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Assessing customer experience improvements and resulting impacts of "Plug and Charge"

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Summary

The E-Mobility industry is beginning to adopt Plug and Charge. Plug and Charge will enable customer identification, authentication, and billing all via the charging cable. This will simplify and streamline the charging experience for drivers. However, it is not clear if customers are willing to pay for these services. If customers are not willing to pay, entities in the e-mobility value chain need to generate revenue streams to pay for the complex investment and development costs of Plug and Charge. There are revenue opportunities stemming from Plug and Charge but who will compete for these opportunities and the overall impact on the competitive landscape needs further analysis.

Keywords: Charging, EVSE (Electric Vehicle Supply Equipment), Policy, Smart Charging, Strategy

1 Introduction

As electric vehicle adoption continues to ramp, competitiveness to deploy and provide charging services to drivers is intensifying. As industry scale emerges charging providers will need to develop both sources of competitive advantage, and differentiation to attract drivers to their assets. The charging experience on offer could be the clear differentiating factor between these providers.

The charging experience we have in place now is based on membership programs, cross-network roaming, and RFID cards. This is likely to change drastically using emerging technologies such as Plug and Charge via the International Organisation for Standardisation (ISO) 15118 standard [1]. This paper aims to assess how the charging experience will be enhanced by these technologies, impacts to the e-mobility industry and the overall customer impact.

2 The customer experience has improved significantly due to roaming

2.1 From RFID collections to roaming services

The public charging experience for electric vehicle drivers is only beginning to emerge. To date, the membership programme model has been the most common for public charging. This membership model means the driver needs to previously register or join the operator's membership program, often requiring a recurring membership fee. The charge point operator issues an RFID card or enables smartphone access to allow the driver to initiate charging. Payment for charging services are accumulated and billed to the registered customer over an agreed time period.

Figure 1 An array of charging network RFID membership cards [2]

A shown in Figure 1. this membership model has resulted in drivers often needing to carry many RFID membership cards to ensure that they have access to public charging infrastructure. A less than ideal experience for the customer, and a frustration that has seen innovation through the emergence of interoperability or roaming providers. These roaming providers enable a single membership or single RFID card that is accepted at a wide range of public charging assets. Two European examples are Plugsurfing, who has access to over 108,000 public chargers [3], and Hubject who have access to over 80,000 chargers [4]. These roaming providers have enhanced the charging experience by enabling customers to roam across networks and borders whilst being billed by a central provider.

Although the charging experience has improved with the emergence of roaming providers, the fundamental experience still relies on carrying a physical identification key or having access to a smartphone which can unlock a public charger. This experience remains sub-optimal as it requires the driver to carry a physical identifier as a pre-requisite of registering with a roaming provider. Emerging technology may be able to solve this issue by moving the identification method to the vehicle itself, removing the need for a physical identification card or token.

2.2 The promise of Plug and Charge

Plug and Charge is an emerging technology built on the ISO 15118 standard. The standard is a communications protocol that enables the electric vehicle and charging equipment to authenticate, authorise, and bill customers via the charging cable [5]. This communication via the charging plug and cable would eliminate both the need for a physical RFID card and authentication via a smartphone app. Plug and Charge simply lets the customer plug in the car, receive a charge, and drive away knowing that payment has been effortlessly managed via a set of digital certificates that contain pre-approved payment configurations.

A high-level overview of the customer interaction is laid out in figure 2. In step 1 the car is plugged into the charging station where the vehicle certificate is sent from, this certificate is received in step 2 by a cloud-based authentication authority, in step 3 the validity of the certificate is approved and sent back to the charging station, where in step 4 the charging station is initiated. This plug and charge process and technology enables the customer to receive a seamless low effort charging experience.

