedented investments in EV charging infrastructure by all levels of government are sparking state and local governments to collaborate to deploy charging infrastructure. To ensure a successful program, agencies responsible for deploying funds should heavily favor an applicant's ability to effectively meet uptime requirements, like the National Electric Vehicle Infrastructure (NEVI) target of 97%.

Funding agencies should require that applicants submit 5-year operations and maintenance plans. These plans should be evaluated on whether they credibly implement the best practices mentioned above. As part of that evaluation, funders should look for proof of an SLA backed by the charging manufacturer or an equipment-trained and authorized service provider. Without these basic capabilities, achieving reliability and high uptime would likely be elusive.

For charging owners and operators
As charging owners and operators assess their options for charging partners, they should strongly consider the ability of technology providers to not only provide superior charging solutions (hardware and software), but also offer and stand behind a robust SLA.

The success of a charging installation and the ultimate return on investment is dependent on a reliable and efficient charging experience. With NEVI and other incentive programs in mind, the ability to provide reliable charging is not only necessary to drive revenue, but required to avoid government fines and other costly penalties. Owners and operators should consider whether their charging technology provider is capable of helping them achieve the highest possible uptime by requesting evidence that they've implemented the best practices discussed herein.

Conclusion
Implementing high functioning and customer satisfying charging infrastructure is a holistic effort from the very first planning conversations through the entire charging site lifecycle. This not only includes procuring the right pieces of the puzzle, but establishing relationships among the providers of hardware, software and services with the goal of a more collaborative operational model.

By thinking proactively about reliability and implementing SLAs that establish agreed upon processes and procedures for resolving issues before they happen, the entire industry can deliver the charging experiences that drivers expect and deserve.

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[i] https://highways.dot.gov/newsroom/president-biden-usdot-and-usdoe-announce-5-billion-over-five-years-national-ev-charging

SUMMARY

Reliable charging infrastructure is critical to the growth of e-mobility and a zero-emission future.

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