ChargerHelp Annual Reliability Report

The State of EV Charging and the Driver Experience

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Foreword

After a record-setting 2023 for electric vehicle (EV) sales in America, this year promises to be even bigger, with EVs accounting for more than 10% of total sales and projected to reach about half of new sales by the end of the decade.

EVs are clearly here to stay! They are central to the future of clean and sustainable transportation in the United States and globally, driven by consumer demand and federal and state ambitions to decarbonize road transportation while reducing tailpipe air pollution in our communities.

Across all 50 states, policymakers, automakers, charging providers, hardware companies, and installers are actively contributing to what this report aptly calls the “in-motion success story” of America’s EV expansion. For the market to grow and expand to all households and drivers, we need a dependable charging network that is highly reliable, functional, and easy to use both in daily life and on long road trips.

While early EVs had a range of 80 miles and were not used for long road trips, current buyers want to enjoy the efficient and quiet electric drive for longer trips, often exceeding an EV’s average range of 200–300 miles. My research suggests that these longer trips are, in many cases, still more challenging than driving a gas car. Charging reliability issues, coupled with a shortage of chargers in some areas and high congestion in others, continue to create a suboptimal experience.

Charging sector leaders are diligently working every day to improve charging reliability and expand EV access for all. Yet, like every growth story, the journey to reliable charging includes significant challenges. Identifying these challenges is the first step to overcoming them — and with this report, a reliable set of data and analysis is now available to do just that.

Focused on the state of EV charging infrastructure, reliability measures, and the root causes of charging failure, this illuminating report equips policymakers, industry experts, and technical professionals with data-driven insights necessary to identify and overcome the sector’s greatest technical challenges to achieve high uptime.

In the following pages, you will find rigorous, timely analysis that demonstrates why and how EVSE reliability has often been stymied. These insights, paired with the recommendations in the report’s conclusion, highlight a clear path forward to a future where higher reliability is a realistic expectation.

For now, take heart in the fact that EV infrastructure reliability has come this far in a rapidly growing and changing environment. Propelled by thoughtful policymaking, industry initiative, and technical ingenuity, the industry has made great strides already — and now has the data needed to charge further forward. By connecting the dots between current challenges and the most accessible, affordable, and effective solutions for improving charging reliability, the industry can come together to forge an even brighter future.

— Gil Tal, Ph.D. (June 2024)

Director, Electric Vehicle Research Center
Professor, Environmental Science and Policy
Institute of Transportation Studies, University of California, Davis

Executive Summary

The number of public EV charge ports in the U.S. has doubled in three years, surpassing 175,000 ports nationwide as of early April 2024. Yet known problems with the electric vehicle charging experience (EVCX) are hurting the industry's reputation, causing frustration among current EV drivers, and inhibiting would-be adopters from making the ICE-to-EV switch.

To understand when, where, and why charging infrastructure reliability falls short, we analyzed more than 19 million individual data points from 2023 across five primary data sources: two complementary sets of first-party data from ChargerHelp's direct EVSE O&M experience, third-party data from Paren, public data from the U.S. DOE's AFDC database, and select electric utility public PUC filings — all focused on L2 and DCFC public charging infrastructure.

We explored three interrelated categories of insights: a) the discrepancy between reported uptime and true uptime, b) how reliability varies by EVSE age, state, and network, and c) the drivers of downtime and what it takes to improve uptime. Our analysis revealed 6 primary findings:

FINDING #1:

True uptime is often lower than reported uptime

"True uptime" refers to EV drivers' actual, on-the-ground experience attempting to charge their electric vehicles on a given port. This is in contrast to a station's or a network's self-reported status via OCPP, an app, or software API. We found that software consistently overestimates station uptime, point-in-time status, and the ability to successfully charge a vehicle.

FINDING #2

Software inaccuracy compounds reliability shortcomings, reducing driver confidence

Software inaccuracies and overestimations of charging station status — coupled with failed charges at supposedly working stations — manifest in at least four specific ways negatively impacting the EV charging experience at more than one-quarter (26%) of stations we analyzed.

FINDING #3

Equipment age correlates with downtime and how reliability varies geographically by state

There is a positive correlation between EVSE infrastructure age and rates of down stations — older stations were more likely to be down. Consequently, states with a longer history of EVSE infrastructure buildout were also more likely to have higher percentages of down stations.

FINDING #4

Charging reliability varies dramatically by network

Examining 20 charging network operators (NOs) reveals a hard fork in the road. Some NOs have a near-flawless record; others consistently experience 10–20% of stations down at any given point in time. For DCFC ports in particular, only 4 networks account for just over one-quarter of ports nationwide, yet account for more than three-quarters of all down ports.

FINDING #5

The causes of downtime and failed charge sessions are multifaceted, although certain problems dominate

Stations showed myriad types of outward, observable signs of station damage and problems, ranging from cable and connector issues to cabinet and screen damage. Component failure or damage was the most common internal symptom found, followed by communications and/or software failures. Together they account for more than two-thirds of symptoms. Looking deeper at down stations only, the payment system condition had a significant, strong positive correlation with working vs. down stations.

FINDING #6

addressing "problem" stations can alleviate a disproportionate burden on EVSE O&M

A small number of "problem stations" required 4 or more work orders to diagnose and resolve issues, placing a burden on O&M resources and dragging down station and network uptime and reliability metrics. During the second half of 2023, nearly half of DCFC stations experienced at least one significant outage, defined as a full, continuous week of downtime. However, 2% of stations experienced 4 or more outages — a cumulative month of downtime in the span of a 6-month period. Worse, 10% of stations experienced extended outage durations lasting 6 to 9+ weeks.

The analysis concludes with a set of recommendations for how the industry can come together to improve uptime and reliability.

Recommendations to improve EVSE reliability, boost uptime, and enhance the EV driver charging experience

A. Ensure data accessibility, including via OCPP

B. Measure uptime effectively with standardized data reporting protocols

C. Allocate O&M-specific funding to maintain and renew EVSE infrastructure

D. Implement comprehensive warranty coverage paired with standardized troubleshooting protocols

E. Promote industry-wide leading practices while expanding technician training and certification

As America's EVSE buildout continues, reliability of the nation's charging infrastructure is paramount. Regulators and the industry are already making strides together, but more can be done in the months and years ahead to ensure greater success for the market and higher satisfaction for EV drivers.

Introduction

The transition to electric vehicles (EVs) is a cornerstone of the U.S. strategy to reduce transportation sector carbon emissions and tailpipe pollution. Globally, automotive original equipment manufacturers (OEMs) are embracing the transition, with consumers drawn to EVs' smooth, peppy acceleration and often lower overall total cost of ownership vs. comparable internal combustion engine (ICE) models. Consequently, the U.S. continues to see record-setting EV adoption and market growth. In 2023, new EV sales surpassed 1 million cars for the first time.

The success of this transition hinges on reliable charging infrastructure (EVSE). To that end, America's EVSE buildout is partly an in-motion success story. The number of public EV charge ports in the U.S. has doubled in three years, surpassing 175,000 ports nationwide as of early April 2024. The federal Bipartisan Infrastructure Law, Inflation Reduction Act, and Joint Office of Energy and Transportation (Joint Office) National Electric Vehicle Infrastructure (NEVI) program — combined with collaboration across major automakers — are scaling the charging infrastructure needed to support millions more EVs on the nation's roadways in the years ahead.

At the same time, shortcomings with the EV driver charging experience (EVCX) — some recently documented in high-profile media stories from USA Today, Bloomberg, and the Wall Street Journal — are hurting the industry's reputation, causing frustration among current EV drivers, and inhibiting would-be adopters from making the ICE-to-EV switch. A May 2024 Plug In America public charging experience survey found that 40% of EV drivers were unsatisfied with public charging availability and reliability, while nearly 70% had encountered a broken or nonfunctional charger within the past year.

Charging perception and reality both often fall short of the NEVI program's 97% uptime target, while "charging anxiety" has supplanted "range anxiety" as a chief concern among current and potential EV drivers. Yet EV drivers ultimately care about the answer to a single, core question: "Can I charge my EV when and where needed?" In this assessment of U.S. charging infrastructure, we take a closer, detailed look at EVSE reliability — so the market ecosystem can together boost reliability, reputation, and EVCX for the shared benefit of EV drivers and the industry alike.

Data Sources And Discussion

We leveraged five primary data sources for this report: two complementary sets of first-party data from ChargerHelp's direct EVSE O&M experience, third-party data from Paren, Inc., public data from the U.S. DOE's AFDC database, and select electric utility public PUC filings — all focused on public charging infrastructure. In total, we analyzed more than 19 million individual data points. Four major datasets contributed the bulk of data points to this analysis (see Figure 1):

ChargerHelp NEVI assessment

When the Joint Office announced its Electric Vehicle (EV) Charger Reliability and Accessibility Accelerator program in September 2023, ChargerHelp sent expert EVSE technicians to visit public sites where the AFDC database showed at least one charging station down, to better understand where and why charge ports were not working. That assessment included more than 4,800 charging stations across the country. Of those, nearly 2,100 were networked stations with status visible remotely via software/ driver apps. Technicians were able to perform a test charge at nearly 1,300 stations.

ChargerHelp O&M service data

As part of ChargerHelp's ongoing work as the only national EVSE-dedicated operations and maintenance (O&M) service provider, our team's experience and EMPWR software platform have covered more than 32,000 EVSE assets spanning 47 states. This includes ~12,000 corresponding work orders and ~2,200 reliability issues addressed. This hands-on data insights is a crucial complement to software-reported charging station telemetry.

U.S. DOE Alternative Fuels Data Center (AFDC)

We downloaded the AFDC database filtered for available and unavailable public L2 and DCFC charging stations in the 50 U.S. states plus Washington, DC. We focused on four dates: January 1 and December 31, 2023, as "bookends" for the calendar year, as well as July 25 and August 8, one week before and after the August 1 federal NEVI reporting deadline. At EOY 2023, the AFDC database contained more than 64,000 public EV charging stations totaling more than 168,000 L2 and DCFC charge ports. We also pulled AFDC data for total number of EV registrations by state through EOY 2022 (the most recent year for which such data was available, updated in mid-2023).

Paren, Inc.

Paren, Inc. uses a variety of techniques (OCPI, software APIs) to aggregate data from four major non-Tesla DCFC charging networks, down to the port level on individual charging station pedestals. Our analysis includes weekly data for H2 2023, spanning the week of July 2, 2023 through the week of December 31, 2023. At EOY 2023, the Paren dataset contained more than 9,700 DCFC charging stations. The H2 2023 data period encompassed more than 12.8 million attempted EV charging sessions.

We analyzed the data in aggregate, by state, by charging network, and by charging level (L2 vs. DCFC) to better understand the dynamics of EVSE up vs. down status at points in time; overall reliability over time (uptime vs. downtime); when, where, and why charging stations fail; and what it takes to keep charging stations online and boost uptime.

Despite growing adoption of standards such as the Open Charge Point Interface (OCPI), EV charging infrastructure data are not yet reported in consistent formats, making direct comparisons between datasets challenging. For example, across the various datasets we analyzed — and even within a given dataset — the distinctions between charging stations vs. charging pedestals vs. charge ports can vary widely. In some cases, 1 station = 1 pedestal = 1 port. In other cases, 1 reported station can = up to 40 pedestals = 40–80 ports. (Further complicating matters, there is often lack of clarity whether a dual-port charging pedestal allows dual / simul-charging or not.)

Through data meta analysis and by inspecting the data by down status, downtime, and charging success, as well as by stations, ports, age, networks, and geographies — we were able to identify and corroborate strong trends and insights that rose above the noise of data variance across datasets.