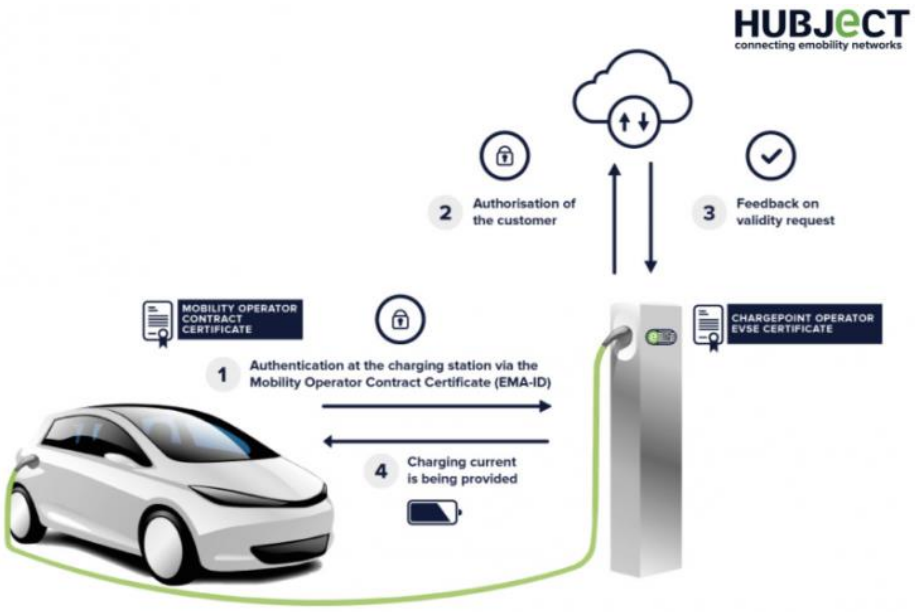

Figure 2 A high-level overview of the Plug and Charge certificate process [6]

3 Plug and Charge will continue to enhance the driver experience

Plug and Charge simplifies the charging experience for customers by both streamlining and simplifying their interactions with the charging equipment. There are improvements with how the customer physically manages the charging session as well as how their overall experience could be improved via enhancements to the wider digital ecosystem.

Improvement of the physical charging experience	
Removes the need to carry a physical membership card	• Identification and authorisation by the vehicle will eliminate the need to carry RFID cards or require authentication via a smartphone to start a charging session. This will increase the speed to start a charging session and eliminates the customer pain point of not being able to charge if they forgot or misplaced their RFID card.
Allows full control from the vehicle information system	• As the vehicle itself will be the main interface between the customer and the charger, full control and information about the charging session will be visible from the in-car display system. This control from the car ensures that no additional equipment is required to authenticate and control the charging session.
Could improve the security of customer data	• RFID cards as a customer identification method have previously encountered some security flaws [7]. While these security issues have been addressed [8], there are vulnerabilities of using a physical identifier such as an RFID card, such as the potential be cloned [9]. Moving to a certificate-based system where an independent party provides certification may result in a higher level of data security, and lower potential for theft of electricity from the charging equipment.

Improvement of the digital charging experience	
Plug and Charge could result in a broader roaming environment	• A well-defined Plug and Charge ecosystem could attract more Charge Point Operators to join roaming programs. Increased adoption of interoperability by operators will have a net benefit for drivers as they will have a wider choice of equipment to use.
New innovations could be possible via the Plug and Charge ecosystem	• A common digital ecosystem and well-established standards could result in an "app store" effect, where innovators begin to layer on new services that benefit customers. An example of this extension could be charging booking services interlinks with public chargers and the vehicle navigation system, potentially reducing wait times to charge.

