cool the earth

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EV DC Fast Charge (DCFC) Infrastructure: Recommendations for Reliability and User Experience

Cool the Earth is currently working on updated recommendations for the NEVI Proposed Rule Making and will provide updates on this website on Aug 22, 2022.

Cool the Earth, a nonprofit organization, has worked for over 8 years to educate consumers about clean electric driving and currently leads a national non-profit collaborative effort, Ride and Drive Clean. Cool the Earth has extensive user-focused experience with public charging including DC Fast (DCFC), working with thousands of members of the public as well as with cities, agencies, NGOs, utilities and CCAs. Unfortunately, our constituents frequently have encountered inoperable kiosks, charging cords that cannot reach vehicle charging inlets, payment systems that do not work and other issues that prevent successful charging.

Widespread Anecdotal Reporting, Driver Surveys, New Reliability Study
There are widespread anecdotal stories from EV drivers regarding failures of public charging. Recent consumer surveys including a survey from the California Air Resources Board found drivers report a high rate of failures at stations.

Cool the Earth recently funded and collaborated with a UC Berkeley Professor Emeritus from the School of Engineering to design and perform a systematic field study[1] of every open-system DCFC plug in the Bay Area. Of the 657 plugs tested 27 percent were not functional. The study has been submitted to a peer-reviewed journal.

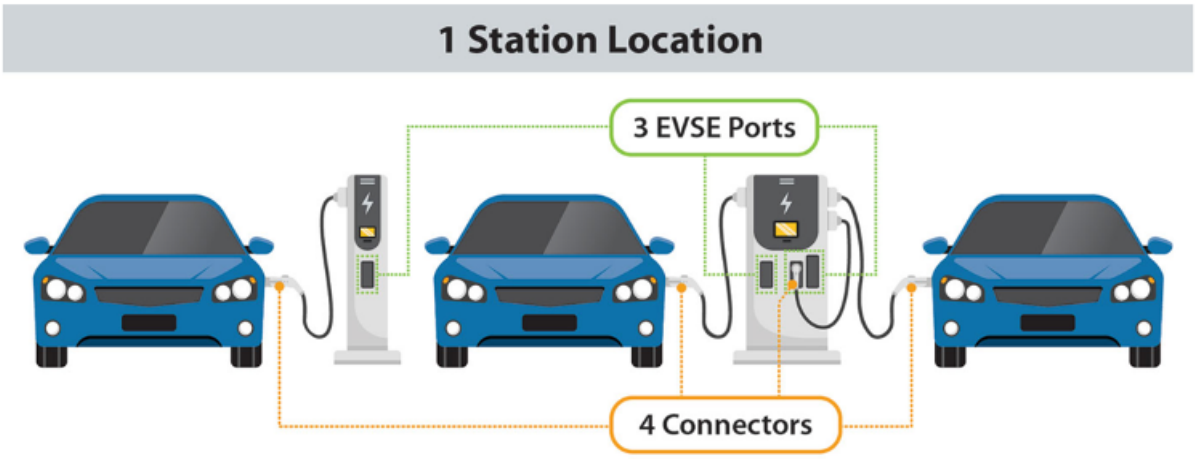
Top Priority Recommendations
Reliable and accessible DCFC is essential for drivers to make the transition into electric vehicles. This is especially the case for those who live in multi-family dwellings and in disadvantaged communities who may not be able to charge at home.

With these comments, we recommend specific requirements for design, performance, and service of stations that are subsidized with public funds. These requirements must be enforceable conditions of funding agreements with consequences for non-compliance. Reliability must be calculated with specific minimum definitions for uptime and downtime at a national level. We recommend that new funding contracts consider the reliability of the current installed charging stations when scoring grants. We also recommend that a final grant payment should be withheld until all conditions have been met. Success must be measured by meeting the expectations of EV drivers, who expect a seamless experience, and by reliable operation of EV charging infrastructure, and not only by a qualitative metric.

[1] [2203.16372] Reliability of Open Public Electric Vehicle Direct Current Fast Chargers

A. Definitions

Cool the Earth recommends adopting consistent language, as listed below. These definitions follow the terminology used by the National Renewable Energy Laboratory Alternative Fueling Station Locator.



Station: A site with one or more EVSE ports at the same address. Examples include a parking garage or a mall parking lot.