AFDC Data

64,653
TOTAL STATIONS AS OF EOY 2023

168,381
TOTAL PORTS (L2 + DCFC)

ChargerHelp's EMPWR data

32,000
ASSETS SERVICED (STATIONS+)

2,200
ISSUES ADDRESSED

12,000
WORK ORDERS PERFORMED

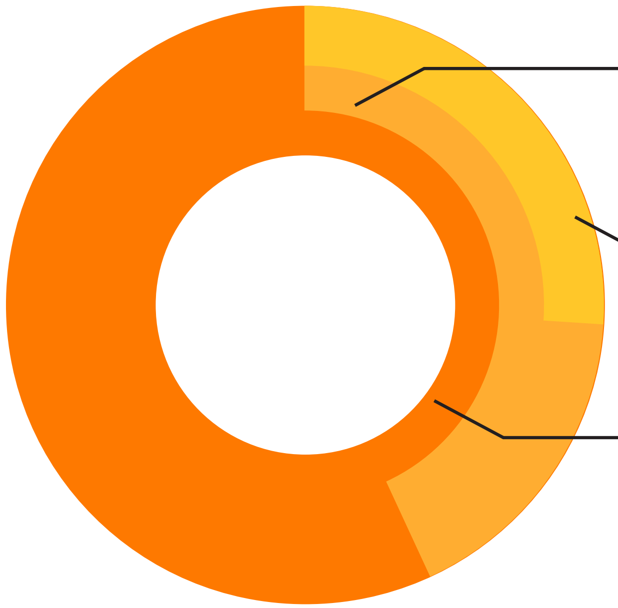
47
STATES COVERED

Paren Data

9,783
DCFC PEDESTALS AS OF EOY 2023

12.8M
ATTEMPTED CHARGES DURING H2 2023

ChargerHelp's NEVI campaign assessment



2,088
NETWORKED PORTS

1,261
GROUND TRUTH TESTED

4,844
UNIQUE PORTS

Findings

We explored three interrelated categories of insights: a) the discrepancy between reported uptime and true uptime, b) how reliability varies by EVSE age, state, and network, and c) the drivers of downtime and what it takes to improve uptime. The analysis revealed 6 primary findings:

1. true uptime is often lower than reported uptime
2. software inaccuracy compounds reliability shortcomings, reducing driver confidence
3. equipment age correlates with downtime and how 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 O&M

FINDING #1

True uptime is often lower than reported uptime

“True uptime” refers to EV drivers’ actual, on-the-ground experience attempting to charge their electric vehicles on a given port. This is in contrast to a station’s or a network’s self-reported status via OCPP, an app, or software API. In a perfect world, true uptime and software-reported uptime would 100% match and therefore be synonymous. However, our analysis revealed common — and sometimes significant — deviation between the two numbers.

In a point-in-time assessment of more than 4,800 charge points across the country, ChargerHelp in-the-field technicians found that for 15.4% of stations, the software-reported station status and the in-person, observed physical station status both indicated that a station was down. However, a much larger 26.3% of test charges failed — including 15% of stations where the software app and in-person physical station status agreed that the charge port was online and available.

Paren data strongly corroborates and reinforces the CH data finding (see Figure 2). Across the networks it monitors, Paren estimates actual station uptime only averages 84% across all stations (vs. 92% as self-reported by stations), with a range of 72–87% estimated actual vs. 79–100% self-reported. Similarly, successful charge attempts only totaled 84% of all charge attempts, with a range of 69–94% by network.

In other words, software consistently overestimates station uptime, point-in-time status, and the ability to successfully charge a vehicle. This indicates a need to apply a “correction coefficient” to get a true understanding of the state of U.S. public charging infrastructure.

For example, at the end of 2023, the AFDC database listed ~129,000 level 2 charge ports, of which ~7,000 (5.6%) self-reported as down. AFDC also listed ~38,000 DCFC ports, of which ~700 (1.8%) self-reported as down. Applying a true uptime “correction coefficient” suggests that the number of L2 and DCFC ports that were down was likely closer to 18% and 15%, respectively (see Figure 3).

FIGURE 2: comparing expected vs. actual station status, uptime, and charging success

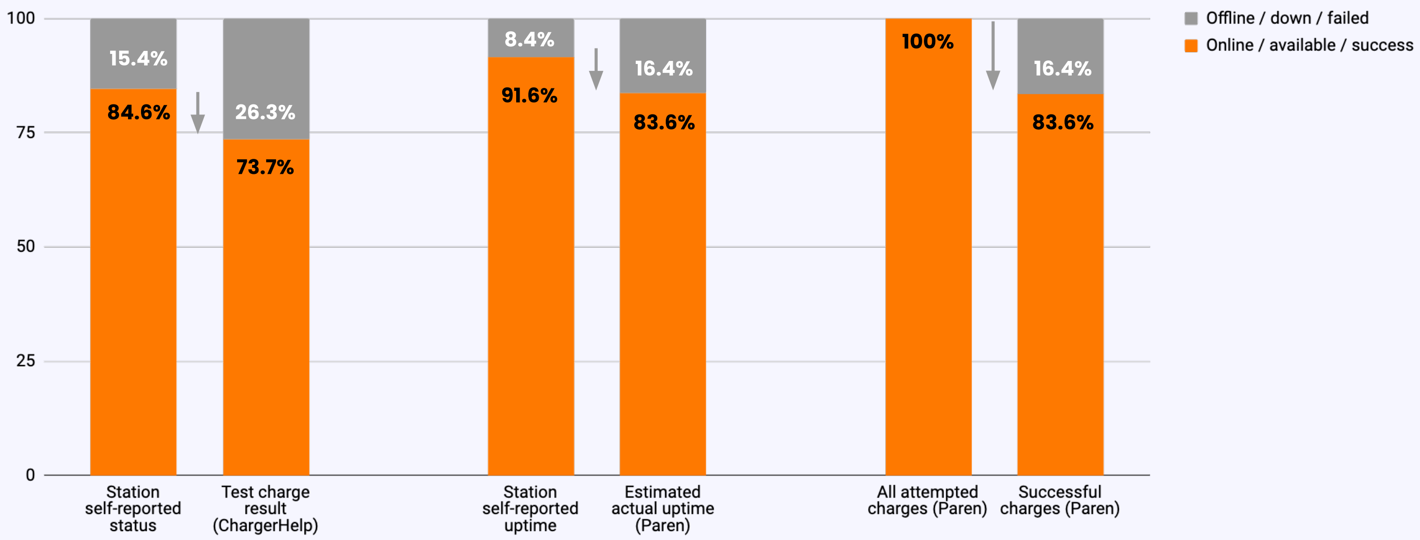
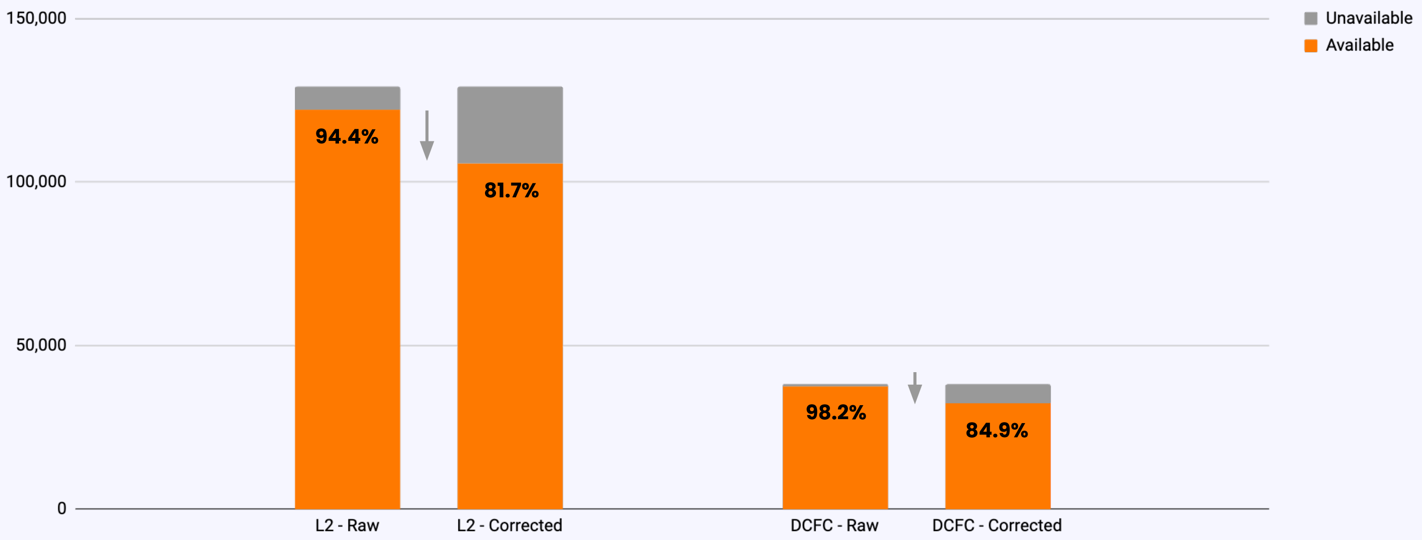


FIGURE 3: US DOE AFDC raw vs. corrected L2 and DCFC port status at EOY 2023



FINDING #2

Software inaccuracy compounds reliability shortcomings, reducing driver confidence

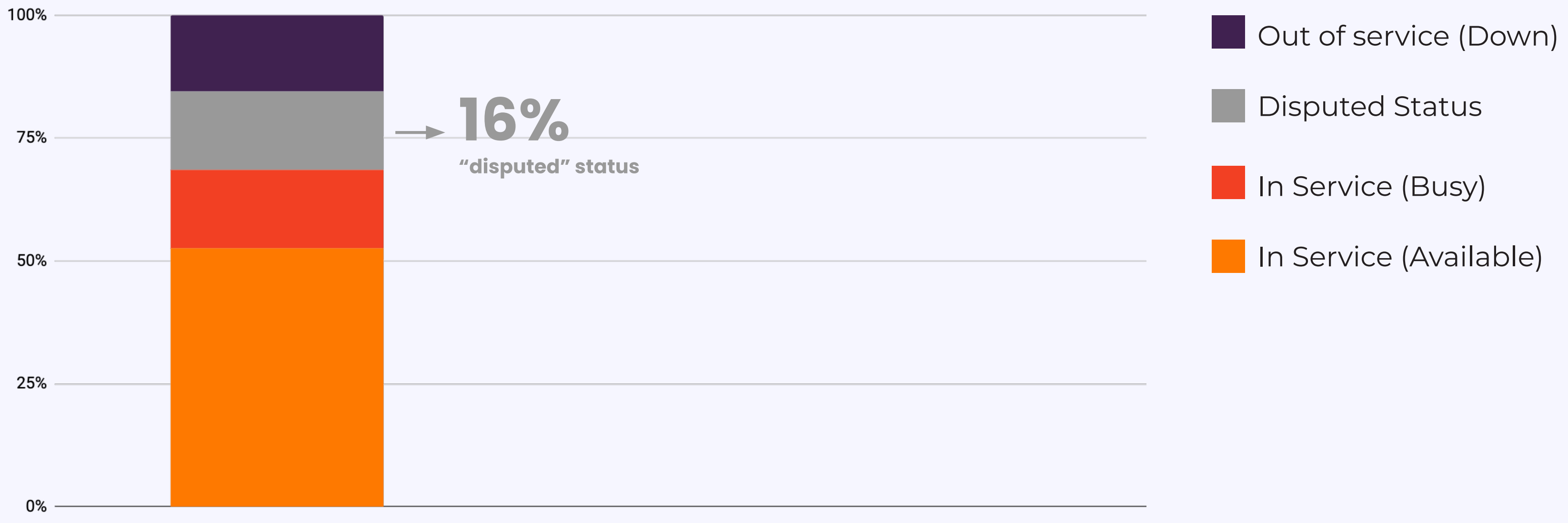
ChargerHelp field technicians found that 16% of the time, a charging station's physical status as observed by an EVSE tech and the station's status as reported in its software app disagreed, including stations that indicated they were operational / online but turned out to be offline in person (see Figure 4).

Worse, an additional 10% of stations (supposedly working ports where both the app and physical status suggested the station was operational) failed a test charge.

These software inaccuracies and overestimations of charging station status — coupled with failed charges at supposedly working stations — manifest in at least four specific ways impacting more than one-quarter (26%) of stations we analyzed (see Figure 5).

- **False positives:** For 1.9% of stations, software reported the station was online and either available or busy, but the in-person physical status was actually offline (i.e., down).
- **False negatives:** For 10.5% of stations, software reported the station was offline (i.e., down), but the in-person physical status was actually online and either available or busy.
- **Occupancy errors:** For 3.6% of stations, software incorrectly reported occupancy status, indicating the station was available when it was actually busy, or vice versa.
- **Undocumented station failure:** For 10.3% of stations, even though software and in-person physical status agreed the station was online and available, the station still failed to deliver a successful test charge.

