California Energy Commission

STAFF REPORT

Results of Field Tests of California's Electric Vehicle Charging Network Conducted Under Assembly Bill 2061

Ensuring Reliable, Equitable Charging for California's Electric Vehicles

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ABSTRACT

Assembly Bill 2061 (Ting, Chapter 345, Statutes of 2022) directs the California Energy Commission (CEC) to develop uptime recordkeeping and reporting standards for publicly funded electric vehicle chargers and charging stations, and beginning January 1, 2025, to assess the uptime of this infrastructure and update the assessment every two years.

To assess uptime, CEC requires continuous data from electric vehicle chargers, which is not yet available. As an interim assessment the CEC commissioned the Electric Vehicle Research Center at University of California, Davis ("UC Davis") to conduct statewide field tests of EV charging ports. This report presents CEC staff analysis of field test data which provides a snapshot of the reliability of specific electric vehicle chargers. Future reporting will include an assessment of uptime derived from data collected under CEC's EV Charger Data and Reliability Standards.

The analyses in this report are based on 3,571 plug-in charge tests and observational data from 12,586 additional EV charging ports conducted between January 2024 and February 2026. From these data, CEC calculated an Operational Rate — the share of EV charging ports that were operational at the time of testing.

For Level 2 charging ports, an Operational Rate of 96.2 percent was observed. For Direct Current Fast Charger (DCFC) ports, the value was 96.4 percent. Differences in the observed Operational Rate between community types (e.g., Disadvantaged Community/Low Income Community, rural, urban) are not statistically significant. The report also presents a supplementary metric, Successful Charge Attempt Rate ("SCAR"), which captures failure modes including payment and vehicle-charging port communication errors. A SCAR value of 93.1 percent for Level 2 charging ports and 94.0 percent for DCFC ports was observed.

Although methodologies differ, these results, when compared to previous studies, suggest the reliability of California's publicly accessible charging network may have measurably improved in recent years.

Keywords: Electric vehicle, charger reliability, charging port, uptime, Operational Rate, equity, Successful Charge Attempt Rate

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EXECUTIVE SUMMARY

With more than 2.6 million electric vehicles sold in California[1] and more than 216,000 public and limited access electric vehicle charging ports installed[2], access to reliable electric vehicle (EV) charging is critical to supporting consumers and continued EV adoption. Assembly Bill 2061 (Ting, Chapter 345, Statutes of 2022) directs the California Energy Commission (CEC) to develop uptime recordkeeping and reporting standards for publicly funded EV chargers and charging stations, and beginning January 1, 2025, to assess the uptime of EV charging infrastructure and update the assessment every two years. Regulations adopted by the CEC in October 2025, the EV Charger Data and Reliability Standards, established required uptime reporting standards and recordkeeping. These regulations took effect April 1, 2026, with the initial uptime data from publicly funded EV charging installations expected at the end of 2026.

As the uptime data expected from the regulations is not yet available, the CEC commissioned the Electric Vehicle Research Center at the University of California, Davis ("UC Davis") to conduct statewide field tests of EV charging ports. The field data reported does not capture ongoing uptime of the tested chargers; instead, it provides a snapshot of the operability of the EV chargers at the time of the field test. Future reporting will include uptime results from data collected through the CEC's EV Charger Data and Reliability Standards.

This report presents the CEC's findings derived from the CEC-funded field study conducted by UC Davis, which tested publicly accessible EV charging ports located throughout the state. The study plug-in tested a total of 3,571 Level 2 (L2) and Direct Current Fast Charging (DCFC) EV charging ports (1,817 L2; 1,754 DCFC) and collected observational data on an additional 12,586 charging ports (6,635 L2; 5,951 DCFC), representing the largest and most detailed dataset of this kind known to the CEC.

While this report does not determine the specific metric defined as Uptime, CEC staff assessed charger reliability using two metrics: Operational Rate, which is a measure of whether the charger was operational at the time of the test, and Successful Charge Attempt Rate (SCAR), which evaluates successful charging sessions at operational charging ports. CEC analysis found Operational Rates of 96.2 percent for L2 charging ports and 96.4 percent for DCFC ports. The SCAR was 93.1 percent for L2 charging ports and 94.0 percent for DCFC ports. For both the Operational Rate and SCAR, differences between rural and urban areas, and between disadvantaged communities or low-income communities and those that are not, were roughly one percentage point or less. Definitions of Operational Rate and SCAR are provided in Chapter 1 of this report along with additional terms in the Glossary.

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1 Cumulative sales through 2025. See California Energy Commission, "New ZEV Sales in California," https://www.energy.ca.gov/data-reports/energy-almanac/zero-emission-vehicle-and-infrastructure-statistics-collection/new-zev.

2 Total public and limited access EV charging ports through 2025. See California Energy Commission, "Electric Vehicle Chargers," https://www.energy.ca.gov/data-reports/energy-almanac/zero-emission-vehicle-and-infrastructure-statistics-collection/electric.

Findings

Reliability is Likely Better Than Previously Reported

Studies published in recent years by other organizations used metrics and methods that may not accurately convey reliability and resulted in lower reliability scores, with rates as low as 72.5 percent (see Appendix A). The CEC's assessment of the UC Davis field test data revealed aggregate charging port Operational Rates of approximately 96 percent for both L2 and DCFC.

Similarly, prior studies have reported relatively poor SCAR for DCFC, varying between 77 and 86 percent (see Appendix A). By comparison, this assessment finds SCAR at 93 percent for L2 and 94 percent for DCFC. As with the Operational Rate, this represents a significant improvement.

Performance Metrics Vary by Charging Network Provider

Overall system performance was high, although it varied across charging network providers. For both L2 and DCFC charging ports, the largest charging network providers significantly outperformed other charging network providers — for both the Operational Rate and SCAR. The largest L2 charging network provider outperformed the average of all other L2 charging network providers by 2 percentage points for Operational Rate and by 11 percentage points for SCAR. The largest charging network provider of DCFC outperformed the average of all others by 7.5 percentage points for Operational Rate and by 8.5 percentage points for SCAR.

