Beyond Utilisation: Optimal Performance of EV Chargepoints

An efficient and reliable deployment of charging infrastructure across the UK is needed to transition drivers to electric vehicles (EVs).

Over recent years, the deployment of charging infrastructure has increased, with 59,590 chargepoints installed at the end of March 2024[1]; however, government policy and strategy has to date been centred around the absolute number of chargepoints, which only tells part the story.

In 2023, the Green Finance Institute (GFI) released 'Demystifying Utilisation', a paper which asked readers to look beyond the number of chargepoints installed as a metric for success, and considered how we can ensure the right chargepoints are in the right place to enable a just and smooth transition to electric mobility.

The paper explained the differences between time and energy-based utilisation metrics, and highlighted most chargepoints report lower energy-based utilisation, with this delta being the most stark for Direct Current (DC) charging.

As investors and installers look to deploy more efficiently, ahead of demand, other metrics must be considered in addition to utilisation. One metric that is often overlooked – and has a direct impact on utilisation – is the performance of chargepoints.

Drawing on the research produced by Newcastle University, this paper discusses the performance of DC chargepoints and seeks to identify and evaluate the limiting factors that prevent DC chargepoints from operating at their maximum capacity.

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Defining Utilisation and Performance

Utilisation rates

Utilisation can be defined as 'the rate at which an EV chargepoint is used'. The two main ways to calculate utilisation are time-based and energy-based. In this paper we will use energy-based utilisation as it is more relevant to chargepoint performance, taking into account the actual energy supplied during a charging event.

Energy-based utilisation can be defined as:

The energy supplied in kilowatts (kW) by a chargepoint, relative to the potential maximum energy that could have been supplied in the same period.

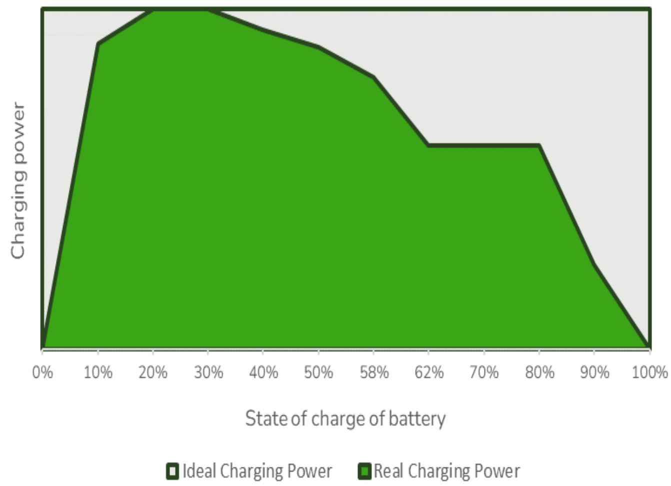
E.g. If a 50kW chargepoint has delivered 120kWh in a 24-hour period, utilisation over that 24-hour period can be calculated using the following: 120kWh / (50kW * 24 hours) = 10% utilisation

Performance

Performance can be defined as a chargepoint's ability to deliver power and charge a car. Optimal performance is when a chargepoint supplies maximum power that matches its capacity, over a 24-hour period; the higher their output, the better they perform.

However, the power delivered during a charging event is never constant. For example, a 50kW chargepoint will not always deliver 50kWh of charge, instead it may only supply an average of 35kWh over the same period. Charging events typically follow a 'charging curve' as shown in figure 1.

Figure 1:



The grey area represents the difference between real power delivered and the maximum power the chargepoint is capable of delivering. The charging curve can be impacted by a number of factors and each car has its own charging curve. The difference in real and ideal charging power is more prevalent in DC chargepoints than Alternating Current (AC) chargepoints. This is because AC chargepoints are closer to delivering their maximum energy supplied due to the lower power rating and the car's battery being able to accept that amount of power. i.e. they have a flatter charging curve. Therefore, this paper focuses on DC chargepoints.

Relationship between utilisation and performance

Utilisation and performance are intrinsically linked together. If chargepoints aren't delivering their maximum power, then they aren't being utilised to their full potential. This paper discusses the limiting factors that affect the performance of a chargepoint and explains what this means for the deployment of charging infrastructure.