FIGURE 4: software-reported vs. in-person physical station status agreement

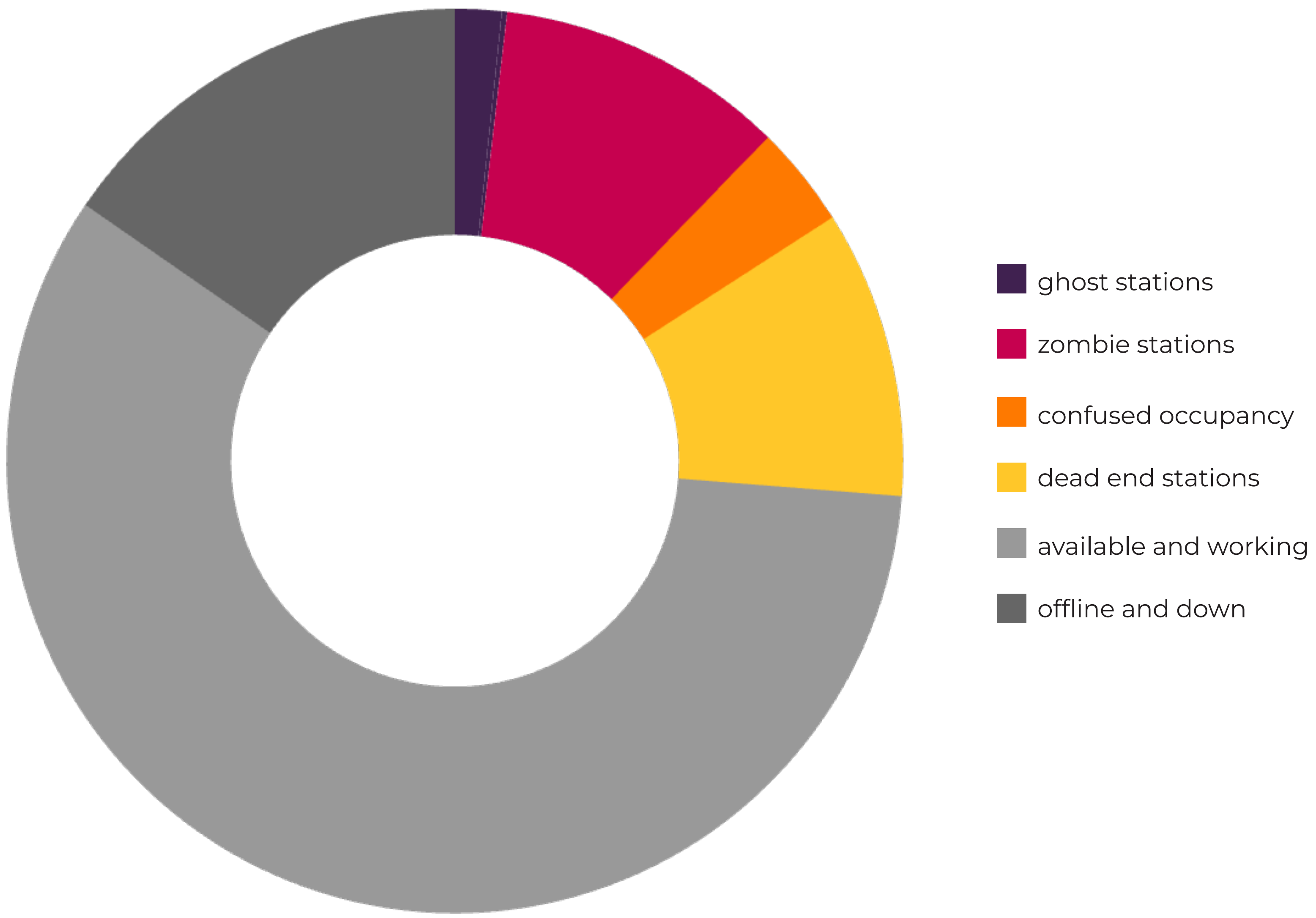


How software inaccuracy impacts EV driver charging experience

When app-reported status, in-person observed physical station status, and actual ability to charge an EV diverge, it negatively impacts EV drivers and exacerbates charging anxiety. More specifically, it translates into four EV driver charging experiences, corresponding to the four major vectors by which software accuracy departs from station reality.

- **GHOST STATIONS:** These false positives appear to be alive but are actually dead or imaginary. The software app says they're online and either available or occupied. In practice, they're physically down. This is a mission-critical "fail" if a driver shows up needing to charge and the station is offline or not even there.
- **ZOMBIE STATIONS:** These false negatives appear to be dead but are actually alive. These stations show as down in the software app, when they're actually working and in service — either available or currently occupied. EVCX reputation takes a hit, drivers get elevated charging anxiety, and charge point operators and drivers get "missed connections" from EVs that don't show up to charge, because they don't think it's possible.
- **CONFUSED OCCUPANCY:** These occupancy errors show incorrect status. Drivers either show up to charge thinking a station is available, but then have to wait because the port is occupied (frustrating). Or they see a port as busy / occupied in the app, when it's actually available (resulting in more "missed connections").
- **DEAD END STATIONS:** Perhaps most confoundingly, these undocumented station failures are stations for which the software app and the in-person physical station status both appear to be working, yet the station still fails to deliver a successful charge to an EV. Like ghost stations, this is an infuriating mission-critical "fail" if a driver shows up needing to charge and the station doesn't charge their EV.

FIGURE 5: software inaccuracy impacts EV driver charging experience in 4 ways



FINDING #3

Equipment age correlates with downtime and how reliability varies geographically by state

We found a positive correlation between EVSE infrastructure age and rates of down stations (see Figures 6 and 7). Perhaps not surprising — but confirmed in the data — older stations were more likely to be down, with a notable step change around the 4-year mark. Both normal equipment degradation over time and improvements in the quality of newer equipment being deployed could help to explain this finding. Consequently, states with a longer history of EVSE infrastructure buildout were more likely to have higher percentages of down stations.

At the end of 2023, every U.S. state had public L2 and DCFC charging stations, although the distribution of those stations were concentrated in certain states (see Figure 8). Just 6 states accounted for more than half of all public L2 and DCFC charge ports (52%), while 16 states accounted for more than three-quarters of all public charging ports (76%). California alone boasted just over one-quarter of public ports nationwide (27%). (In fact, in late April 2024, the California governor's office announced that the state now had 1 public or shared EV charging station for every 5 gas stations.) In a sign of broader market growth, at EOY 2023, 31 U.S. states had 1,000 or more public L2 and DCFC charge ports, according to the AFDC database, spanning the West, East, South, and Midwest.

Nationwide at EOY 2023, 4.7% of America's public EV charging station ports overall were out of service, ranging from <1% in North Dakota and Alaska to >10% in Washington, DC (see Figure 9). We found no strong correlations with variables such as state population, dominant political affiliation (e.g., red, blue, purple state), EV market size, or state reputation as being "EV friendly." Generally, those with a greater number of chargers started deploying infrastructure earlier, resulting in a higher share of older chargers and thus higher rate of down chargers vs. other states.

For example, Washington State ranks among top states for number of overall EV registrations, EV new car sales, and total electric car miles, yet it ranks lower for EV charging infrastructure reliability — with one of the highest percentages of down stations, according to our analysis of AFDC data. Meanwhile, Ohio — which in December 2023 installed the nation's first DCFC station using public NEVI funds — has some of the most-reliable EV charging infrastructure alongside other Great Lakes / Midwestern states including Illinois and Minnesota. All of these Midwest states (OH, IL, MN) have younger EVSE networks with more-recent average install dates for their charging stations, compared to Washington and other EV "legacy" states with older average EVSE network age, such as California and Washington, DC (see Figure 10).

When we examine DCFC infrastructure in particular — where two-thirds of the Bipartisan Infrastructure Law's $7.5 billion in funding is allocated — we see even wider variance in state-by-state EVSE reliability. The minimum and maximum values for down stations, downtime, and failed charge attempts have broad spreads (see Figures 11 and 12).

FIGURE 6: % all stations down (L2 + DCFC) vs. average open date of DCFC stations

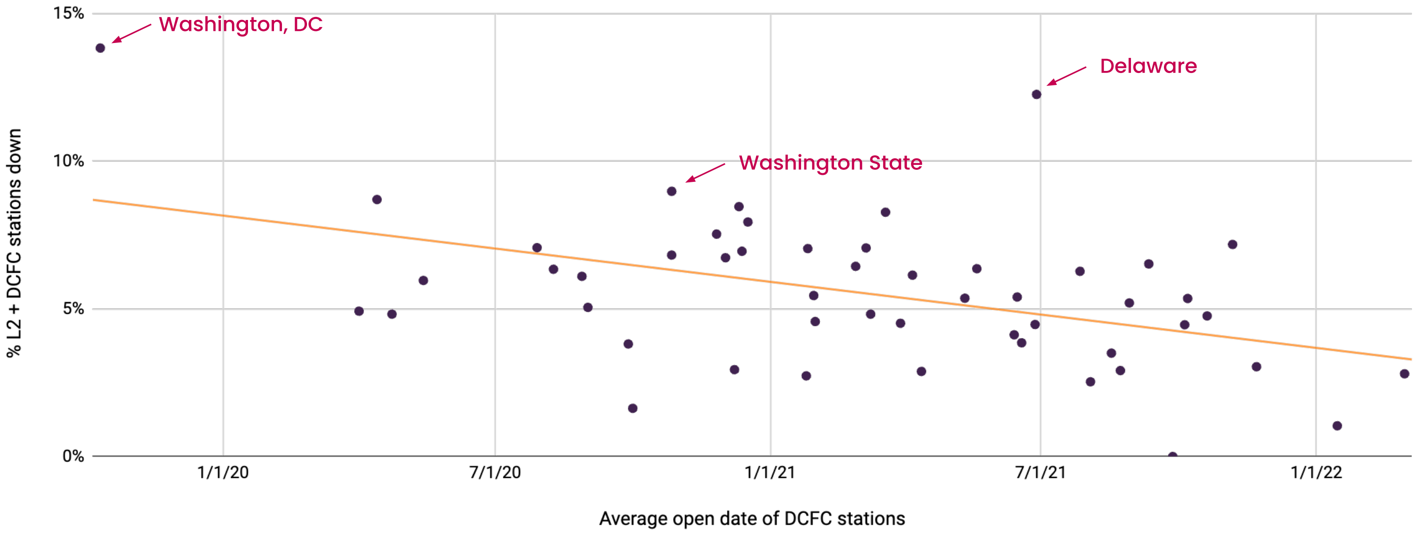


FIGURE 7: % of stations from install period listed as down at EOY 2023

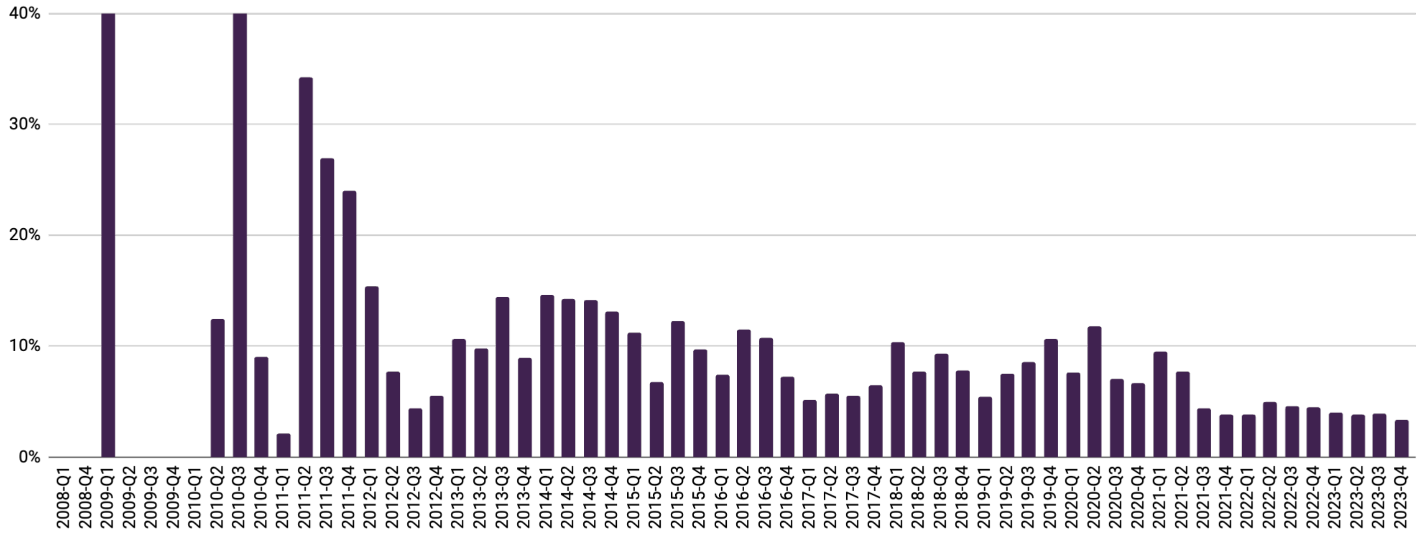


FIGURE 8: total public L2 + DCFC charge ports by state, EOY 2023 (AFDC)

