ASSURE CHARGE: A DATA DRIVEN APPROACH TO SERVICING AND MAINTAINING EV CHARGE POINTS

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ABSTRACT

The reliability of Electric Vehicle Supply Equipment (EVSE) is a critical factor in the widespread adoption of EVs to meet decarbonisation targets. The Assure Charge project has identified several key areas for improving EVSE reliability, particularly the need for more clearly defined roles and responsibilities in maintaining EVSE and the need for the sharing of data between charge point operators (CPOs) and third parties to provide services such as fault diagnosis and performance reporting. The project has demonstrated a fault diagnostics and job matching platform for EVSE repair on a set of public on street chargers. Using such platforms, EVSE faults can be diagnosed and often remotely repaired to reduce potential inconvenience to EV users and improve their charging experience.

INTRODUCTION

The electric revolution of transport is well underway with UK Battery Electric Vehicle (BEV) registrations increasing by 76% in 2021 compared to 2020 and BEV registrations exceeding those of Diesel cars in 2021 [1]. Public charging infrastructure must meet this growing demand and provide a positive charging experience to EV users otherwise there is a risk of slowing uptake due to publicised unsatisfactory experiences.

The Assure Charge project, funded by the Innovate UK fund 'Infrastructure Solutions for Zero Emissions Vehicles', is led by the charge point provider Connected Kerb Ltd. and the PNDC, University of Strathclyde. The project aims to improve reliability of public EV charging infrastructure by leveraging connected data from EV charging infrastructure to inform operation and maintenance (O&M) and fault repair processes. Furthermore, through stakeholder engagement and researching the business models and incentives prevalent in the public EV supply equipment (EVSE) industry, the Assure Charge project aims to provide insights for those organisations responsible for operation and maintaining public EVSE.

PROJECT BACKGROUND

The motivation for the Assure Charge project comes from the gap in the 99% availability target proposed by the UK government and the reality of 8% of public EVSE being out of service in 2019 [2]. The causes of high numbers of EVSE being out of service are wide ranging and include lack of profit incentive with subsidised EVSE; unclear division of responsibilities between the multiple parties involved in the installation, maintenance and operation of public EV charging infrastructure; lack of proactive fault detection and resolution; lack of accountability in the form of service level agreements (SLAs) between owners and suppliers; and lack of performance monitoring.

To address these issues this project investigates and demonstrates:

1. The EV user experience and performance of EV charging infrastructure today.
2. How connected data from EVSE can be used for fault prediction, identification and classification, reapplying asset management strategies from other industries.
3. Where the installation of additional environmental sensors can be added to EVSE, allowing new data sources to be gathered and correlated with existing data sets for O&M use cases.
4. The relevance of EVSE data standards, including Open Charge Point Protocol (OCPP) [3] and Open Charge Point Interface (OCPI) [4], in gathering and sharing O&M relevant data across different organizations and systems.
5. The pros and cons of a number of EVSE owner/operator/maintainer structures relating to servicing and maintenance, including how each facilitates or prevents ease of data sharing.
6. How third-party and local O&M service providers providing first and second line fault response can be a more efficient than centralized support teams tied to a single EVSE manufacturer or operator.
7. Future procurement and maintenance contract structures that incentivize EVSE industry stakeholders to provide high-levels of device reliability and user satisfaction at least cost.

The project team has deployed 10 public on-street charge points with three hosts to demonstrate the O&M data analysis techniques developed and to evaluate their value to EVSE owners. The charge points have been integrated with a data analytics and job matching platform (the 'Assure Charge' platform) to demonstrate predictive maintenance and repair by a local workforce. Parking and tilt sensors have been installed to indicate occupied bays and damage to the EVSE.