Port: An EVSE port provides power to charge only one vehicle at a time even though it may have multiple connectors.

Kiosk (post): The structure that houses one or more EVSE ports.

Connector: a connector is the item at the end of the cable that plugs into a vehicle to charge it. Multiple connectors and connector types (such as CHAdeMO and CCS) can be available for one EVSE port, but only one vehicle will charge at a time.

EVSE: an EVSE charger refers to the equipment used to charge a single electric vehicle, including the electrical conductors, related equipment, screen, payment system, cable, connector, software, and communications protocols that deliver energy to a single vehicle. If a kiosk can charge only one EV at a time, it comprises one EVSE. If a kiosk can charge 2 EVs at the same time, it comprises two EVSEs. This includes hardware and software, but does not include infrastructure upstream from the charger (e.g. the electricity grid, cellular and WiFi).

B. EV Charging Station Design

Charging stations must be designed to provide comfortable and safe user experiences.

- The kiosk and parking spot shall be covered to protect EV drivers and the kiosks from the elements.

- The station shall be monitored 24 hours per day
- Adequate lighting shall be provided per IES guidelines
- At least one kiosk at each station shall be accessible according to relevant ADA requirements
- The charging cable shall have a retraction line to support the weight of the cable
- The screen legibility and touch input shall follow similar product usability guidelines (e.g., bank ATM Design Guidelines).
- Parking shall be designed per local code requirements and shall accommodate a full size EV without the vehicle intruding into the drive lane, with adequate space on both sides for easy access.
- The cable shall be long enough to reach the EV inlet ports of all EVs
- For stations along designated Alternative Fuel Corridors, at least one kiosk must be drive-through to allow charging of long vehicles or EVs towing trailers.

C. EVSE Reliability

In order to achieve a rapid transition to electric vehicle driving, a highly reliable and easy to use charging infrastructure is critical to building confidence as consumers shift from using familiar gas vehicles to unfamiliar electric vehicles. Unfortunately, consumers currently experience frequent barriers to charging. For instance, in a survey (CARB 2022[2]) EV drivers reported experiencing broken plugs, unexpected shut off during charging, charging station not functioning, payment problems, and the need to contact customer service via cell phone. This experience appears to contradict a simultaneous survey of the EV service providers (EVSPs) who reported 95 to 98 percent uptime of their public chargers.

Cool the Earth's recent study, in collaboration with UC Berkeley, also found similar poor performance of DCFC.[3] Of the 657 open public DCFC CCS EVSEs evaluated in the greater Bay Area, 72.5 percent were functional at the time of testing while 27.5 percent were either not functional or the cable was too short to reach the EV inlet. The most common cause of a nonfunctional EVSE was an electrical systems failure which included an unresponsive or unavailable screen, a payment system failure, a charge initiation failure, a connection failure, or a broken connector.

Recommendations for Reliability and Functionality

To ensure a reliable and functional DCFC charging infrastructure, Cool the Earth recommends that publicly-funded EVSE meet a minimum of (1) a 97 percent uptime guarantee at the individual EVSE level for a minimum of five years and (2) a 97 percent functionality based on field testing.

A 97 percent uptime guarantee or higher has already been established in public or ratepayer funded programs across North America:

- The Federal Highway Administration's National Electric Vehicle Formula program requires a greater than 97 percent uptime guarantee at the individual station level .[4]

[2] https://ww2.arb.ca.gov/sites/default/files/2022-02/EVSE%20Standards%20Technology%20Review%204Feb22.pdf
[3] https://arxiv.org/abs/2203.16372
[4] FHWA 2022. The National Electric Vehicle Infrastructure Formula Program Guidance, US DOT Federal Highway Administration, February 10, 2022, p.22
https://www.fhwa.dot.gov/environment/alternative_fuel_corridors/nominations/90d_nevi_formula_program_guidance.pdf

- The New York State Energy and Research Development Authority requires 97 percent uptime for its DCFC grant program.[5]
- ConEdison's Make Ready EV Program requires 99 percent uptime for DCFC EVSE.[6]
- Louisville Gas & Electric requires 99 percent uptime for DCFC EVSE.[7]
- Florida Power & Light requires 98 percent uptime for both Level 2 and DCFC EVSE in an RFP.[8]
- CEC's EV charging grant solicitations for multi-family housing and rural communities.[9]
- The Regional Electric Vehicle Plan for the West recommends a 97 percent uptime requirement for charging stations.[10]
- The Northeast States for Coordinated Air Use Management recommends a 99 percent uptime requirement for DCFC EVSE.[11]

Uptime guarantees ensure EVSEs are online and operational for drivers when they need them, minimizing consumer frustration and maximizing the public benefit provided to drivers from EVSE funded by public dollars. When an EVSE is not operational, this public benefit is not delivered. For these reasons, it is critical that publicly-funded EVSE adhere to clearly defined uptime guarantees and that these requirements are enforced.