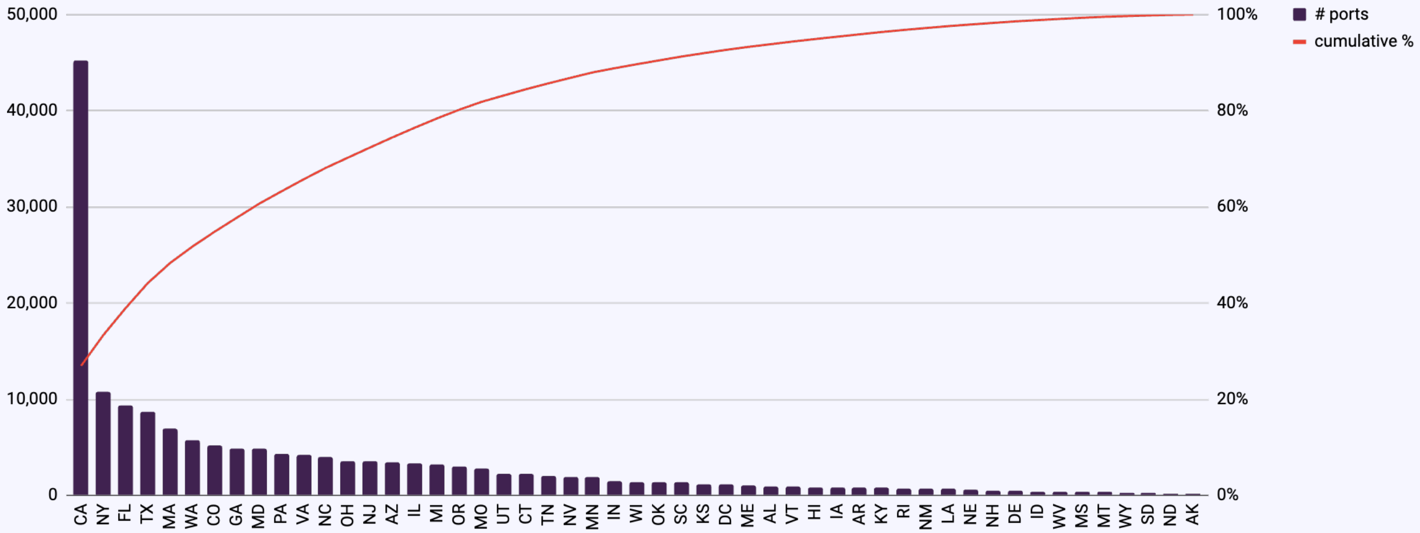


FIGURE 9: % all ports (L2 + DCFC) down by state, EOY 2023 (AFDC)

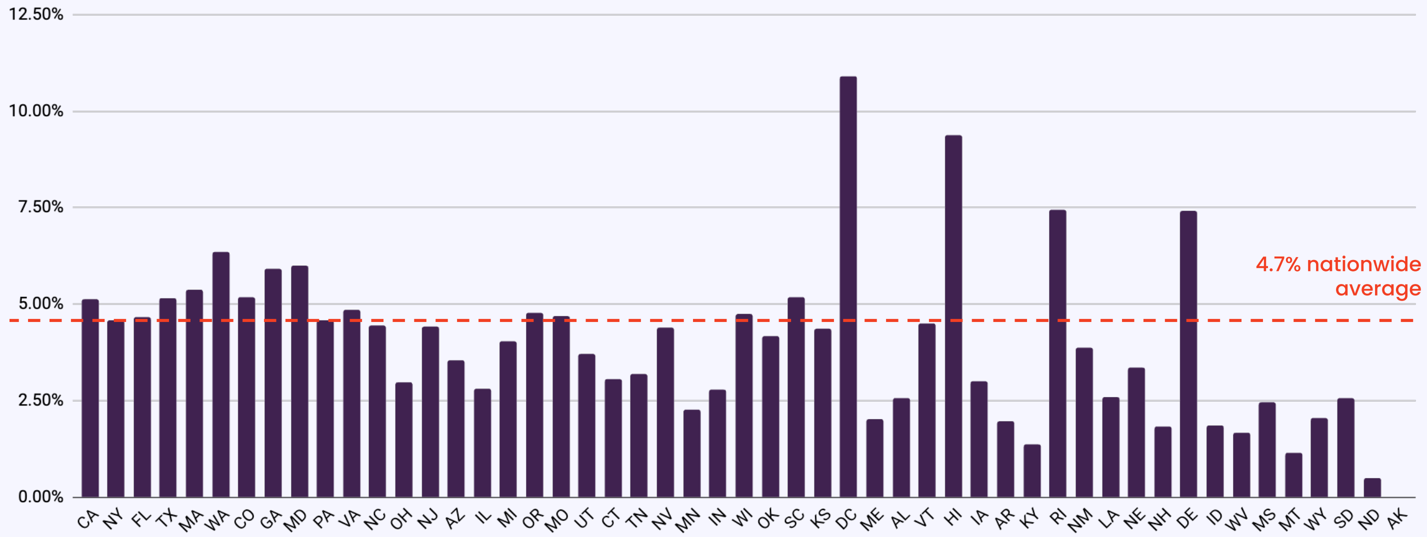


FIGURE 10a: % all ports down (L2 + DCFC), EOY 2023 (AFDC)

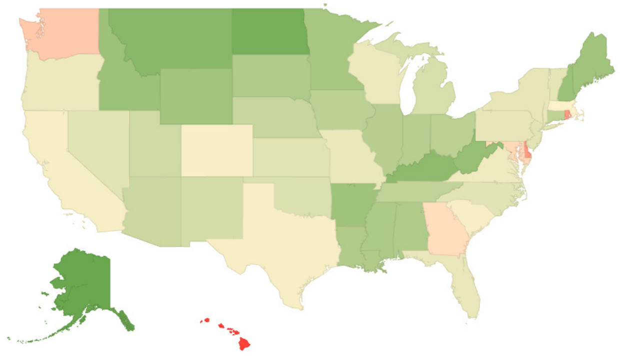


FIGURE 10b: % L2 only ports down, EOY 2023 (AFDC)

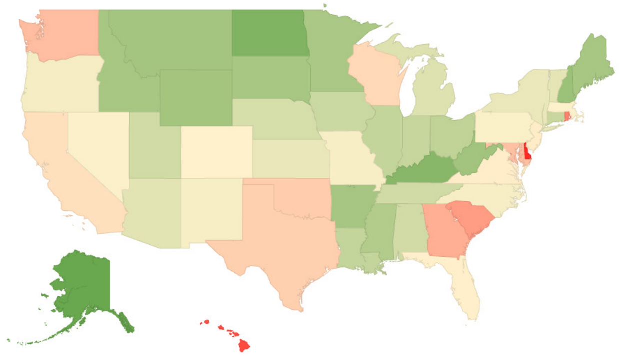
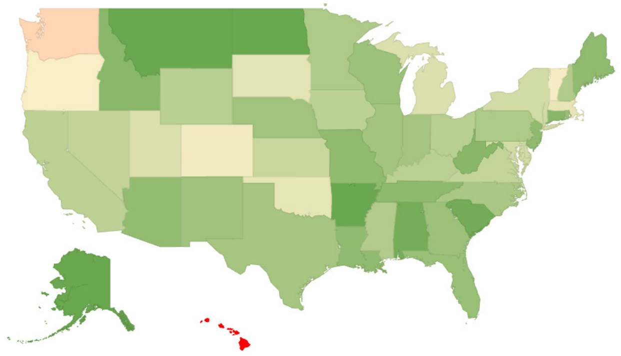


FIGURE 10c: % DCFC only ports down, EOY 2023 (AFDC)



fewer down ports | more down ports

FIGURE 11: focus on DCFC ports (down status, downtime, failed charge attempts)

FIGURE 12a: DCFC % downtime (Paren)

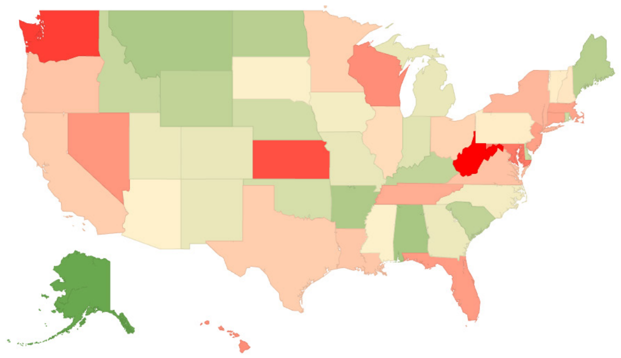
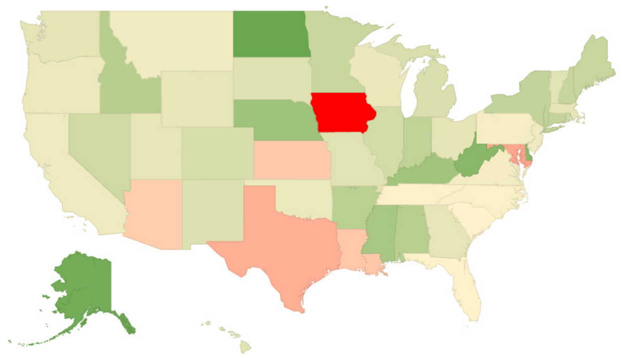


FIGURE 12b: DCFC % failed charge attempts (Paren)



lower downtime, fewer failed charges — higher downtime, more failed charges

EV adoption rates and driver competition for working, available charge points might be as important as true uptime

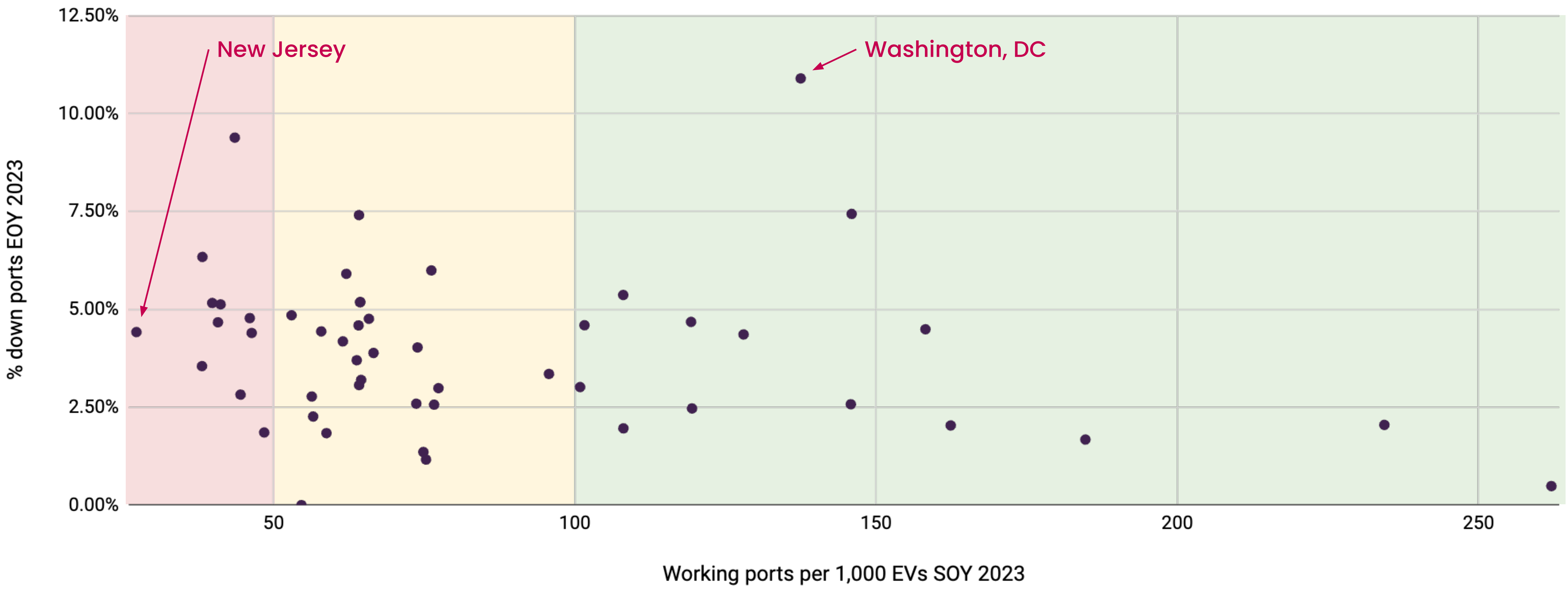
The nexus of state-by-state EVSE buildout and aging charging networks together have implications for how the industry plans for infrastructure maintenance and renewal, and also has regional impacts that affect driver experience. For example, percent true uptime and the percent of down stations at a point in time might not be the best measure of EV driver charging experience in a given state. The number of working charge ports relative to overall EV charging demand (such as total EV registrations in a state) might better reflect EVCX. Uptime and up/down status partly influences this, but so does overall buildout of a state's EVSE network (see Figure 13).