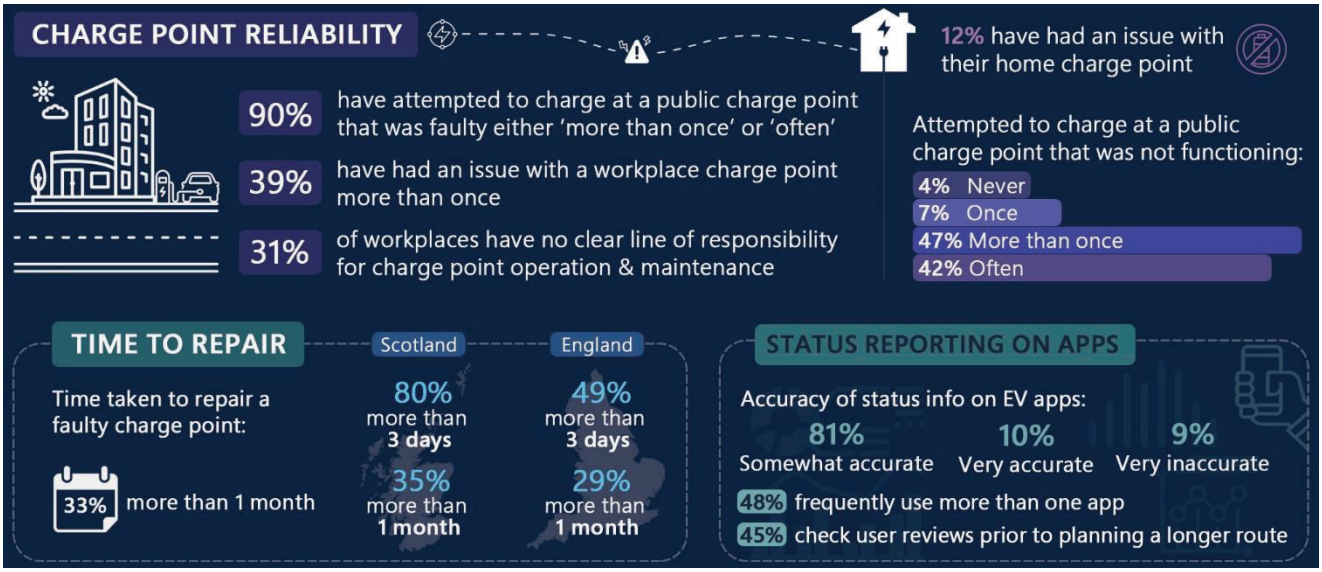

Figure 1: Selected results from the Assure Charge Public Survey of 643 EV users

Using the Assure Charge platform the project is demonstrating how charger uptime can be improved and monitored to adhere to SLAs. This paper outlines the findings related to the above research areas and presents recommendations to a number of different stakeholder types. This includes lessons for EVSE hosts, like local authorities, who are currently deciding their role and the best approaches for meeting the growing need of public charging requirements. The project has uncovered inadequacies in current local authority procurement and SLA contracts, something that needs to improve as EV adoption and charging infrastructure scales.

STAKEHOLDER ENGAGEMENT

In the Assure Charge project, surveys were carried out regarding the reliability of EV charging infrastructure by EVA England which received 235 responses and EVA Scotland which received 408 responses. Some of the key survey results are shown in Figure 1. One-to-one interviews were also carried out with industry stakeholders including charge point operators (CPOs), hosts and fleet owners. It was found that 47% of EV users have been prevented more than once from charging at a charging site due to no working charge points being available, and 42% experienced this often. 33% of respondents reported faulty charge points taking more than a month to fix which is often due to units being out of warranty without a viable option for a maintenance contract for the charge point host.

In one-to-one interviews, CPOs reported between 50% and 90% of faults on EVSE were due to 'user error' which is a strong indication that the charging process is not straightforward enough for widespread adoption. Another widespread issue with EVSE reliability is that they frequently experience dropped communications (comms) resulting in unreliable or 'unknown' status reporting on apps. This erodes trust in the status reporting, and 81% of our survey respondents said the public EV map status information was 'somewhat accurate' with only 10% responding 'very accurate'.

There is a pressing need to improve the user experience. This paper provides recommendations based on stakeholder engagement, to increase the reliability of public EV charging infrastructure.

TIERED MAINTENANCE APPROACH

A key finding in stakeholder and industry surveys was that the process of reporting and resolving a faulted EVSE was complex and typically involved multiple parties with blurred responsibilities. The exact scenario depends upon the owner/operator model, with some evidence suggesting that local authority owned / privately operated EVSE was a particularly challenging model. It is proposed that a tiered fault resolution process will permit the quickest and most efficient resolution of EVSE faults. A multi-party SLA should provide the foundation for this.