Payment Failures Impact Charger Usability

This report finds that credit and debit card payments failed more than 34 percent of the time (on the first attempt). Plug-in payment (Plug & Charge, Tesla supercharging, Autocharge, etc.) failed only 2.3 percent of the time, although most of those plug-in payment tests were from a single charging network provider. All other payment types (app, membership card, QR code, etc.) failed 14 percent of the time. The relatively high failure rate of both credit card and app/QR code payments highlight issues with how these payment methods were deployed at the charging stations included in this study. Notably, testers were ultimately able to authenticate another form of payment in most cases, but this still represents a burden to drivers, who may not have access to all the payment types available to UC Davis testers. Efficacy of payment methods will be further evaluated in future assessments.

Conclusion

This CEC assessment of the UC Davis field data reveals that the performance and reliability of publicly available EV chargers in California are likely higher than previously reported. However, variability among charging network providers suggests there are improvements that still need to be pursued. Next steps by the CEC include receiving and analyzing EV charger time-series station performance data, as required by the EV Charger Data and Reliability Standards regulations. These new datasets will serve as the basis for a more robust assessment of EV charger reliability in accordance with AB 2061.

CHAPTER 1:
Background and Definitions

As California's network of public and limited access electric vehicle (EV) charging ports surpasses 216,000[3] and continues to climb, it is essential to monitor and evaluate the reliability of that network. Consumers weigh many factors when deciding to choose an EV, but a central one is confidence that they will be able to charge. Charging port reliability is therefore critical to mass-market EV adoption.

Assembly Bill 2061 (Ting, Chapter 345, Statutes of 2022) directs the California Energy Commission (CEC) to develop uptime recordkeeping and reporting standards for publicly funded electric vehicle chargers and charging stations, and, beginning January 1, 2025, to assess the uptime of electric vehicle charging infrastructure and update the assessment every two years, including, at a minimum, an assessment of equitable access to reliable charging stations in low-, moderate-, and high-income communities.

In October 2025, the CEC adopted first-in-the-nation regulations that established the required uptime reporting standards and recordkeeping for publicly funded EV charging ports. These EV Charger Data and Reliability Standards[4] regulations took effect April 1, 2026, with the initial data submittals expected near the end of 2026.

Because the underlying data and associated analyses mandated by the regulations are not yet available, the CEC commissioned the Electric Vehicle Research Center at the University of California, Davis ("UC Davis") to conduct statewide field tests of EV charging ports to provide an initial assessment of the reliability of California's network of EV charging ports. The field data reported does not capture ongoing EV charging port reliability (i.e., the *Uptime* metric), instead it provides a snapshot of the operability of the ports at the time of the field test.

As a result, this CEC analysis relies on two calculated metrics, *Operational Rate* and *Successful Charge Attempt Rate* (SCAR). Those are defined as follows:

> Operational Rate: among an identified group of charging ports, the percentage of those that were operational (yes/no) at the time of testing.
>
> Successful Charge Attempt Rate: among an identified group of charging ports, the percentage of which an EV was able to successfully charge (among those that were determined to be otherwise operational).

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3 Total public and limited access EV charging ports through 2025. See California Energy Commission, "Electric Vehicle Chargers," https://www.energy.ca.gov/data-reports/energy-almanac/zero-emission-vehicle-and-infrastructure-statistics-collection/electric.

4 EV Charger Data and Reliability Standards. See California Code of Regulations, Tit. 20, Div. 2, Chap. 12, Article 2. https://govt.westlaw.com/calregs/Browse/Home/California/CaliforniaCodeofRegulations?guid=I640868402CA311F19B10D6964DDE20FB&originationContext=documenttoc&transitionType=Default&contextData=(sc.Default)&bhcp=1.

In subsequent assessments, the CEC will include new charger reliability data collected through the CEC's EV Charger Data and Reliability Standards. Specifically, as automated EV charger data streams (e.g., continuous charger status data) become available, the CEC will include the additional metric of *Uptime* to convey the ongoing availability of charging ports over a defined period (typically one year) and related trends. Additional definitions of terms are available in the Glossary of this report.

The UC Davis field study tested publicly accessible Level 2 (L2) and Direct Current Fast Charging (DCFC) ports. This report analyzes the results obtained from the field tests to measure reliability characteristics at a point in time, based on both plug-in tests and observational data from randomly selected EV charging ports located throughout the state. To assess equitable access as required by AB 2061, the study covered four community types:

- Communities designated as Disadvantaged Communities (DAC) or Low-Income Communities (LIC)
- Communities designated as not DAC/LIC
- Rural communities
- Urban communities

This is the largest such dataset covering California's network of EV charging stations that the CEC has assembled to date. Similar to previous field studies from other organizations (see Appendix A), these data represent a point-in-time evaluation of the functionality of the charging ports tested and observed.

Previous studies generally reported lower reliability, in part because they used varying methodologies and broadly included factors ancillary to reliability, which lowered their reliability scores. For example, many previous studies combined operational failures and failed charging sessions into one metric. A potential flaw in this approach relates to this determination of "failure" — where some operational failures not typically considered in the calculation of Uptime are included. This approach artificially lowers the Uptime metric presented in these previous studies. Although both failure types fall under the umbrella of reliability, they are separate issues that should be measured separately. Chapter 2 discusses the difference between operational failures and failed charging sessions in more detail. Some previous studies also include non-reliability issues as failures in their metrics (e.g., design flaws and inconveniences), which further depressed reported reliability metrics. As described in detail in Chapter 2, the UC Davis field test data allows for some level of direct comparison with those earlier studies.

CHAPTER 2:
Methods and Results

Methods

Study Structure

This report analyzes data from a study the CEC commissioned from UC Davis. The study data are separated into two broad categories: plug-in tests and observational data. Plug-in tests were performed by physically plugging the charging port into the vehicle and attempting to charge. Observational data were collected by inspecting the charging ports for functionality without plugging in. The study conducted plug-in tests on 3,571 charging ports (1,817 L2 and 1,754 DCFC) located throughout the state and collected observational data on an additional 12,586 charging ports (6,635 L2 and 5,951 DCFC) from January 2024 to February 2026.

Both the L2 and DCFC samples were grouped in DAC/LIC, non-DAC/LIC, rural, and urban communities. The samples were also grouped by charging network provider.

Reliability Metrics

The CEC identified two key metrics for this field study, defined in Chapter 1, to evaluate whether a customer can reliably charge: Operational Rate and Successful Charge Attempt Rate, or "SCAR".