States with more-robust EVSE infrastructure might have a sufficient number of working stations to satisfy EV demand in their market, even if they have higher rates of downtime and down stations. Conversely, states with lower rates of downtime and down stations (generally a good thing, considered indicative of positive EVCX), might still experience EV charging congestion and competition problems among drivers if EV adoption is outpacing EVSE buildout, resulting in too few EV charge ports relative to EV driver demand, negatively impacting EVCX.

For example, at the start of 2023, New Jersey had a relatively low percentage of down ports (4.4% adjusted). From a classic EVSE reliability and uptime perspective, this is a good sign. However, New Jersey also had the lowest number of working charge ports per 1,000 registered EVs on the state's roads (27 ports per 1k EVs). This suggests charging station congestion from drivers and/or too few working charge ports to satisfy the demand of the state's EVs, negatively impacting EVCX. For a contrasting example, at SOY 2023, Washington, DC, had a significantly higher percentage of down ports (10.9% adjusted). Yet, DC also boasts one of the highest ratios of working charge ports per 1,000 registered EVs on its roads (137 ports per 1k EVs). Even taking overflow EV charging demand from neighboring Maryland and Virginia into account, this suggests a far better ratio of working charge ports to EVs, despite seemingly worse EVSE reliability metrics.

In other words, a stronger indicator of positive EVCX might be the raw number of working charge ports relative to total number of EVs on a state's roads, regardless of a state's EVSE network % downtime or % down stations at a point in time — even as higher uptime and more working stations boost driver confidence overall.

FIGURE 13: working ports per 1,000 registered EVs vs. % down ports



FINDING #4

Charging reliability varies dramatically by network

When examining 20 charging network operators (NOs) that have at least 500 charge ports in their network, it reveals a hard fork in the road. Some networks have a (seemingly) near-flawless record, with few or no reported down stations (or ports) at EOY 2023. Others consistently experience 10–20% of their stations down at any given point in time (see Figure 14). Thus EV driver experience — good or bad — depends in no small part on which network they typically charge their vehicle on.

Generally, L2 ports are more numerous but have lower reported down rates (0–10+%). By contrast, DCFC down ports are a significant problem (10–70% down at EOY 2023 on some major networks, see Figure 15). Although they represent a smaller aggregate absolute number of ports, this has huge impacts because DCFC ports have fast EV throughput with very short dwell / charge times vs. L2 stations and ports, and usually more EV driver urgency.

Although the 70% down DCFC ports represents an extreme edge case on one specific network, other prominent networks also show concerning rates of down DCFC ports. Only 4 networks account for just over one-quarter of DCFC ports nationwide, yet they contribute more than three-quarters of all down DCFC ports. Just one of those networks accounted for 40% of down DCFC ports at EOY 2023 (see Figure 16).

We found similar, wide variability on a network-by-network basis for the four networks covered in the Paren data, across both metrics of DCFC uptime (see Figure 17) as well as success / failure of attempted charges (see Figure 18). Certain networks were far more likely to show incorrect station or port status in its app, while other networks were significantly more likely to result in failed charge attempts.

Although we consistently found large differences from one network to another, it is important to note that the network operator itself might not be the principal driver of EVSE reliability and uptime. Some networks are characterized by homogenous, single-OEM EVSE hardware; other networks comprise a heterogeneous makeup of myriad EVSE hardware OEMs of varying levels of reliability.

Moreover, we anecdotally suspect that the operating model is another key influence. Vertically integrated networks with points of accountability for station uptime, reliability, and O&M not surprisingly often show better performance metrics. Meanwhile, networks where numerous individual and “mom-and-pop” operators own and/or operator individual stations tend to result in worse reliability performance.

FIGURE 14: % self-reported down stations, max during 2023 (AFDC)

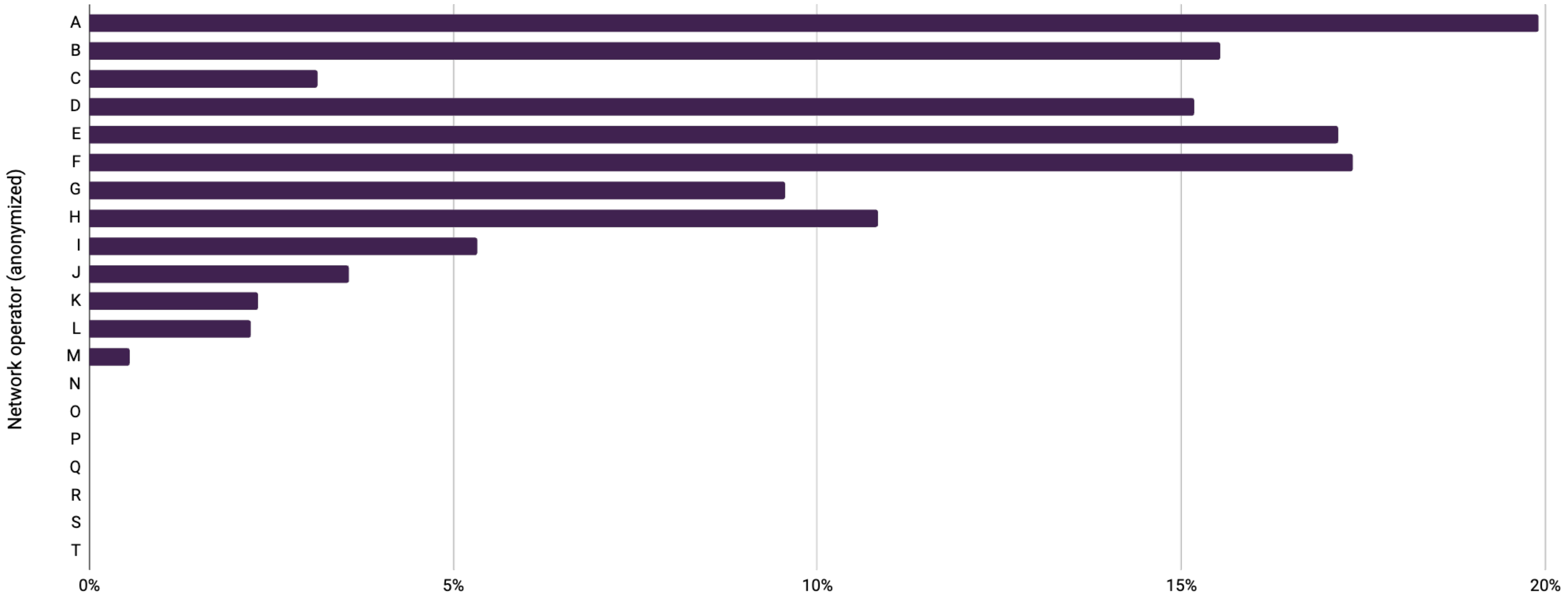


FIGURE 15: % self-reported down DCFC ports, max during 2023 (AFDC)