Measuring the Performance of DC Chargepoints

To maximise the existing network, and future networks, we must measure performance. Researchers at Newcastle University have derived a simple calculation to measure this:

Performance = Availability * Use * Limiting factors

Availability - highlights the proportion of time a chargepoint is available to use i.e. the chargepoint is in good working order.

Use - represents the proportion of a day a chargepoint is used. Typically, a charging window is not a 24-hour period. Drawing from the research data from Newcastle University, 90% of all public DC charging events occurred between 6am and 10pm, therefore we can take the use-charging window to be 16 hours.

Limiting factors - factors that impact the power delivered from the chargepoint so that it's not delivering maximum potential output.

The limiting factors include:

1. Available local network capacity

The demand for electricity increases as more people charge their cars and the balance between power generation and power consumption is important to avoid electric blackouts. This affects the total amount of power delivered at one time, which limits the performance of the chargepoint as the connectors will not be able to provide their maximum power and people will have to charge for longer.

2. Distribution of the electricity available for a chargepoint across various connectors

The number of vehicles and connectors in use can have an impact on the power supplied to each vehicle e.g., the power available for the chargepoint will first go to the connector with the higher power required, leaving the second connector with less power.

3. Maximum charging power of the battery

The largest charge current the battery can accept. For example if you plug a 50kWh battery into a 150kW charger, the maximum power provided will be limited to 50kW. This limiting factor should not be confused with the power rating of a chargepoint; with a 7kW chargepoint, even if the car has a higher charge capacity, the power will be restricted to 7kW. This is not a limiting factor as the chargepoint is delivering its maximum power.

4. State of charging & changing curve

The charging curve represents the variation in the speed at which an EV charges. Charging curves vary between makes and models, with some EVs drawing more power and having a steadier curve. Typically, a battery will charge faster between 20% and 80% than between 80% and 100%. The battery State of Health (SoH) also has an impact on the state of charging and the charging curve.

5. Price

Chargepoints are working optimally so long as they are delivering power, however price charged can be a limiting factor as it determines how long a person may stay at a chargepoint. If pricing is low, some drivers may choose to stay even after the vehicle is 100% charged which means the chargepoint is not delivering power for that additional time and is unavailable to the next driver. Effective pricing strategies such as additional time-based fees once the car is fully charged can mitigate longer dwell times and optimise the chargepoint's performance.

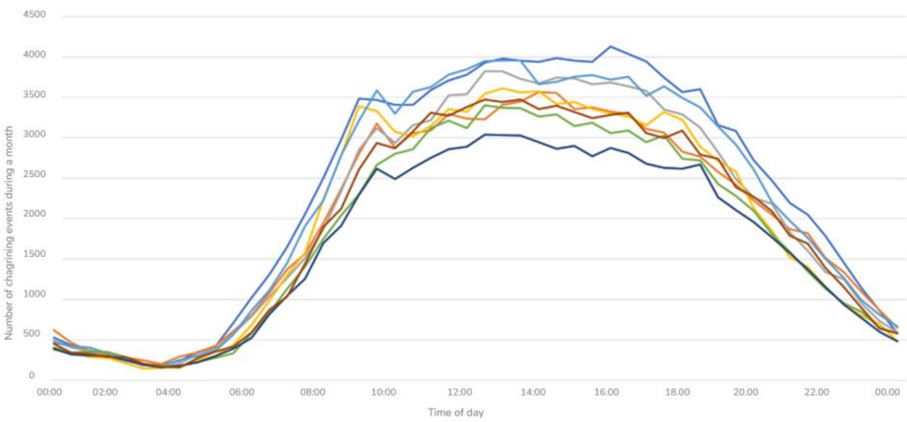
6. Ambient Temperature

Outside temperature can significantly impact the rate of charge and the battery performance. Colder temperatures typically require more charging events.

7. Charging window

People's behaviour and their choice of where and when to charge their car has an impact on the performance of chargepoints. People often want to charge at the same time, leading to a spike in demand for electricity. Factors such as rush hour and people typically charging at the start or end of the day affects the charging window. The graph below shows the distribution of public DC charging events across a 24-hour period of a month.

Number of public DC charging events at all type of connectors by time of the day for one month:



Evaluating and Assessing Limiting Factors:

The limiting factors listed are independent however are influenced by either:

1. The chargepoint
2. The car
3. Grid availability and capacity

Below is a table that summarises the limiting factors and which category they fall into. It is important to note that when calculating performance, the limiting factor may not be constant over a whole charging period e.g. the grid can vary in capacity and therefore the category itself may become the limiting factor.