4 Plug and Charge improves experience but are customers willing to pay?

Overall the charging experience will improve for customers as the effort to begin and manage their charging session is simplified. There is, however, an outstanding question to ask; are customers willing to pay for this enhancement? Starting a charging session with a card, or with a smartphone application may not be an overwhelming burden on drivers. We must balance any improvement with a view of potential downsides to understand if customers are on balance better off from Plug & Charge, and how much so. Three impacts are immediately clear;

Customer willingness to pay impacts	
Higher Unit Economics	• While the customer experience can be simplified through Plug and Charge, the underlying architecture is complex. A seamless experience relies upon a well-managed public key infrastructure that validates and identifies users and providers through a set of digital certificates. The development costs and effort required to establish the underlying technology is significant across the entire e-mobility value chain. Automakers, charge point operators, technology service providers, and charging equipment manufacturers all must invest in developing and rigorously testing the plug and charge technology. These investments in plug and charge technology will be potentially passed on to the end customer, making the public charging experience more expensive. • Not only do development costs of the new technology raise the unit economics of charging, but customers must also pay to keep existing payment services running in parallel. Electric vehicles to date are not Plug and Charge ready, meaning e-mobility operators need to manage both legacy vehicles and newer vehicles compatible with Plug and Charge, the management costs of multi-standards may be ultimately paid for by consumers.
Back End Co-Ordination	• With added complexity in the data and technology architecture of Plug and Charge there is an increased level of coordination needed throughout the industry. Increasing coordination of data flows and integrations results in more potential break points in the overall system. An increased number of breakpoints in the back-end architecture could result in a higher probability of charging failure, or error, creating a worse customer experience. While these breakpoints could be mitigated, overall ecosystem reliability will be tied to the rigour of integration testing. As the e-mobility industry is growing rapidly, the pace of integration testing could require substantial ongoing effort.
Re-Inventing the Payment Ecosystem	• Reducing customer effort by moving away from a physical identifier, is largely solving a legacy problem caused by the charging landscape being tied to a membership structure. The Plug and Charge solution is rooted in the assumption that charging must require a membership base where customers pay for access to a network and are identified and approved at the time of charging. The credit card reader and established banking system can provide a seamless, low effort customer experience already without the need to develop a detailed identification payment mechanism via the charging cable. Credit card payments at the charging equipment using "Tap and Pay" contactless credit cards or NFC enabled smartphones would provide an already ubiquitous and very fast mechanism of payment, whilst enabling an easy way to roam across charging providers. • Regardless of any potential benefits of membership platforms, charge point operators may be forced to provide credit card services by regulators. California for example, through the EV Open Access Act (SB454) will require that customers gain the same access to plug in infrastructure as conventional cars have with petrol stations [10]. This would mean no membership is required, credit card payments are available, and pricing is transparent.

On balance it isn't clear if the physical and digital experience improvements of Plug and Charge outweigh potentially higher charging costs and increased operator complexity. This complexity and customer willingness to pay challenge suggests two clear opportunities;

No Frills Charging
There may be an opportunity for very lean, no-frills operators to offer charging services at a lower cost. Providing services with no support for Plug and Charge or other networking technology could reduce the overall operator cost base. This model could improve the unit economics of charging at the cost of a potentially less comprehensive charging experience which may suit certain segments of EV drivers.

Secondary Revenue Streams to Support Development Costs
If operators can develop new revenue streams that stem from Plug and Charge, the development costs may not need to be passed on directly to customers. If operators can generate a strong business case from services adjacent to Plug and Charge, these revenues could fund the overall development costs without needed to be paid for via charging services.

5 Is there a strong business case for pursuing Plug and Charge?

There is a strong push for Plug and Charge adoption from certain parties, and if the business case is strong enough, the parties with the most to gain could fund and manage the overall technology development and coordination challenges. Three distinct stakeholders in the e-mobility landscape stand out as having the most to gain from Plug & Charge. Firstly, Automakers may use Plug and Charge to control the complete vehicle experience. Secondly, the big four GAFA (Google, Apple, Facebook, Amazon) technology companies may use Plug and Charge to capture customer data and extend their existing business models. And thirdly, Electricity Utilities may use Plug and Charge to extend their customer relationship to the public space.

5.1 Automakers may use Plug and Charge to control the complete vehicle experience

Plug & Charge could create immense value for Automakers in an e-mobility dominated landscape by providing a pathway to gain a closer customer relationship during their charging interactions, enabling the automaker to provide better terms to their drivers and begin to explore new business models.