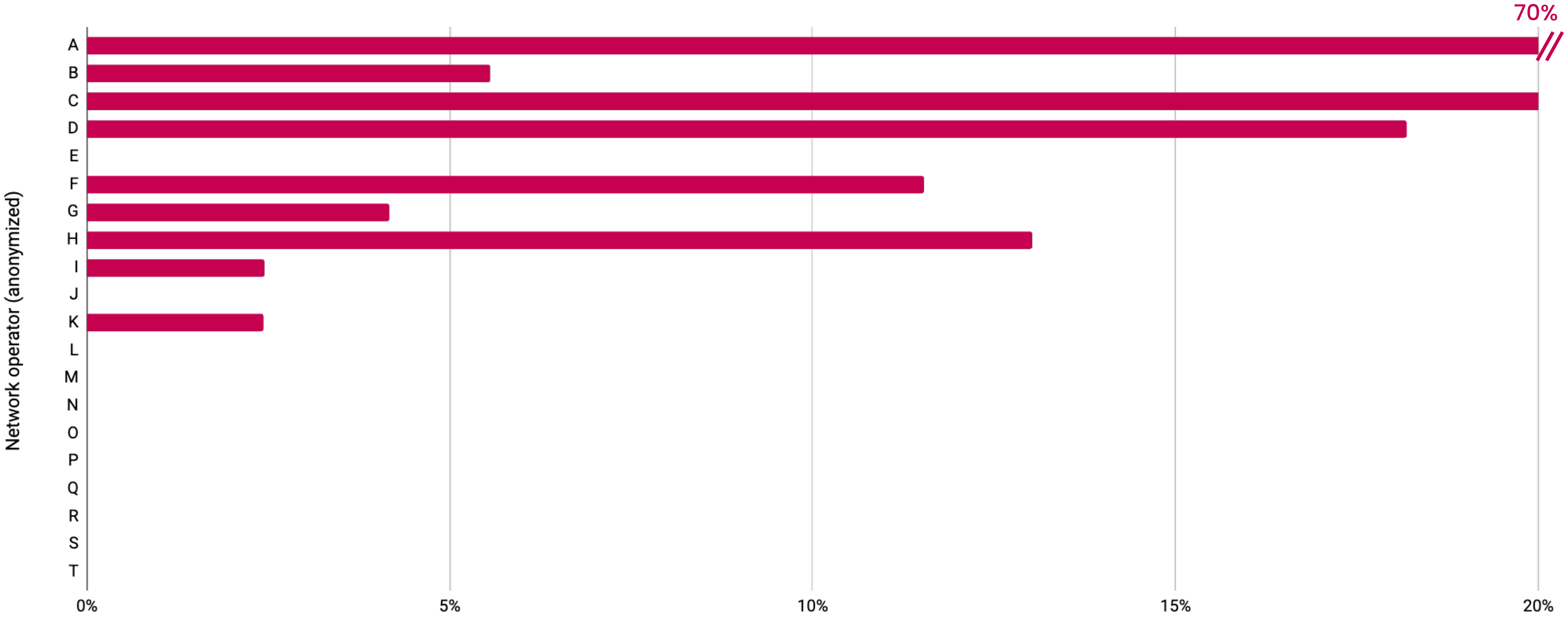


FIGURE 16a: DCFC ports by network

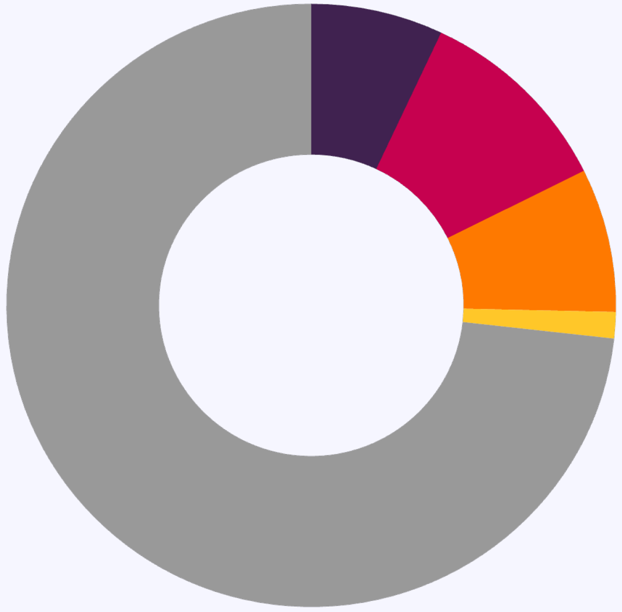


FIGURE 16b: network % contribution to down DCFC ports, EOY 23

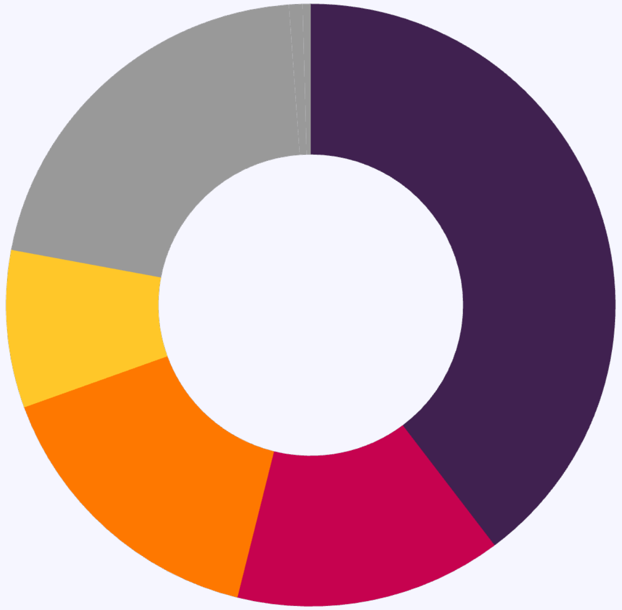


FIGURE 17: self-reported vs. inferred uptime across 4 DCFC networks, last 8 weeks of 2023 (Paren)

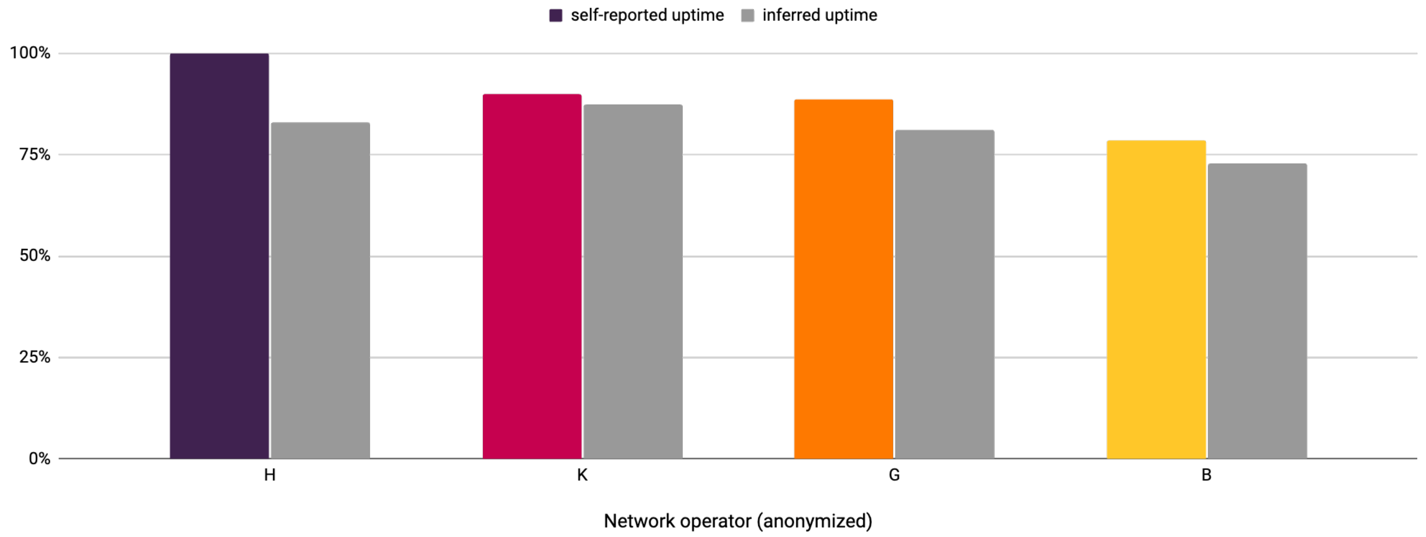
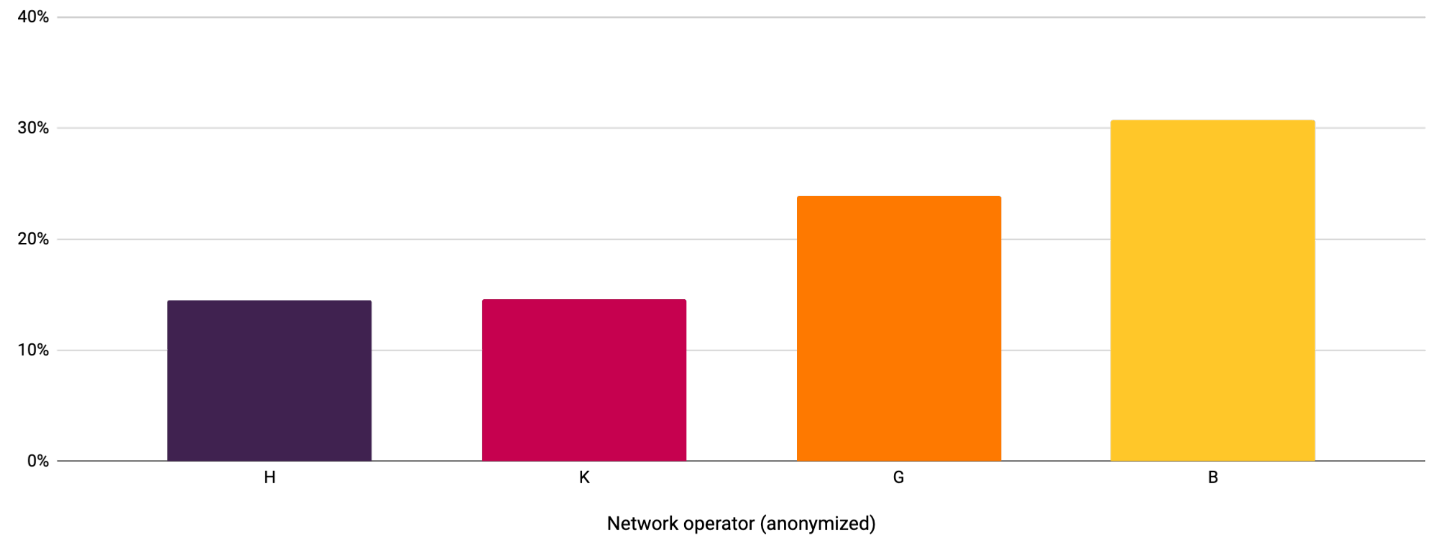


FIGURE 18: % failed charge attempts by network (Paren)



FINDING #5

The causes of downtime and failed charge sessions are multifaceted, although certain problems dominate

Stations showed myriad types of outward, observable signs of station damage and problems, ranging from cable and connector issues to cabinet and screen damage. Screens, used by drivers to observe station status and interact with the chargers, and retractors, useful for keeping cables and connectors off the ground and away from damage, were the most frequently damaged components of chargers assessed (see Figure 19).

Looking deeper at down stations only, however, the payment system condition had a significant, strong positive correlation with working vs. down stations (see Figure 20). Working stations had few, if any, payment system issues. Meanwhile, nearly half of down stations had broken / nonworking payment systems.

An alternative view of symptom prevalence based on ChargerHelp's EVSE O&M experience reveals that internal evidence of component failure or damage is the most common symptom found, followed by communications and/or software failures. Together they account for more than two-thirds of symptoms. By contrast, electrical problems and site damage (such as vandalism) combined accounted for less than 2% of symptoms (see Figure 21).

FIGURE 19: rates of observable charging station damage (ChargerHelp)

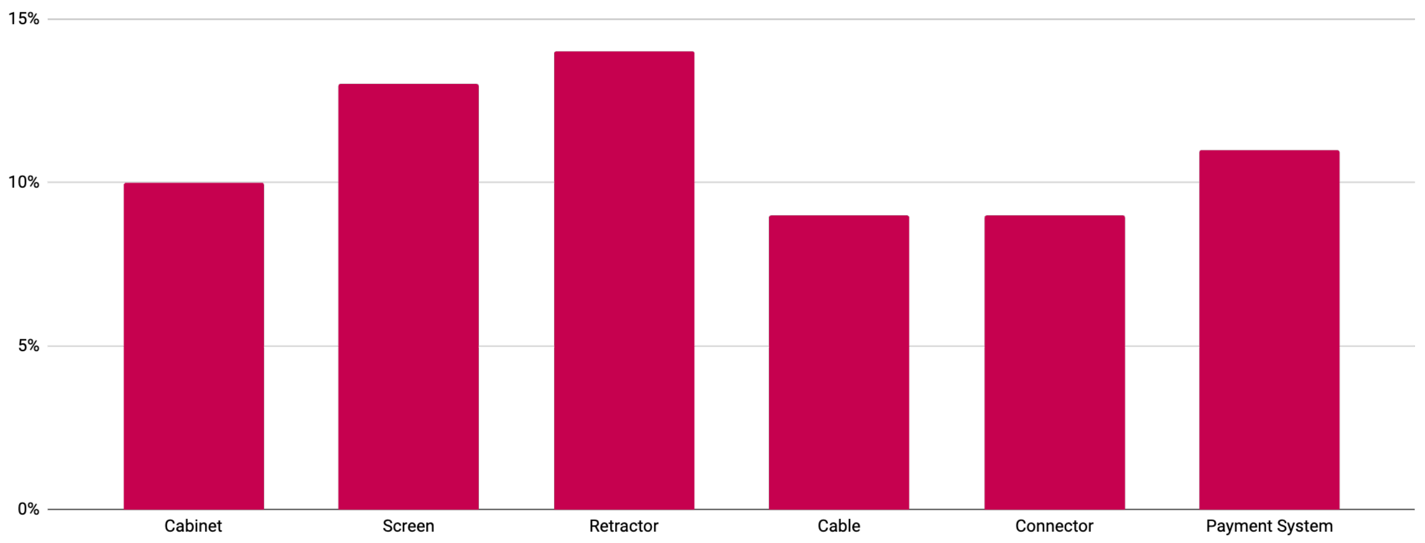


FIGURE 20: relative prevalence of observable damage at down stations (ChargerHelp)