<table>
<tr><td colspan="3">Charging Window</td></tr>
<tr><td colspan="3">Availability of the chargepoint</td></tr>
<tr><th colspan="3">Performance</th></tr>
<tr><th>Chargepoint</th><th>Car</th><th>Grid</th></tr>
<tr><td>Distribution of power among connectors</td><td>State of charge of the battery</td><td>Network Availability</td></tr>
<tr><td>Price</td><td>Maximum charging power</td><td></td></tr>
<tr><td colspan="2">Limiting factors related to the outside temperature</td><td></td></tr>
</table>

As mentioned, these calculations and limiting factors have been drawn from the research of Newcastle University and this study will be published in 2024.

Discussion

Why is this important?

Identifying limiting factors are important as it enables manufacturers, installers and network operators to implement measures to mitigate their impact and ensure chargepoints are performing optimally.

For example, an installer may not install a 150kW chargepoint in a rural area where the electricity network cannot deliver the power needed or be upgraded. Understanding how limiting factors such as the availability of power interact with optimal performance can open discussions on energy flexibility contracts, unlocking future revenue models.

There are, however, some limiting factors that are more difficult to control. Areas which experience a major drop in temperature during winter will see chargers used more frequently, and could see demand increase by 20% in winter. Different types of cars react differently to changes in temperature and so it is difficult to factor this into analysis.

Pricing and consumer behaviour also have an impact. Price strategies can include adding a fee if the car has not moved after it's fully charged which can encourage drivers to move and free up the chargepoint, so that it can be used again.

Alternatively, lowering the price at times where usage is low, can encourage some drivers to charge at that time, thus managing grid capacity, increasing the charging window and increasing optimal performance.

Understanding these limiting factors can help installers ensure the right chargepoints are installed in the right places instead of focusing on maximising the number of chargepoints installed. This will improve performance, improve the consumer experience and reduce the risk of stranded assets. From a financier's perspective, improving the performance of existing chargepoints leads to an increase utilisation rates which in turn brings higher returns.

Conclusions

This paper and the research by Newcastle University highlight the different limiting factors that affect the efficiency of chargepoints but also demonstrates how the impact of these can be difficult to assess. If installers and investors can better understand these factors and where they can be mitigated, a data-led deployment strategy can ensure we maximise the performance of the existing network and deliver an efficient roll out of charging infrastructure across the entire country.

Call to action:

Stakeholders across the industry should share more data on chargepoint performance and analysis of this data, so we can better understand these limiting factors and develop ways to improve and mitigate them.

[1] EV charging statistics 2024 – Zapmap (zap-map.com)

About the Green Finance Institute (GFI)

The Green Finance Institute was launched in 2019 to support the mainstreaming of green finance both in the UK and overseas. Uniquely positioned as an independent, commercially-focused organisation led by bankers and seed-funded by government, the GFI adopted a pioneering strategy of identifying the barriers to investment in real economy decarbonisation by sector, and committing to develop the solutions to demonstrate they could be overcome – a "think and do tank" of financial professionals, unencumbered by the short-term profit-making pressures of mainstream finance.

The GFI's programmes and partnerships are all thoughtfully constructed to expand our influence with the decision-makers who are key to transforming systems and our efforts are supported by an effective communications strategy.

The GFI's transport coalition was set up to unlock the financial barriers to the decarbonisation of road transport and enabling infrastructure, initially in the UK, to support the transition to a zero-carbon and climate resilient economy.

For more information, please visit
www.greenfinanceinstitute.co.uk/programmes/cdrt/

Future Mobility Research Group at Newcastle University

The new Research Hub for Decarbonised Adaptable and Resilient Transport Infrastructures (DARe) is led by Newcastle University as part of the Future Mobility Research Group. The hub will help to upgrade and decarbonise the UK's complex and interconnected national, regional and local transport infrastructures and to adapt to the effects of climate change.

DARe identifies pathways and solutions for delivering a resilient, net-zero transport system that works for people and communities. It will soon host world-leading researchers who will provide expertise, modelling and data tailored to each area and each transport challenge.

https://www.ncl.ac.uk/engineering/research/civil-engineering/future-mobility/