D. Calculating and Reporting of Uptime

Uptime guarantees must be measured and enforced through a standardized uptime data reporting framework. Collecting reliability data is the only way to understand the performance of publicly funded charging stations, whether reliability is a problem, and to what extent it is a problem.

In developing reliability reporting requirements, excluded time should be minimized. Excluded time hides operational issues that are very real for EV drivers. These issues need to be acknowledged and solutions found, not ignored.

The ability to report uptime necessarily requires that needed data is available and collected continuously for each EVSE by the EVSP. As such, each government entity funding EVSE installation should require 24/7/365 connectivity and monitoring of the operations of each charger, with a penalty for non-compliance. Reliability data should be reported quarterly to the funding agency for a minimum period of 5 years. All reliability analysis should be published for public stakeholder review and assessment.

We recommend the following definitions and implementation of calculating and reporting reliability data.

Uptime: the percent of time, net of allowable excluded time, that the EVSE is operational and charging can be sustained until either the battery is charged to the vehicle limit or the customer ends the charge.

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[5] NYSERDA PON 4509, Page 11

[6] Consolidated Edison Company of New York, Inc. *Electric Vehicle Infrastructure Make-Ready Program Implementation Plan*. September 2020. Page 7

[7] Louisville Gas and Electric. *Direct Current Fast charger Project Requirements*. 2021. Page 5

[8] Florida Power & Light. *Electric Vehicle Supply Equipment Request for Proposal: Scope of Work*. 2021. Page 5

[9] https://www.energy.ca.gov/solicitations/2021-11/gfo-21-603-reliable-equitable-and-accessible-charging-multi-family-housing

[10] https://www.naseo.org/Data/Sites/1/revwest_volminimumstandards.pdf

[11] NESCAUM. Building reliable EV charging networks: Model state grant and procurement contract provisions for public EV charging. Northeast States for Coordinated Air Use Management. Boston, MA. May 2019. https://www.nescaum.org/documents/model-contractprovisions-for-public-evse-5-24-19.pdf/

Uptime should be calculated and reported for each EVSE. Uptime calculations at the EVSE level are necessary to provide the needed detailed understanding of reliability and identify user experience with troublesome EVSEs.

A standardized formula to calculate uptime, such as the one below, is necessary to provide accurate and consistent information.

> EVSE Uptime (UT) % = 100* ((Hrs in the period - Excluded time) - (Downtime - Excluded time))/(Hrs in the period - Excluded time)

Average uptime can also be calculated and reported at the station level as additional information, but not as a substitute for EVSE-level uptime. Average station uptime calculations must include each EVSE at the station. We offer the following formula for consideration.

> Average Station Uptime % = Sum (EVSE UT1 + EVSE UT2 + . . . EVSE UTN) / N
>
> N = total number of EVSE at the station

Downtime: the total time an EVSE is not operational, e.g., unable to initiate and sustain a charge at the expected level for the expected charging duration. Recording of downtime shall be initiated by any of the following:

- The detection of a system fault through the EVSP network where the fault results in the inability to charge.
- A customer call to the service number to report a non-functional EVSE.
- On-site maintenance and servicing reports a non-functioning EVSE.
- Third party testing at the charging station reports a non-functioning EVSE or that the EVSE is not delivering power at the intended rate.
- In the case of vandalism or theft, recording of downtime shall start 24 hrs after the EVSP identifies or is notified of the issue.
- Any of the failures listed under Excluded Time.

Excluded Time: the total time an EVSE is not operational that is outside the control of the EVSP, including the following:

- Upstream power loss
- Upstream internet and/or cloud services failure (does not include connection issues)
- Upstream cellular failure (does not include spotty cell reception)
- Force majeure, i.e. catastrophic unforeseen weather events
- Site access restrictions outside the control of the EVSP and permitted under the terms of the incentive agreement (e.g. closing a parking garage 12-6 am, planned maintenance, etc.)