The data from these field tests represent a point-in-time evaluation of the charging ports tested or observed. This point-in-time data does not permit the calculation of Uptime, because calculating Uptime requires continuous operational data from a charging port over a period of time. However, data from the UC Davis field tests study are sufficient to determine the Operational Rate, representing the percentage of charging ports that were operational at the time of evaluation. This metric is a representative indicator of the reliability of the charging network in California. Future assessments will measure Uptime as described in Chapter 3.

Even when a charging port is operational, there are still circumstances in which a charging session may fail. The causes of these failed charging sessions vary but are most often due to failures in communication between the EV and the charging port or payment system failures. The fact that these failures occur at operational charging ports requires that this be studied and understood separately from Uptime and its alternatives. In response the CEC developed the SCAR metric[5], which measures the percentage of charging sessions that were successful during testing. The fact that these failures occur at operational charging ports requires it to be studied and understood separately from uptime and its alternatives. SCAR can be directly evaluated from the UC Davis field study data.

5 The ChargeX Consortium did similar work in parallel to the CEC but developed slightly different metrics. https://driveelectric.gov/chargex-consortium

Results

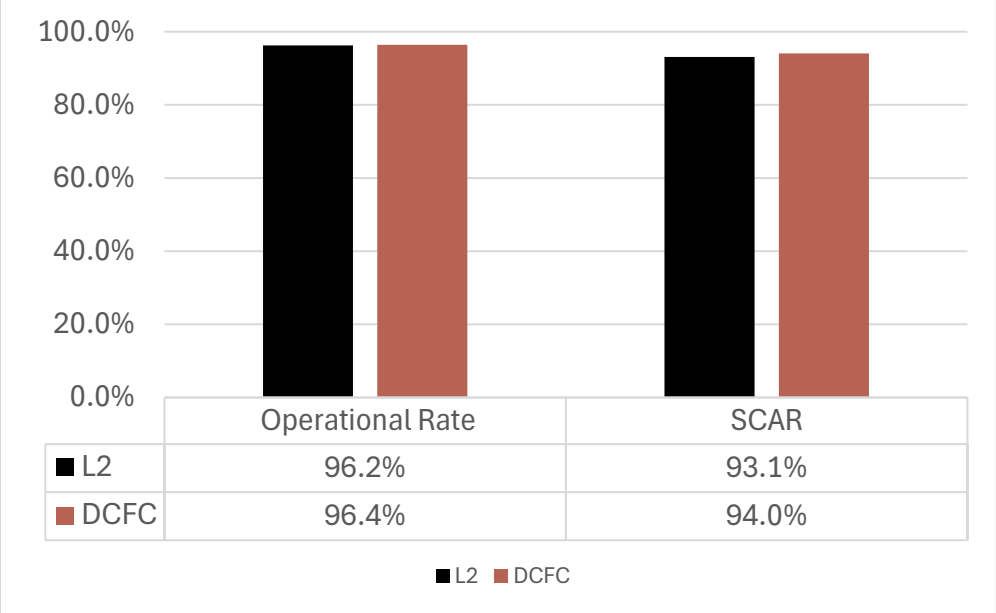
Overall Results

UC Davis testers attempted to access 10,027 L2 and 8,320 DCFC publicly accessible charging ports. Of those, testers successfully accessed 8,452 L2 and 7,705 DCFC ports. Of the L2 charging ports accessed, 1,817 were plug-in tested and 6,635 additional were observed. Of the DCFC ports accessed, 1,754 were plug-in tested and 5,951 were observed. These data are illustrated in the Sankey diagrams in Figures 2 and 3. More granular breakdowns of these data can be found in Appendix B.

The Operational Rate metric was calculated using both plug-in tests and observational data. In the cases of potential operational failures within the observational dataset, a statistical weighting was applied based on plug-in test data. The Operational Rate was 96.2 percent for L2 and 96.4 percent for DCFC. SCAR was calculated using only plug-in test data and was 93.1 percent for L2 and 94.0 percent for DCFC. See Figure 1.

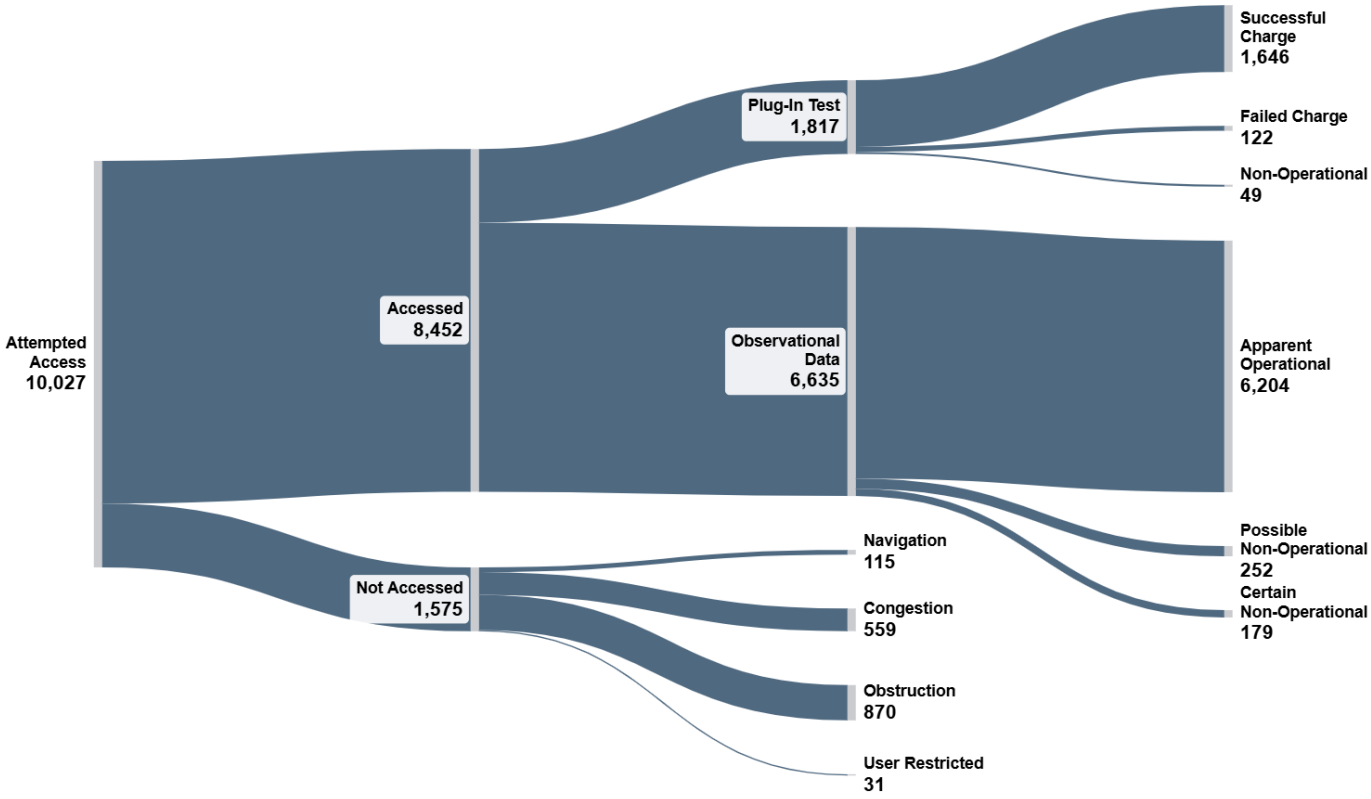
More details on the specific types of failures and methods for calculating the overall Operational Rates and SCAR can be found in Appendix B.