The SLA should clearly define each party's responsibilities for maintenance and communicating with other parties, including assigning/reassigning fault tickets in a timely manner. A tiered approach enables remote or locally staffed fault resolution when possible, leveraging CPO staff and the EVSE owner's in-house staff when most efficient. If a tiered fault resolution process is adopted, it is important that all staff members with defined responsibilities are adequately trained. Figure 2 provides an example of the structure of one tiered maintenance approach.

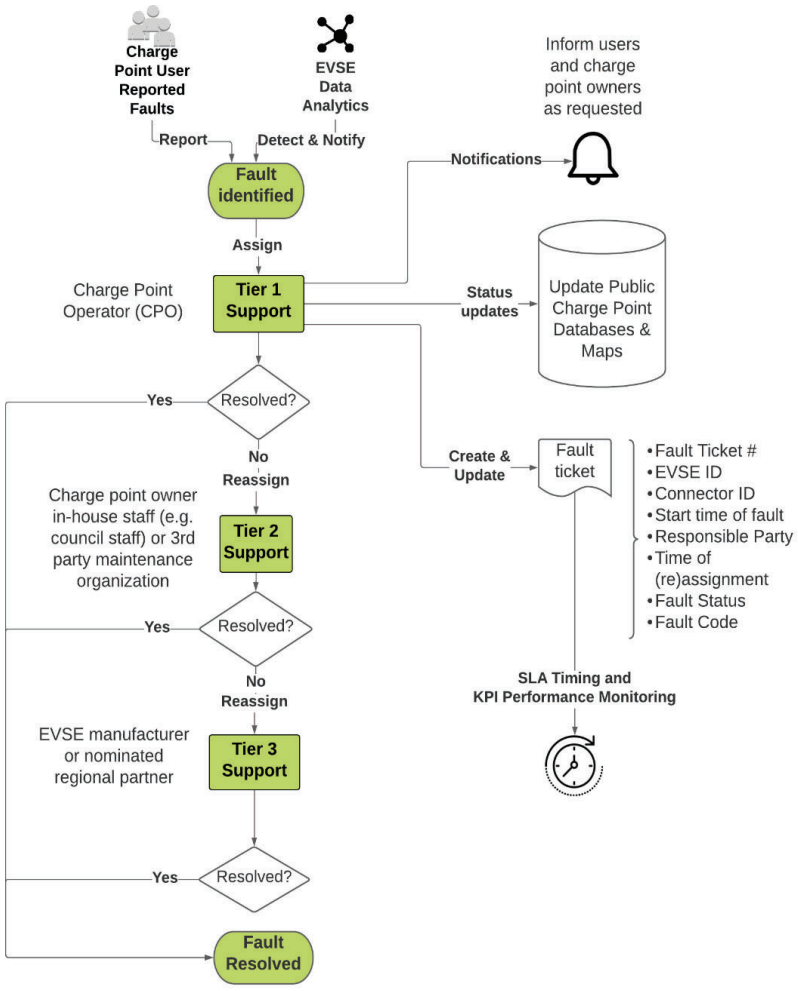

Figure 2: Tiered fault resolution process overview

Fault Ticket Management

When a fault is first identified - either by user notification or automatic identification – the first step should be to log it within a fault ticket management system. This allows the fault to be tracked, reassigned as the fault resolution process progresses and response times measured.

The resolution or reassignment time for each tier of support needs to be coordinated and agreed in advance to meet the overall SLA associated with the severity of the fault.

Tier 1 support: would typically be fulfilled by the CPOs staff who should initially attempt to resolve faults remotely using comms with the EVSE. A number of common faults can be resolved remotely including:

- Stuck cable/connector
- Reset residual current device (RCD) or circuit breaker (CB) if safe and within any retry attempt counter.
- Soft EVSE reset
- Hard EVSE reset

Tier 2 support: would typically be fulfilled by staff located close to the EVSE. This could be in-house local authority staff or an appointed third-party maintenance provider. The designated staff may vary on a site-by-site basis across the EVSE estate depending on location, remoteness, and proximity to local authority depots. Using local staff, partners and grouping Tier 2 work across equipment and networks has potential for significant operational cost savings.