EVSPs should be required to separately report details of both Downtime and Excluded Time. These reports should provide information including but not limited to type, frequency, number of and length of incidents and occurrences. Separate reports of Downtime and Excluded Time would provide a robust understanding of these issues, and the opportunity to develop solutions.

E. Vandalism and Theft

Cool the Earth recommends that vandalism and theft not be included in Excluded Time. These two issues are real and potentially significant limitations on EVSE functionality, especially for disadvantaged communities. If they are allowed as Excluded Time they will be collectively ignored. Instead Cool the Earth recommends that these potential issues are recognized and addressed creatively in grant solicitations with the goal of developing joint solutions. For instance, the following could be considered:

- Include bonus points for resilient EVSE equipment in grant solicitation scoring
- Request proposals for enhanced security stations and kiosks in areas identified with high vandalism and theft risk, with the potential for additional funding for these
- Require security cameras in each EVSE, similar to ATM cameras
- Encourage station siting in high visibility/high traffic locations

F. Third-Party Uptime Verification

To ensure compliance, it is essential that reported EVSE performance be verified by an independent third-party. Third-party verification of EVSP-reported uptime should involve the review and verification of the raw data and calculations provided by the EVSP, including reported uptime, downtime and excluded time.

G. Third-Party Field Testing

Not all system failures are included in uptime/downtime calculations because not all system failures are currently detectable by the EVSP network. Some examples of possible undetected failures are cut charging cord, payment system problems, broken screen, etc. Therefore, field-based testing is needed to complement uptime reporting.

Field testing of each EVSE, to confirm charging at the intended rate, should be a standardized and validated process, performed by a third party. This testing should be required at the time of initial operation and at periodic intervals thereafter with results reported to the EVSP and the funding agency.

H. EV Charging Station Service and Maintenance

The owners of charging stations should also be required to submit detailed service and maintenance plans for review and evaluation prior to being funded. The following are recommended minimum service and maintenance conditions:

- The site owner or EVSP will maintain an ongoing service contract with a requirement for service within 24 hours of notification.
- Monthly maintenance and cleaning of all kiosks and the related parking space.
- 24/7/365 customer call center to receive service calls
- 24/7/365 connectivity and monitoring of the operations of each charger

I. Publically Available Real-Time Reporting of Reliability

Real-time data on EVSE status, such as operational condition, occupancy, connector type, location, etc. would be extremely useful to EV owners who need to locate a functioning charger while traveling. Such data would also be useful to better understand the actual reliability of the EV infrastructure so that EV drivers can adjust their expectations accordingly. Real-time data could be reported by EVSPs to the NREL Alternative Fuels Data Center (AFDC) and published on the National AFDC map and database.

The data could also be made available for commercial applications that provide locations of EV charging stations and information on EVSE status to EV drivers.

J. Credit/Debit Card Point of Sale Requirements

The UC Berkeley study identified that point-of-sale credit card payments are a significant point of failure. Of the 375 EVSEs that successfully charged, credit card payments failed in 25 percent of the cases and the EVSP app or membership card was required to initiate the charge.

Unreliability of POS credit/debit card payment systems present a significant consumer usability issue. If an EVSE includes a POS credit/debit reader, drivers will expect it to work and will be frustrated if it fails and they must call customer service or download an app to initiate a charge. Unreliable POS systems also present an equity issue, since disadvantaged communities are more likely to rely on these unreliable systems.

Importantly, when the POS credit/debit card system fails, that event is not captured by the process for calculating uptime. The proposed uptime definition includes time the "EVSE is operational and charging can be sustained . . . ". However, an EVSE may be classified as "up" if the credit card reader fails because that failure cannot be detected.

Given these significant issues, potential mandates for POS credit/debit payment systems should be carefully considered.

K. Enforcement

The above requirements to improve charging infrastructure performance are meaningless unless there are enforceable consequences for non-compliance. We recommend dividing the grant payment into several portions. The final payment should be withheld until all performance, maintenance, and reporting requirements have been met consistently for a period of 12 months after the date of initial operation. If consistent 97 percent uptime is not met during the initial 12 months of an EVSE's operation, the funding entity should institute a financial penalty.

Thank you for your consideration,

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