Figure 1: Overall Reliability Metrics



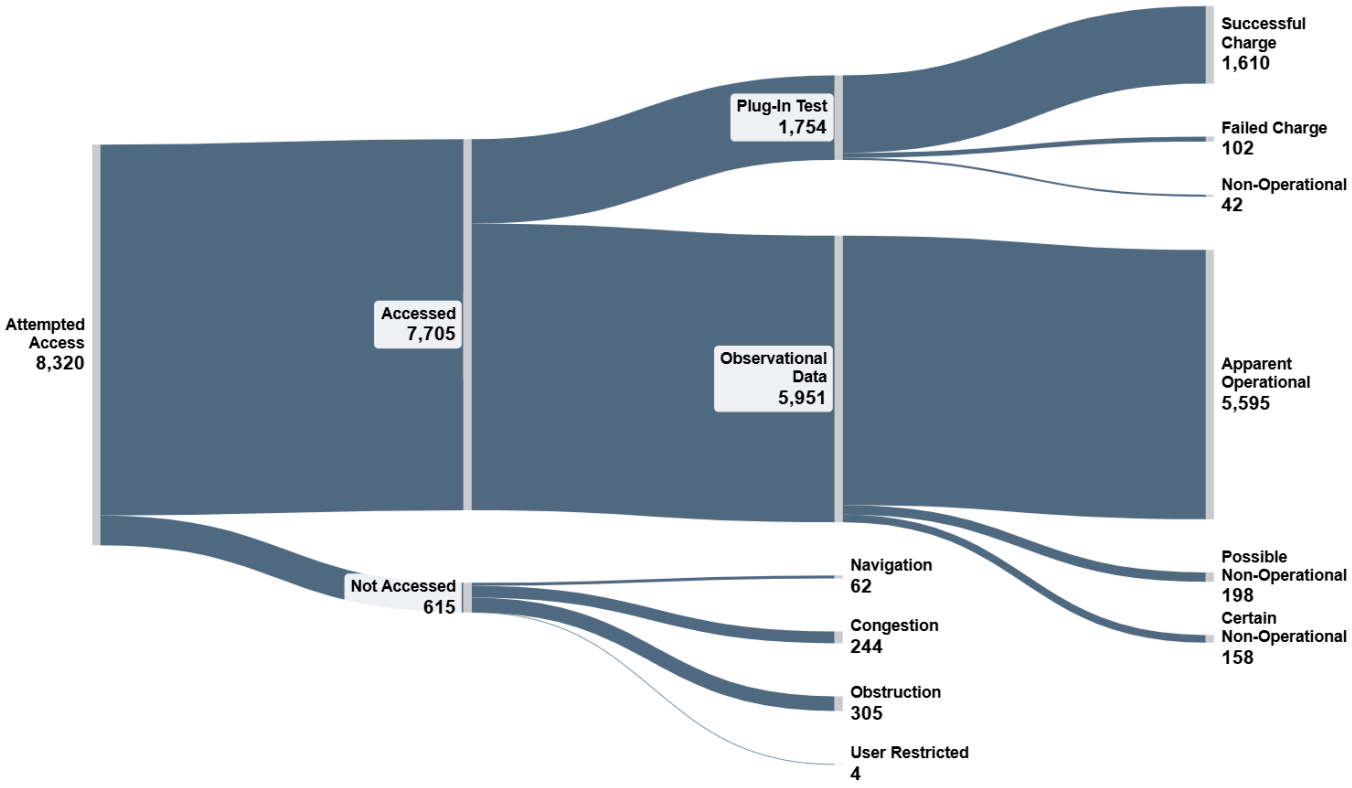
Source: CEC staff analysis of UC Davis study data