Tier 3 support: would typically be fulfilled by the EVSE manufacturer or by a manufacturer approved local maintenance provider. Tier 3 support staff are often located far from the EVSE, especially in rural deployments. This reality needs to be considered when the EVSE owner agrees SLA response times with the Tier 3 provider. If a Tier 3 provider wants to extend SLA response times for a remotely located EVSE, the owner should request increased training and support for local Tier 2 support providers. This process should minimise the requirement for Tier 3 support to travel to remote EVSE locations, a process that can introduce significant delays in the time to repair.

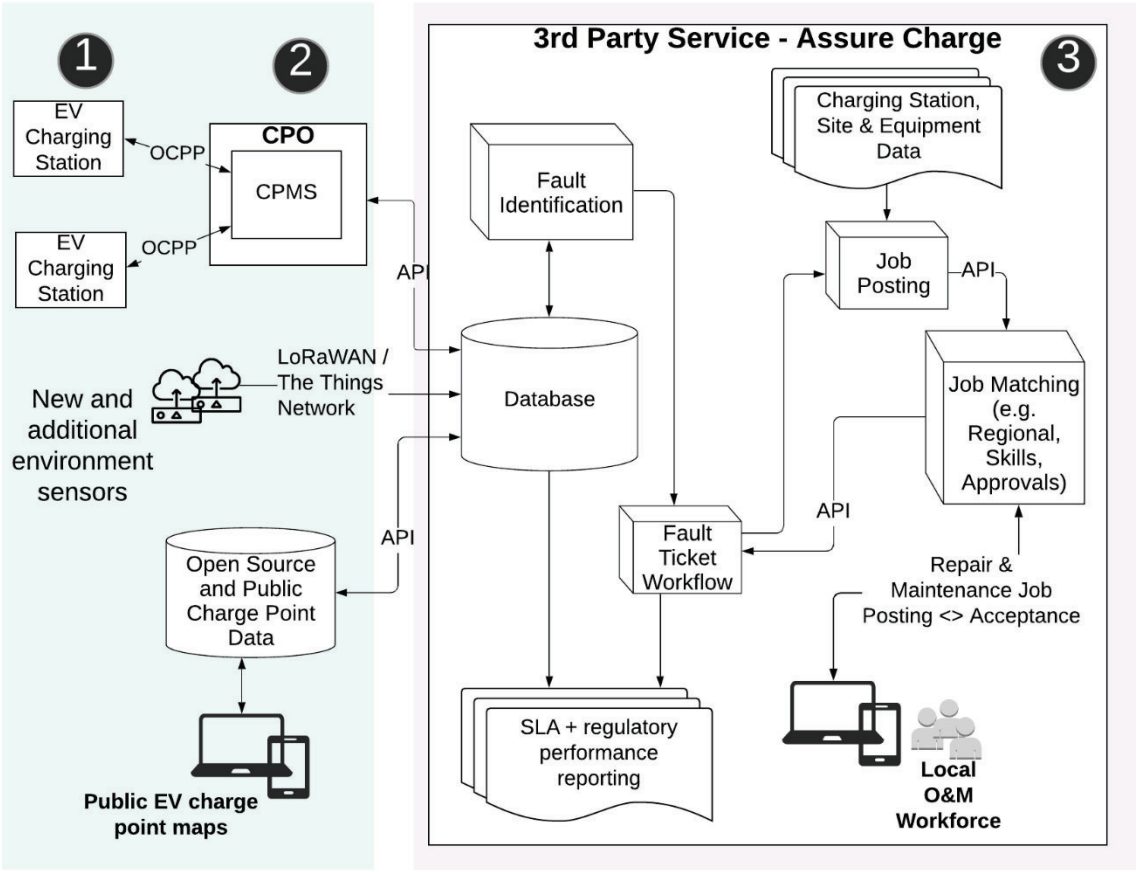

Figure 3: Assure Charge Platform

ASSURE CHARGE PLATFORM

The Assure Charge platform has been developed to improve the reliability of EVSE by linking charge point maintenance requirements with a well-regulated and efficient platform of service providers. The Assure Charge platform incorporates the tiered task management approach discussed above to effectively manage EVSE maintenance and repair involving multiple parties (CPO, host, owner, manufacturer, and maintainer).