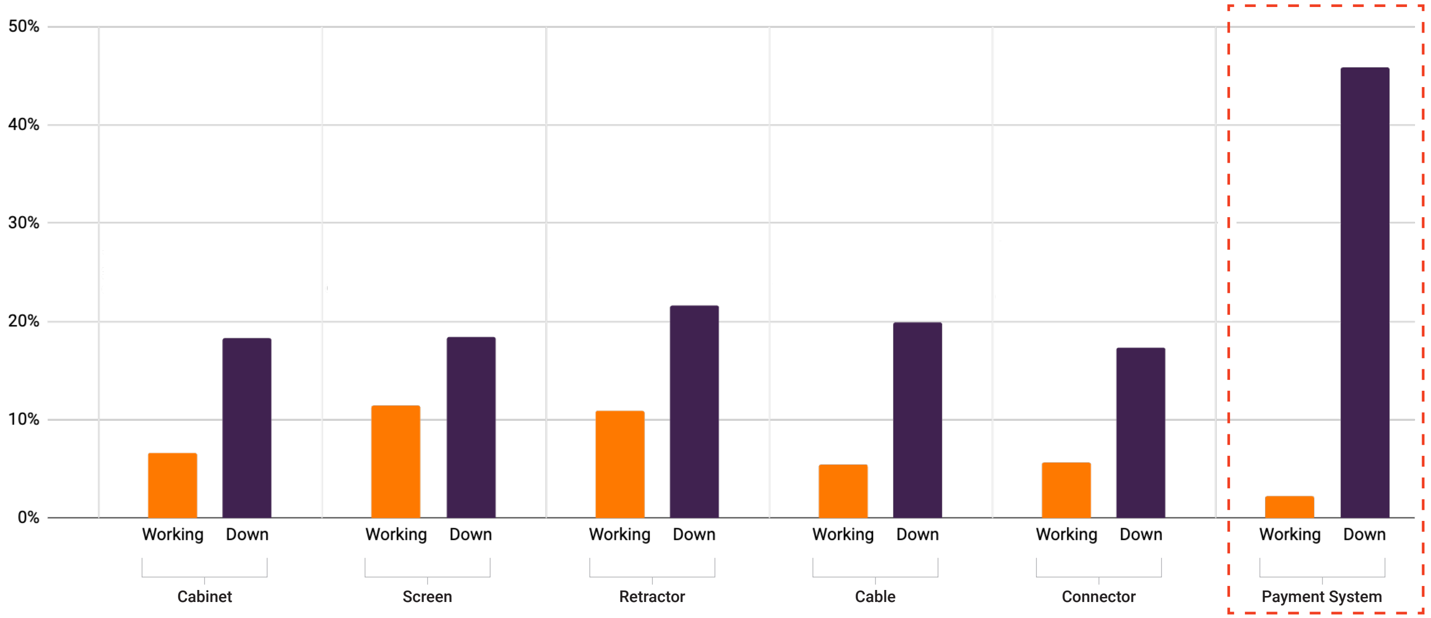
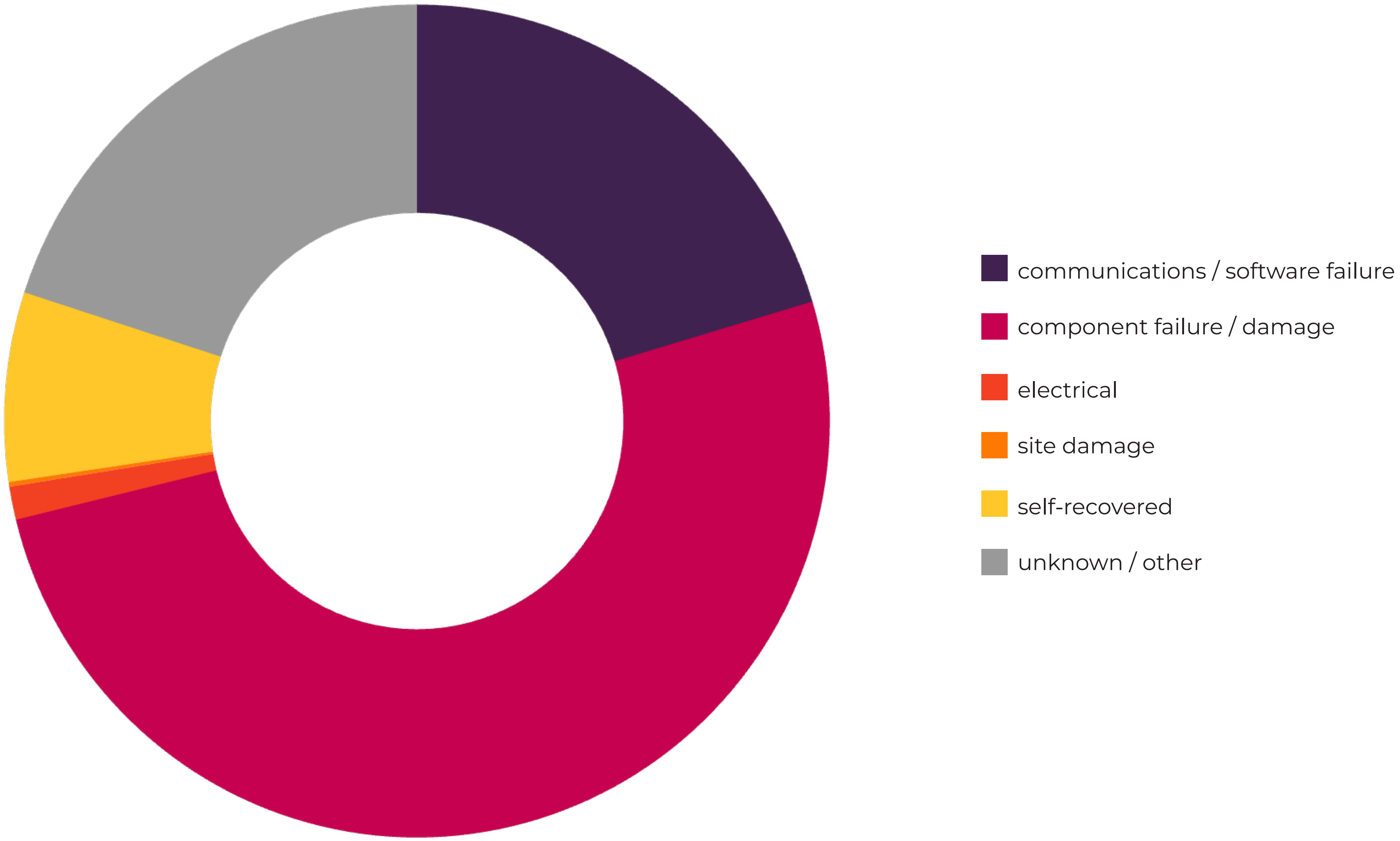


FIGURE 21: charging station symptoms as fraction of all symptoms



FINDING #6

Addressing "problem" stations can alleviate a disproportionate burden on EVSE O&M

Across ChargerHelp's experience servicing more than 32,000 EVSE assets, two-thirds of problems (66%) required just a single work order to address an asset repair or O&M issue. However, a small number of "problem stations" (3.5%) required 4 or more work orders to diagnose and resolve issues, placing a burden on O&M resources and dragging down station and network uptime and reliability metrics (see Figure 22).

Cross-referencing the Paren data, during the second half of 2023, nearly half of DCFC stations experienced at least one significant outage, defined as a full, continuous week of downtime. However, 2% of stations experienced 4 or more outages — a cumulative month of downtime in the span of a 6-month period (see Figure 23). Worse, 10% of stations experienced outage durations lasting 6 to 9+ weeks, meaning they were continuously out of service for a month or more at a time (see Figure 24).

Across the dataset, the average outage duration was 2.57 weeks; the median was 1 week. By contrast, achieving the NEVI 97% uptime target requires a maximum annual total outage time of 1.57 weeks (~11 days). Problem stations are far exceeding that amount of downtime in half the calendar period, dragging down overall uptime metrics for their respective networks.

Note: these stats only include outages that started and ended during H2 2023. It undercounts outages that started prior to H2 and, likewise, underrepresents outage duration that lasted into 2024.

FIGURE 22: EVSE O&M work orders per issue (ChargerHelp)

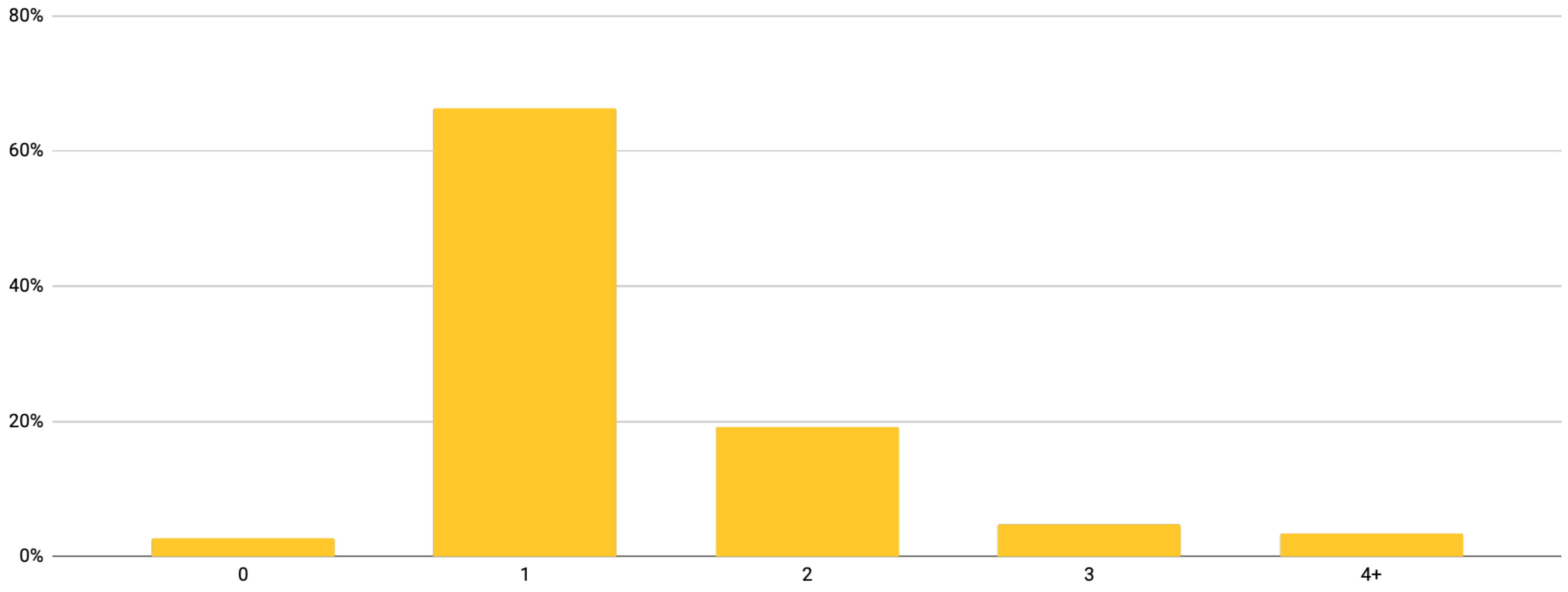


FIGURE 23: outages per DCFC charger (Paren)

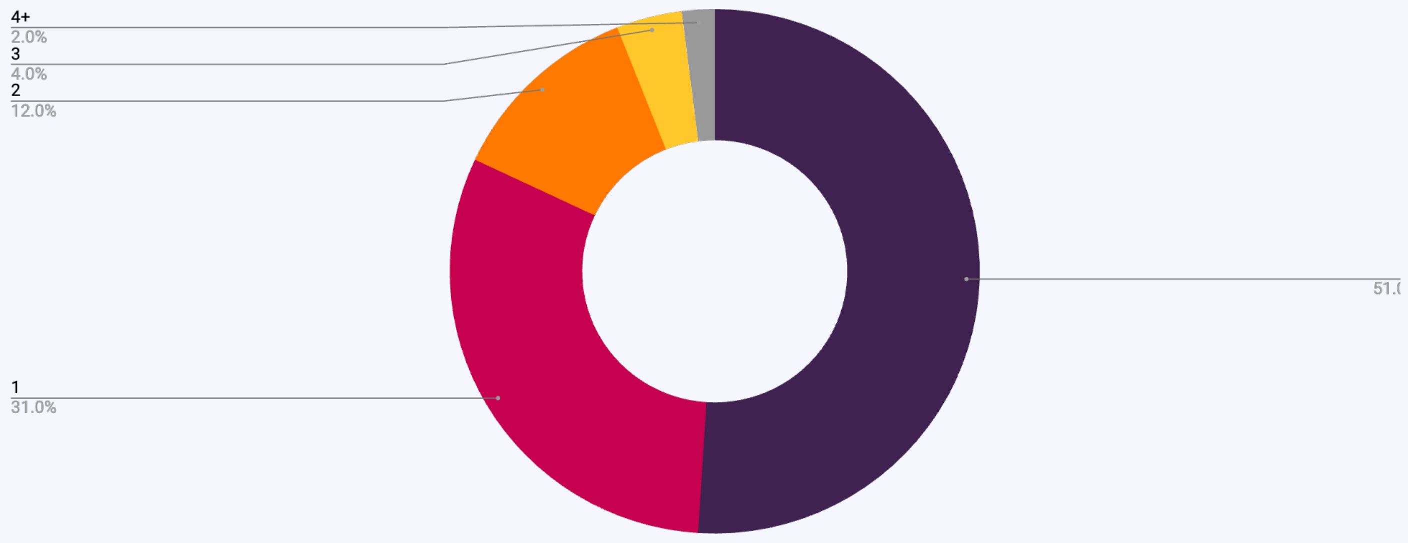
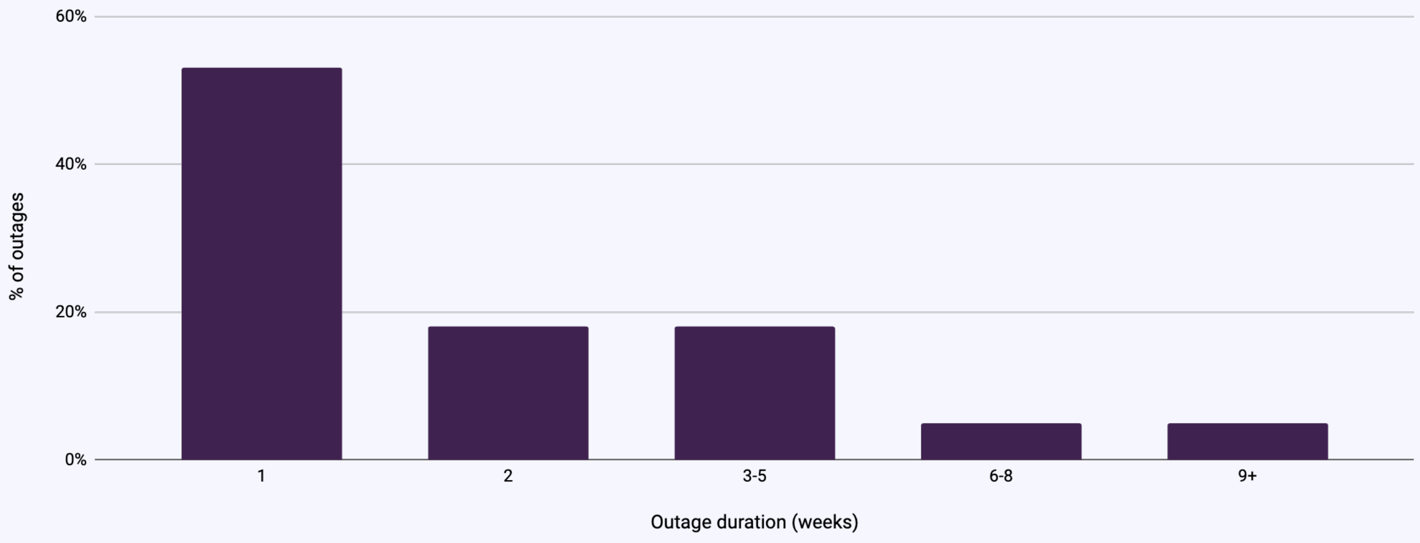