Figure 2: Overall Testing Results for L2 Charging Ports



Source: CEC staff analysis of UC Davis study data

Figure 3: Overall Testing Results for DC Fast Charger Ports

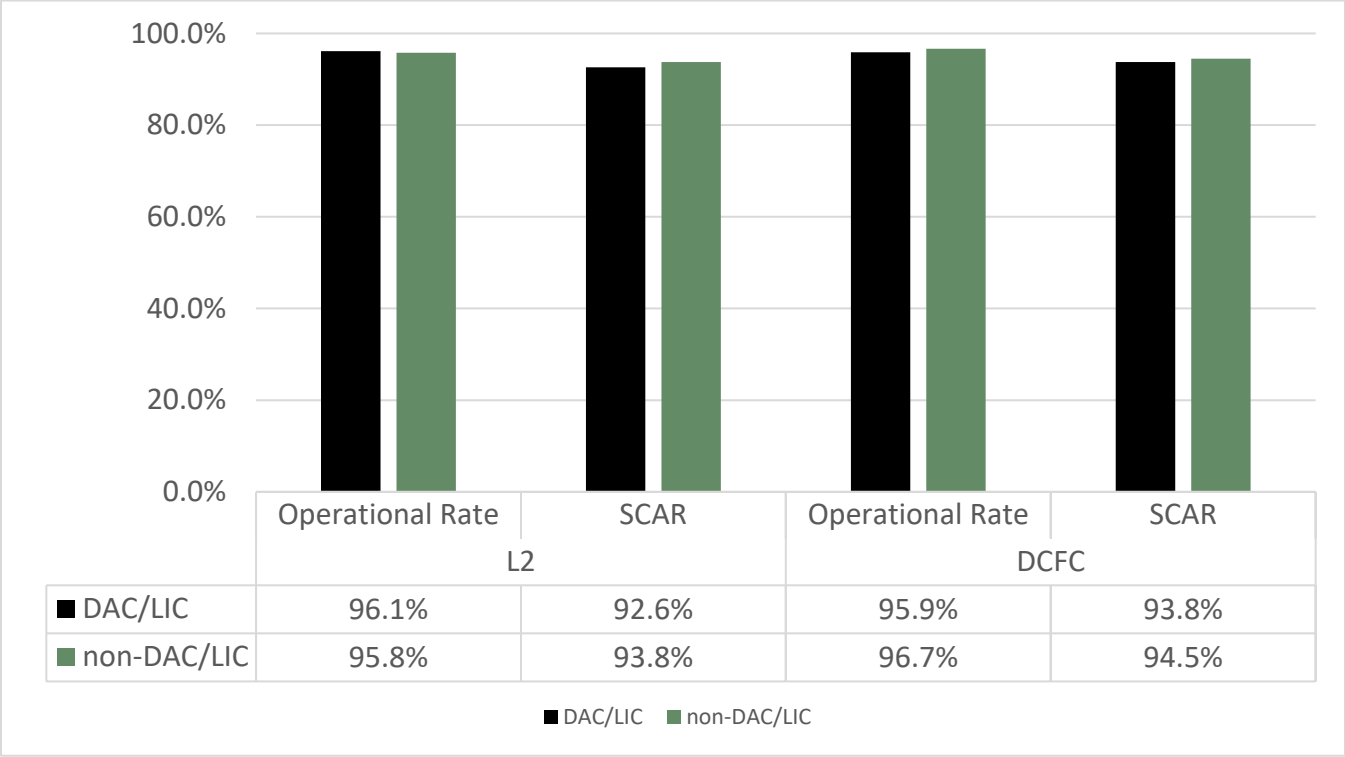


Source: CEC staff analysis of UC Davis study data

Disadvantaged and Low-Income Communities (DAC/LIC)

As shown in Figure 4, the difference in Operational Rate and SCAR between DAC/LIC and non-DAC/LIC was between 0.3 and 1.2 percentage points for both L2 and DCFC. These differences are minor and were within the margin of error at a 99% confidence level. More details on the Operational Rate, SCAR, and underlying data for DAC/LIC and non-DAC/LIC can be found in Appendix B.

Figure 1: Reliability Metrics in Disadvantaged and Low-Income Communities



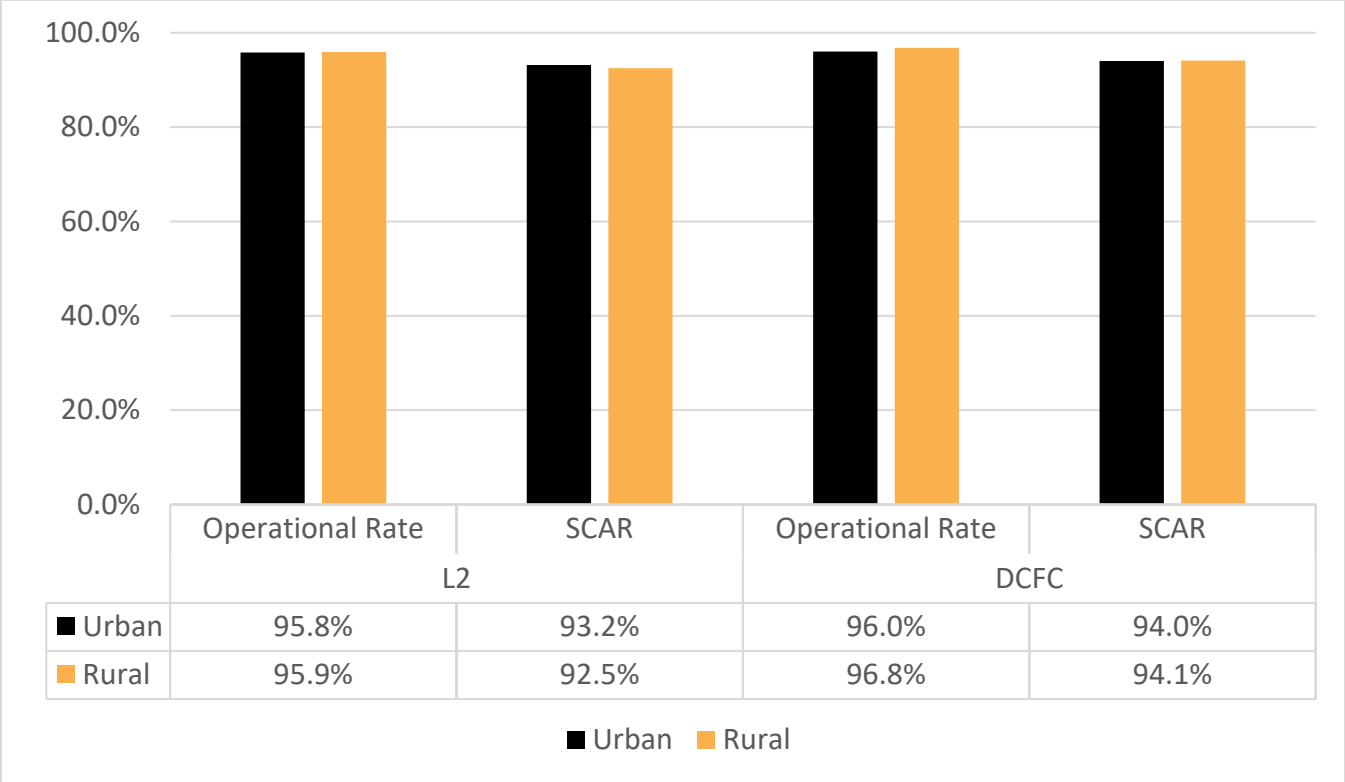
	L2 Operational Rate	L2 SCAR	DCFC Operational Rate	DCFC SCAR
DAC/LIC	96.1%	92.6%	95.9%	93.8%
non-DAC/LIC	95.8%	93.8%	96.7%	94.5%

Source: CEC staff analysis of UC Davis study data

Results in Rural and Urban Communities

As shown in Figure 5, the difference between rural and urban communities in terms of Operational Rate and SCAR varied by 0.1 to 0.8 percentage points for both L2 and DCFC. As with the results in the DAC/LIC comparison, these differences were within the margin of error at a 99% confidence level.