The platform takes OCPP status and fault data from EVSE via the Charge Point Management System's (CPMS) API. Using this telemetry as well as data from tilt and parking sensors connected via LoRaWAN, faults and parking violations are diagnosed and categorised. The Things Network, a global open LoRaWAN network, is used to collect data from the sensors.

Repair, maintenance, and parking enforcement jobs are created and assigned to a local trained workforce via a job matching/task management app. As well as providing this functionality, the platform provides Key Performance Indicator (KPI) reporting to assess performance of the CPO and maintenance providers against targets which can be set in their SLAs. The architecture of the Assure Charge platform is shown in Figure 3 which includes the data flows between the CPMS, and the Assure Charge monitoring system and job matching service.

Fault Identification

Faults are identified based on rules within the Assure Charge monitoring platform. When these rules are triggered a fault ticket is created which can be assigned to Tier 1 support for attempted remote reset, and if this is unsuccessful can be posted to the job matching app for Tier 2 support. The rules within Table 1 identify and create tickets for EVSE fault repair, scheduled maintenance, and parking enforcement.

Table 1: Assure Charge Fault Rules

Rule/Ticket	Criteria
EVSE Fault Repair	IF status = faulty
EVSE Maintenance Task	IF time since maintenance = 6 months
Parking enforcement	IF parking sensor state = occupied AND status <> In use
Lost comms	IF status = disconnected for >24h

Low session count	IF number of charging sessions in a day < 10% of daily average
Zero energy charges	IF consecutive number of zero energy charges >5 AND zero successful charges in last day

Job Posting

Once a fault or parking enforcement ticket is triggered using the rules in Table 1, the Assure Charge task management platform receives data fields relevant for the job type. These jobs are then assigned to local trained technicians and parking enforcement officers with the relevant training and certification within a local authority or region. Where a specific designated contact is not allocated, the platform can optionally advertise the job to registered 3rd party providers.

CONCLUSIONS/RECOMMENDATIONS

The Assure Charge project has identified several key challenges to the reliable operation of EV charging infrastructure.

Many of the recommendations from this project relate to the need for better defined business models, operational structures and incentives which can enable platforms such as those developed in the Assure Charge project to improve EVSE reliability. The following key recommendations are made based on the findings of the project to date:

- CPOs should be encouraged to provide access to data for hosts and third-party service providers (via API or OCPI) to facilitate the provision of fault diagnostic and performance monitoring platforms such as the Assure Charge platform described in this paper, to maximise the value from EVSE data.
- The charging process must become frictionless with no requirement for initiating a charge or logging in using apps or RFID cards. This will reduce the amount of support calls relating to difficulties in users interfacing with EVSE.
- Ensure that all charge points have roaming SIM network providers. Many are restricted to a single network which reduces the robustness of their mobile connection. Furthermore, the comms restoration and synchronisation process should be standardised to ensure rapid recovery from dropped comms. These measures will reduce the frequency and duration of instances of lost comms with EVSE which have been found to be beyond acceptable levels in this project.
- Careful consideration must be given to the business models of EVSE ownership and operation. Particularly around the public EV charging tariffs required to provide sufficient revenue to pay for the maintenance and servicing required to guarantee reliability.
- A more competitive 'generic' manufacturer/ installer/CPO agnostic maintenance contract market would provide more options for hosts to maintain EVSE, especially beyond their warranty period.
- Increase training and recruitment of accredited EV charging repair workforce. Shortage of skilled technicians to carry out repairs can result in increased times to repair charge points and make markets for 3rd party services weak.
- EV maintenance providers with a large national pool of technicians and hosts with in-house trained staff can offer improved reliability. For hosts without these options, platforms to access skilled local technicians should be developed particularly for hosts without maintenance contracts.
- Provide a single trusted source of aggregated EV status information rather than EV users having to access multiple apps. An improved National Charge Point Registry with real-time status for all public charge points appears to be a low risk investment.

The Assure Charge platform is being tested at the time of writing and preliminary results have demonstrated that tiered ticket management can streamline the fault resolution process. Using the data analytics rules in Table 1 to predict faults, which in some cases can be remotely resolved using Tier 1 support, or in other cases can be resolved using trained on-site Tier 2 maintenance and parking enforcement officers. This increases EVSE uptimes and reduces the cost of sending more expensive Tier 3 maintenance providers to site.

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