FIGURE 24: % outages by outage duration



MTTR + MTBF as EVSE O&M metrics to complement true uptime

ChargerHelp uses two metrics to better track EVSE reliability: mean time to repair (MTTR) and mean time between failures (MTBF). In short, they catalog how quickly a down station returns to working condition, and how much time elapses between issues that cause a station to go down.

MTTR and MTBF are analogous to well-established metrics in the electric utility industry: the system average interruption duration index (SAIDI) and system average interruption frequency index (SAIFI). In layman's terms, MTTR and MTBF track how quickly EV charging station problems are fixed and how frequently problems occur.

EVSE O&M programs that reduce MTTR and lengthen MTBF together can better increase charging station uptime and boost overall reliability. The industry is currently oriented around response times defined in service-level agreements (SLAs). However, SLA-based response times are only a proxy for MTTR and MTBF. Directly measuring MTTR and MTBF — and setting O&M SLAs around such ultimate metrics — can serve as better metrics for O&M planning geared around higher uptime.

Recommendations

The current state of EVSE reliability in the U.S. is the byproduct of the industry's early approach to charging infrastructure buildout. Although charging station uptime is implicitly in the best interest of the EV market overall, EV driver experience, and EV adoption, there was no regulatory mandate or concrete business case for it. EVSE hardware and software were sold up front, detached from robust warranties and comprehensive O&M resourcing.

Today, many warranties offered to site hosts are limited to "parts only." Even when network providers have a warranty program like ChargePoint's Assure, there is a need for more coordination between EV charging manufacturers and network providers to increase uptime. This lack of coordination typically pertains to troubleshooting. Troubleshooting becomes challenging because it is unclear whether the issue lies with the station, hardware, telecommunications, or the vehicle itself, making it difficult to determine who is responsible for troubleshooting.

Moreover, even as programs like NEVI have brought needed uptime requirements and reporting standards to the table, there remains a massive amount of legacy EVSE infrastructure not bound by those parameters.

We thus offer the following set of recommendations for how the industry can come together to improve uptime and reliability:

A. Ensure data accessibility, including via OCPP
B. Measure uptime effectively with standardized data reporting protocols
C. Allocate O&M-specific funding to maintain and renew EVSE infrastructure
D. Implement comprehensive warranty coverage paired with standardized troubleshooting protocols
E. Promote industry-wide leading practices while expanding technician training and certification

A: Ensure data accessibility, including via OCPP

Enhance the accessibility of Open Charge Point Protocol (OCPP) data and other relevant diagnostic information for network providers and station operators. This will aid in more accurately diagnosing issues without extensive physical troubleshooting, thereby increasing the efficiency of maintenance operations.

Examples: AMPECO's OCPP backend solution supports OCPP 1.5, 1.6, and the latest OCPP protocol 2.0.1; has ready integrations with the 70+ leading charging station manufacturers; and includes a robust, well-documented API. California Energy Commission 2023 guidance (updated April 2024) requires all publicly available state- and ratepayer-funded chargers installed on or after January 1, 2024 to share real-time data on the availability and accessibility of the chargers.

B: Measure uptime effectively with standardized data reporting protocols

Although the Federal Highway Administration's (FHWA) final ruling includes an uptime definition, there remains a broader lack of consensus for how to best calculate EV charging infrastructure reliability. Fundamentally, any updated, improved uptime metric should programmatically reconcile the current disparity between what software is self-reporting and the on-the-ground charging experience of EV drivers. Establish standardized real-time data reporting protocols across the industry to improve the accuracy and reliability of reported information.

This involves establishing enhanced reliability standards that detail specific requirements for operational reliability and performance of EV charging stations. The aim is to go beyond NEVI's foundational requirements to include precise metrics for uptime, maintenance response times, quality of service, and user satisfaction, creating clear, measurable goals that enhance the reliability of EV charging stations.

Further, regulatory oversight of enhanced reliability standards would help ensure adherence to these higher standards, fostering greater consumer confidence and encouraging broader EV adoption. This would include regular inspections, compliance audits, and penalties for non-compliance, ensuring that the standards are actively maintained.

Examples: Various initiatives — including the Public Service Commission of Maryland's Electric Vehicle Work Group — aim to standardize a common, accepted uptime definition. EVSE manufacturers such as Fractal EV are incorporating elements into the charger user interface, as a way to better capture EV driver feedback, while EV OEMs such as Rivian have unveiled charging station reliability scoring that incorporates the driver community's collective experience with a given charging station. The Joint Office's Electric Vehicle Charging Analytics and Reporting Tool (EV-ChART), unveiled February 2024, is a web-based data portal and analytics platform that includes standardized data formatting.

C: Allocate O&M-specific funding to maintain and renew EVSE infrastructure

America's network of legacy EV charging infrastructure is extensive and aging, while new installs are rolling out at record pace. In fact, the oldest still-in-operation charging station in the AFDC database is nearly 30 years old (well beyond the expected lifespan of most EVSE hardware) and dates to 1995 (for use with the General Motors EV1, one of the first mass-produced EVs in America). Dedicated funding for legacy and new infrastructure is crucial to maintain overall network reliability and uptime, especially as EVSE buildout accelerates and existing charging stations risk getting left in the proverbial rearview mirror.

In tandem, encourage the drafting and utilization of O&M-specific Requests for Proposals (RFPs) that clearly outline the requirements and expectations for EV charging station maintenance. This clarity will help ensure that all potential contractors have a precise understanding of the scope of work, leading to more-effective station management and upkeep.

Examples: The NEVI program's Electric Vehicle Charger Reliability and Accessibility Accelerator Program Grant awards granting funding "to repair or replace broken or non-operational electric vehicle charging ports to improve the reliability of existing charging infrastructure." The FY 2022 and 2023 grant cycles awarded nearly $149 million to state departments of transportation and local government entities in 20 states, covering more than 4,400 charging ports. In January 2024, Colorado announced state grant funding specifically dedicated to support EV charging O&M across nearly 200 locations statewide. Southern California Edison's Approved Product List for EV Hardware (APL) could serve as inspiration for something similar with EVSE O&M.

Beyond general uptime to driver-centric uptime metrics

Currently, uptime definitions lean toward calculating uptime on a rolling monthly basis for the prior 12-month period, at a time granularity of minutes — inclusive of both hardware and software aspects, but excluding certain events outside the charging station operator's control, such as electric utility service interruptions or Internet or cellular service provider interruptions.

However, this general view of uptime doesn't adequately take into account important aspects of the EV driver experience. In particular, the timing of downtime could have an outsized positive or negative effect on the overall EV charging experience. For example, from a charging experience standpoint, short-duration but peak-demand downtime could be worse than longer-duration downtime at off-peak times.

Consider the hypothetical case of a workplace L2 charger that employees use to charge their EVs during the workday. In this case, weekday, daytime charging station downtime would have a huge impact on drivers, compared to station downtime that occurred overnight or on weekends — even if the resulting general uptime was the same percentage.

Or consider a scenario involving a DCFC charging station during the Thanksgiving holiday long weekend, when Americans drive more and there's more EV charging demand and greater "competition" at high-occupancy, high-throughput stations. A down DCFC charging station during such a peak demand period has a far worse impact on EV drivers than downtime outside of the holiday weekend.

Uptime metrics that take into consideration ultimate impact on EV driver experience should be part of the industry's roadmap.

D: Implement comprehensive warranty coverage paired with standardized troubleshooting protocols

Implement robust warranty programs that guarantee the uptime and reliability of charging stations, regardless of the specific issue's origin. These warranties should encompass a broad spectrum of potential problems, from hardware malfunctions to software issues, and include parts and labor to ensure quick and efficient resolution.

In parallel, introduce minimum reliability standards that are enforced by regulatory oversight to ensure consistency across all charging networks — and develop standardized troubleshooting protocols that utilize real-time data and error codes to identify and resolve issues swiftly. This approach will minimize the need for onsite technician visits, reduce downtime, and cut costs associated with prolonged station inactivity.

Examples: TThe ChargeX consortium under Idaho National Laboratory has proposed minimum required error codes. ChargerHelp's Reliability as a Service (RaaS) subscription offers unlimited corrective maintenance, support from certified EVSE technicians, and proactive network monitoring. RaaS spans Level 2 and DCFC charging stations, comprehensively covering more than 25 EVSE hardware and software companies under a single, holistic umbrella. Coupled with a robust parts-inventory plan, RaaS ensures high reliability and uptime, in part through optimized, prebuilt service workflows to efficiently diagnose and resolve issues.

E: Promote industry-wide leading practices while expanding technician training and certification

Improve communication channels between technicians and manufacturers to reduce wait times and expedite troubleshooting processes. This could involve dedicated support lines, improved remote diagnostic tools, and faster response times for onsite technician dispatch.

Further, address the current bottlenecks in technician training by adopting a "train-the-trainer" model and partnering with workforce training organizations. This strategy will increase the availability of training slots and reduce logistical burdens on technicians seeking certification, potentially including subsidized or manufacturer-supported training programs.

Examples: EV Connect's 24/7 customer service provides a more-direct connection to both remote support as well as technician dispatch into the field, when necessary. Tritium Academy is one of the industry's best examples of technician training programs, even though the company overall declared insolvency in April 2024. SAE International's EVSE Technician Certification is expanding the pool of skilled professionals in the field.

About ChargerHelp

ChargerHelp (CH) is fixing the single, greatest barrier to faster electric vehicle (EV) adoption: the charging experience.

As the first company exclusively dedicated to EVSE operations and maintenance (O&M), we're working together with the entire EVSE value chain to make true uptime the norm — so the overall EV market can flourish. We achieve that goal through three pillars:

- Offering turnkey EVSE O&M through Reliability as a Service (RaaS),
- Empowering EVSE owners and operators, as well as EVSE O&M providers, through the EMPWR software platform, and
- Providing learning and development programming to foster a skilled EVSE technician workforce.

Headquartered in Los Angeles, CA, USA, CH is proudly a women- and minority-owned business boosting the EV market for all.

For more information, please visit https://www.chargerhelp.com/.