Figure 2: Rural and Urban Reliability



	L2		DCFC	
	Operational Rate	SCAR	Operational Rate	SCAR
Urban	95.8%	93.2%	96.0%	94.0%
Rural	95.9%	92.5%	96.8%	94.1%

Source: CEC staff analysis of UC Davis study data

More details on the Operational Rate, SCAR, and underlying data for rural and urban communities can be found in Appendix B.

Results by Major Charging Network Providers

The data were also analyzed by charging network provider, with performance varying across networks. For both L2 and DCFC, the largest charging network provider outperformed others for both the Operational Rate and SCAR, which raised the statewide averages found in this study.

For L2, the largest charging network provider recorded an Operational Rate of 97.0 percent and a SCAR of 96.5 percent, compared with averages of 94.9 percent and 85.6 percent across all other networks. For DCFC, the largest charging network provider recorded 99.6 percent and 98.3 percent for Operational Rate and SCAR, compared with averages of 92.1 percent and 89.7 percent across all other networks.

Even excluding the largest charging network provider, reliability measures in this dataset exceeded the levels reported in past studies, though the variance among charging network providers shows clear room for improvement for lower-performing networks. More details on

the Operational Rate, SCAR, and underlying data by charging network provider can be found in Appendix B.

Payments

Payment authorization is a critical step in a driver's ability to successfully charge and is directly relevant to SCAR. During testing, UC Davis testers were assigned a payment method for each plug-in test. If that payment method failed, testers could select from other payment options until they were able to successfully authorize payment and proceed with charging. In many cases, testers had to cycle through multiple payment options before successfully charging.[6]

CEC staff evaluated the success of the assigned payment for the initial attempt. Overall, the initial payment attempt failed 17.7 percent of the time, comprising three major categories:

- Credit or debit card, with a failure rate of 34.4 percent
- Plug-in payment (e.g. Plug & Charge, Tesla Supercharging, Autocharge), with a failure rate of 2.3 percent
- All other payment methods (e.g. app, membership card, QR code), with a failure rate of 14.0 percent

Many of the failures above were ultimately followed by a successful charge by cycling through different payment methods. Further, credit card payment success varied by the exact credit card method used, with tap being the most reliable. Finally, the plug-in payment success rate was dominated by a single charging network provider with a closed system, so these results may not generalize to the plug-in payment driver experience across the broader market.

More details on first attempt payment success or failure can be found in Appendix B.

Accessing EV Charging Ports

The UC Davis field testing attempted to access 10,027 L2 and 8,320 DCFC ports. Of those, testers were unable to access 1,575 L2 and 615 DCFC ports. Factors that prevented testers from accessing EV charging ports included:

- Navigation: difficulty locating a charging station
- Obstructions: something physically blocking the charging port
- Congestion: all charging ports occupied for extended periods

Access issues are not reliability issues; charging ports that were not accessed are not included in the reliability analyses presented above. However, they do describe very real challenges faced by EV drivers. Of these, obstructions are the least able to be mitigated by a driver. Nearly 9 percent of all L2 and 7 percent of DCFC ports were obstructed. These obstructions ranged from construction and dumpsters to internal combustion engine vehicle blocking access.

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6 Testers were assigned a random payment method for each plug-in test. If that payment method failed, testers would select the next payment method from any of the options they had available to them until they successfully authorized payment or exhausted all options. Other available payment methods depended on what was accepted at the charger but generally included RFID tags, other credit / debit cards, and smartphone applications.

CHAPTER 3: Discussion

The reliability of charging ports is critical to the mass-market adoption of EVs, which in turn is critical to California reaching pollution reduction and climate goals. Even the perception of poor reliability in public EV charging presents an obstacle to mass market adoption.
The results presented in Chapter 2 of this report lead to three major findings:

1. The reliability of EV charging ports is likely better than results from past reports.
2. Although the overall reliability of the charging network in California is high, there are differences in performance between charging network providers.
3. The type and number of payment methods available at an EV charger, and which one is used by the driver, can greatly impact the success rate of a charging attempt.

These findings are based on extensive field testing of a large number of charging ports by UC Davis. The CEC assessment of these data enables a level of direct comparison with other studies and methodologies, pointing to possible explanations for the differences in results. The CEC's method of decoupling operational failures from failed charging sessions provides a more discrete assessment of reliability issues and identifies targeted areas for improvement.

Although these results reflect EV charger performance at a specific time when these data were collected, they are encouraging. Most charging ports allowed successful EV charging sessions, with SCAR values of 93 percent and 94 percent for L2 and DCFC ports, respectively. However, EV driver needs and expectations demand even better performance.

Variability among charging network providers suggests further assessment and industry attention to reliability is needed. The largest charging network providers for both L2 and DCFC were also the most reliable. Although these large networks serve the largest share of EV customers, drivers expect and need *all* EV charging networks to operate at comparable levels of reliability.

The study identified several pain points for EV charging customers. Although testers were ultimately able to charge at their chosen port, they often had to cycle through multiple payment methods before succeeding. For credit cards, tap payments were more reliable than chip or swipe, but overall credit card success rates remained lower than other payment methods. The reasons for this gap in credit card success merit further study; possible explanations include weather-related failures, poor software integration with payment terminals, and separate, inferior cellular or other digital connectivity for the terminals themselves.

The apparent success of plug-in payment is another area warranting further investigation. The vast majority of all plug-in payment attempts tested in this study involved a single large charging network provider, using vehicles from that same charging network provider. As a result, these findings do not necessarily reflect how plug-in payment would perform broadly across multiple charging network providers serving a diverse electric vehicle mix.

Finally, EV drivers face several challenges that fall outside the scope of charging port reliability but nevertheless negatively impact the perception of EV charger reliability. These challenges include obstructions, charging station congestion and layout, and location and ease of navigation to EV charging stations.

Specifically, obstructions that block access to a charging station or individual ports, such as dumpsters, other vehicles, and locked gates, functionally render the stations inoperable. Congestion was also a persistent issue for testers: while not a reliability issue in itself, it affects customer convenience and satisfaction, Navigation challenges existed as well — charging ports were not always located where testers expected to find them. Locating a charging port can sometimes depend on consumers correcting inaccurate information in existing databases; providing better location information at the time of installation could help mitigate such problems.

Ongoing challenges aside, the results of this assessment point toward an improving trend in EV charger reliability. These field test results and analyses serve as an important reference point and will improve our understanding of factors impacting EV charger reliability. The results will inform the state's efforts to improve not only the reliability of EV charging ports but also the overall charging experience.

Next Steps

Starting in late 2026, CEC staff will begin collecting time-series data required by regulations.[7] These data will serve as the basis for the first official assessment of the Uptime metric of EV charging infrastructure required by AB 2061.[8]

7 EV Charger Data and Reliability Standards (California Code of Regulations, Tit. 20, Div. 2, Chap. 12, Article 2).

8 California Legislature. 2022. Transportation Electrification: Electric Vehicle charging Infrastructure. Assembly Bill 2061, 2021-2022 Regular Session, Chapter 345. Enacted September 16, 2022. https://legiscan.com/CA/text/AB2061/id/2607090

GLOSSARY

ALTERNATING CURRENT (AC) — Flow of electricity that constantly changes direction between positive and negative sides. Almost all power produced by electric utilities in the United States is AC current operating at 60 cycles per second.

AC Level 2 (Level 2 or L2) – means a charger that operates on a circuit greater than or equal to 208 volts and transfers alternating-current (AC) electricity to a device in an EV that converts alternating current to direct current to charge an EV battery.

CALIFORNIA CODE OF REGULATIONS (CCR) — The official compilation and publication of the regulations adopted, amended, or repealed by state agencies under the Administrative Procedure Act (APA). Properly adopted regulations that have been filed with the Secretary of State have the force of law. The CCR is compiled into titles and organized into divisions containing the regulations of state agencies.[9]

CHARGER — A device with one or more charging ports and connectors for charging EVs. Also referred to as *electric vehicle supply equipment* (EVSE).

CHARGING CONNECTOR — A charging connector (or plug) is the cable-end that physically plugs into your vehicle.

CHARGING NETWORK — A collection of chargers located on one or more properties that are connected via digital communications to manage the facilitation of payment, the facilitation of electrical charging, and any related data requests.

CHARGING NETWORK PROVIDER – means the entity that operates the digital communication network that remotely manages the chargers including, but not limited to, authorizing customer transactions and monitoring charger operative status. Charging network providers can also be charging station operators or can manufacture chargers.

CHARGING PORT — The station-side equipment that manages and dispenses electricity. One charging port/post might house multiple different connector types (such as CCS, CHAdeMO, or NACS) to accommodate different vehicle inlets, but it will only deliver power to one vehicle at a time

CHARGING SESSION — The period after a charge attempt during which the electric vehicle is allowed to request energy. Charging sessions can be terminated by the customer, the electric vehicle, the charger, the charging station operator, or the charging network provider.

CHARGING STATION — The area in the immediate vicinity of one or more chargers and includes the charger, supporting equipment, parking areas adjacent to the charger, and lanes for vehicle ingress and egress.

CHARGING STATION OPERATOR – The entity that owns the charger and supporting equipment at one or more charging stations. Although this entity can delegate responsibility for certain aspects of charging station operation and maintenance to subcontractors, this

9 California Office of Administrative Law (https://oal.ca.gov/).

entity retains responsibility for operation and maintenance of chargers and supporting equipment.

DIRECT CURRENT FAST CHARGER (DC fast charger) – A charger that enables rapid charging by delivering direct-current (DC) electricity to an EV battery.

DOWNTIME — A period that a charger is not capable of successfully dispensing electricity or otherwise not functioning as designed.

ELECTRIC VEHICLE (EV) — A vehicle that is either partially or fully powered by electric power received from an external power source. For regulation, this definition does not include golf carts, electric bicycles, or other micromobility devices.

ELECTRIC VEHICLE SUPPLY EQUIPMENT (EVSE) — Device designed to supply power to EVs. EVSE can charge a wide variety of EVs, including BEVs and PHEVs.

KILOWATT (kW) — One thousand watts. A unit to measure the instantaneous power required by a device in order to operate. On a hot summer afternoon, a typical home — with central air conditioning and other equipment in use — might demand 4 kW.

KILOWATT-HOUR (kWh) — A unit of energy measurement representing the total amount of electricity consumed. It equals one kilowatt (kW) of power sustained consistently for one hour.

OPEN CHARGE POINT INTERFACE (OCPI) — An open-source communication protocol that governs the communication among multiple charging networks, other communication networks, and software applications to provide information and services for EV drivers.

OPEN CHARGE POINT PROTOCOL (OCPP) — An open-source communication protocol that specifies communication between chargers and the charging networks that remotely manage the chargers.[10]

OPERATIONAL RATE – Measures whether the charging port was operational at the time of testing.

ORIGINAL EQUIPMENT MANUFACTURER (OEM) — A manufacturer that makes equipment or components that are then marketed by its client, another manufacturer, or a reseller, usually under that reseller's own name.

PLUG-IN HYBRID ELECTRIC VEHICLE (PHEV) — PHEVs are powered by an internal combustion engine and an electric motor that uses energy stored in a battery. The vehicle can be plugged in to an electric power source to charge the battery. Typical PHEVs travel 20-50 miles on electricity alone, and all can also operate solely on gasoline (similar to a conventional hybrid).

PLUG-IN PAYMENT — Automatic payment initiated by connecting a charging port to a vehicle charging inlet. Examples include ISO 15118 Plug & Charge, Tesla Supercharging, and EVgo Autocharge.

SUCCESSFUL CHARGING ATTEMPT RATE (SCAR) – Measures whether an EV was able to successfully charge at a charging port that is operational.

10 Open Charge Alliance Protocol Webpage (https://www.openchargealliance.org/protocols/).

UPTIME – Measures the percentage of time a charging port is operational as designed.

ZERO-EMISSION VEHICLE (ZEV) — Vehicles that produce no emissions from the onboard source of power (for example, an electric vehicle).

APPENDIX A:
Past Studies on EV Charging Reliability

While there are articles and reports on charger reliability generally, there is a lack of rigorously collected and publicly available data on the reliability of EV chargers installed and operated in California.

The included studies are listed chronologically. The University of California, Berkeley, and ChargerHelp reports are based, at least in part, on field testing chargers. ChargerHelp is a leading maintenance service provider for EV chargers. The UC Davis report referenced in this chapter is distinct from the UC Davis field testing study that is the cornerstone of this CEC report. The UC Davis report referenced in this chapter is based on remote monitoring data, but it is the only other study that characterizes successful charging sessions that CEC staff is aware of. The field test studies by UC Berkeley and ChargerHelp report reliability in different manners from each other and from this CEC report. Therefore, it is difficult to conduct an apples-to-apples comparison across these studies.

UC Berkeley – Reliability of Open Public Electric Vehicle Direct Current Fast Chargers

This is the first empirical study known to the CEC that investigated the reliability of a significant number of EV chargers. This 2022 study sent testers to 181 charging stations and evaluated 657 chargers.[11] Chargers were evaluated by either attempting to charge an EV using a specified test protocol or by observing them successfully charging a third-party EV.

This study found that San Francisco Bay Area DCFC were able to successfully charge the EVs tested 72.5 percent of the time. Of the 27.5 percent that were not able to successfully charge the EVs tested:

- 8.1 percent were due to apparently inoperative charging stations (downtime),
- 7.5 percent were due to failed charging sessions,
- 7.2 percent were due to "payment system failures"
- 4.9 percent were due to "station design failures."

For this study, "payment system failures" refer only to failures in the charging station operator's or charging network provider's internal customer payment authorization systems, not external credit card authorization systems.

11 Rempel, David, Carleen Cullen, Mary Matteson Bryan, and Gustavo Vianna Cezar. (University of California, Berkeley). 2023. *Reliability of Open Public Electric Vehicle Direct Current Fast Chargers*, https://www.osti.gov/servlets/purl/2327095#:~:text=Of%20the%20655%20open%20public,to%20reach%20the%20EV%20inlet.

UC Davis — Reliability of Corridor DCFC and the Prevalence of No-Charge Events

This study looked at data from 54 corridors, 50- to 62.5-kilowatt (kW) fast chargers installed (mostly by early 2021) and operated by the California Department of Transportation (Caltrans).[12] Data covered about 17 months, from June 15, 2021, to November 22, 2022. Caltrans used two brands of charger, denoted as "Brand B" and "Brand C" for the study.

"Brand C" had 7,654 visits. Of these visits, 6,087 successfully charged on the first attempt, 465 successfully charged on subsequent attempts, and 1,102 resulted in failure/no-charge events, for an 86 percent success rate. Of the 40,724 visits for "Brand B," 27,617 successfully charged on the first attempt, 3,610 successfully charged on subsequent attempts, and 9,497 resulted in failure/no-charge events, for a 77 percent success rate.

Notably, within the successful charges for "Brand C," there was a 2 percent chance of charge interruption in which the charge ended without the customer requesting it to end. No charge interruptions were reported for "Brand B," though it is not clear if this is due to lack of data or an actual absence of the phenomenon among "Brand B" users.

ChargerHelp 2024 Annual Reliability Report

This 2024 industry report is likely the most comprehensive, empirical analysis of the real-world reliability of publicly available EV chargers to date. Produced by ChargerHelp, an operations and maintenance service provider for EV chargers, the report uses four national datasets to analyze the real-world reliability of EV chargers throughout the United States from the consumer perspective.[13] These datasets include data from the Alternative Fuels Data Center[14] (AFDC), ChargerHelp's own internal data, field-testing data, and data from Paren, Inc., a collector of EV charger data. Each of these datasets contained varying types and volumes of data and offered different insights. The field-testing data are of particular relevance to this report as they are analogous to the study UC DAVIS conducted on behalf of the CEC.

ChargerHelp collected observational data on 4,844 charging ports and attempted to charge at 1,300 of them. It used these observational data to develop what it calls "true uptime," which appears closest to the driver experience gap rate discussed in subsequent chapters of this CEC report.

The ChargerHelp report presents six key findings:

1. True uptime is often lower than reported uptime.
2. Software inaccuracy compounds reliability shortcomings, reducing driver confidence.

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12 Gamage, Tisura, Alan Jenn, and Gil Tal. (University of California, Davis). 2023. *Reliability of Corridor DC Fast Chargers and the Prevalence of No-Charge Events*, https://evs36.com/wp-content/uploads/finalpapers/FinalPaper_Gamage_Tisura.pdf.

13 ChargerHelp. June 2024. ChargerHelp Annual Reliability Report: The State of EV Charging and the Driver Experience, https://www.chargerhelp.com/2024-annual-reliability-report-2/.

14 U.S. Department of Energy, Energy Efficiency & Renewable Energy. "Alternative Fuels Data Center," https://afdc.energy.gov/.

3. Equipment age correlates with downtime and reliability varies geographically by state.
4. Charging reliability varies dramatically by network.
5. The causes of downtime and failed charge sessions are multifaceted, although certain problems dominate.
6. Addressing "problem" stations can alleviate a disproportionate burden on EVSE operations and maintenance.

The ChargerHelp findings are consistent with the findings in this CEC report but are a different focus. This is where the challenge lies when comparing different reports that define reliability, failures, and driver experience differently. While a detailed discussion of each of the ChargerHelp findings is beyond the scope of this report, the insights regarding the age of the charger and variance across different networks are notable and warrant further examination.

APPENDIX B:
Data

The Appendix B Excel Workbook is uploaded to the CEC website here: https://www.energy.ca.gov/publications/2026/results-field-tests-californias-electric-vehicle-charging-network-conducted.