5.1.1 Moving the charging interaction to an in-vehicle experience

Plug and Charge sets a pathway for the customer to control the charging interaction from the driving seat, including setting charge speeds, and cost limit preferences. This control would enable a car branded experience on all types of charging infrastructure, like the Tesla Supercharging Experience today (Figure 3). While a great experience for the customer, this charging experience would enable automakers to manage the overall brand experience and reduce the customer recognition of other e-mobility providers, effectively white labelling charging operators across the competitive landscape.

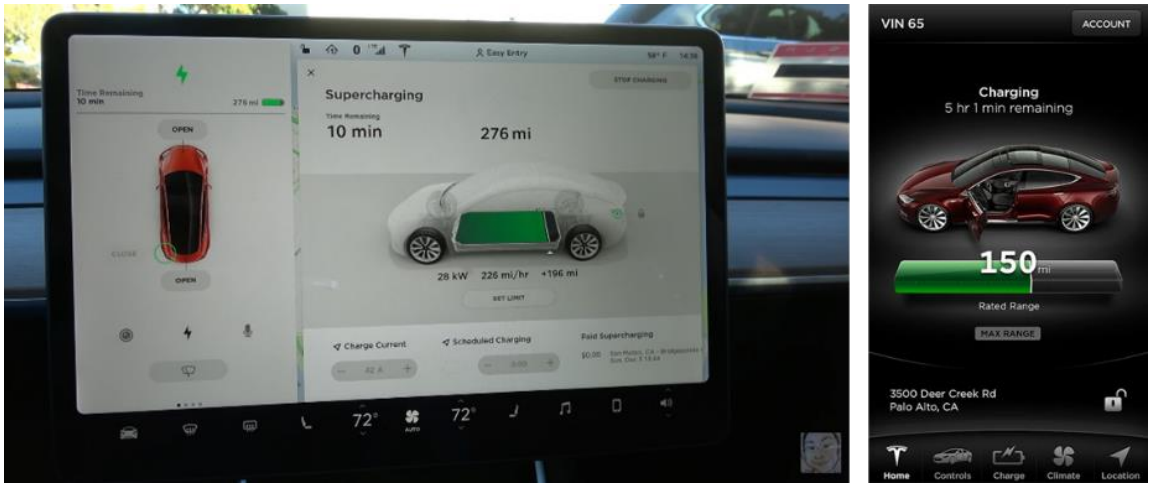

Figure 3 Tesla in car charging equipment controls [11]

5.1.2 Volume to negotiate terms and access to charging infrastructure

If automakers can own the charging interaction, they may gain strong bargaining power to negotiate cheaper or more widespread services for their drivers. Ownership and influence of a large customer group provides automakers the ability to innovate new business models that sit on top of the Plug and Charge ecosystem, for example, offering complimentary fuel, or bundled charging services. The automaker could begin to send pricing offers to drivers such as bulk charging rates, charging subscriptions, or bundled charging services with the vehicle purchase. Toyota has begun to trial this complimentary fuel model with their Hydrogen Mirai model where customers receive $15,000 worth of fuel at purchase (Figure 4). A potential extension of this business model is a full "Vehicle as a Service" offering where car pricing and car loan financing includes the ongoing cost to run the vehicle [12].

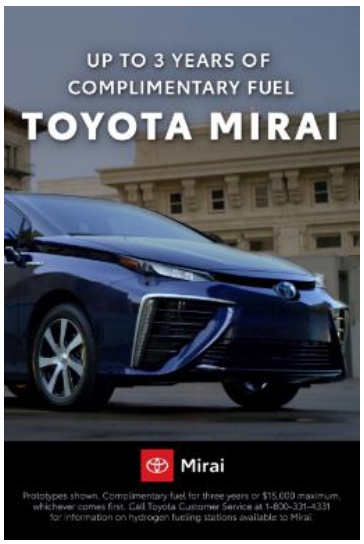

Figure 4 Toyota Mirai complimentary fuel advertisement [13]

5.1.3 Vehicle charging could be the launchpad for automakers to blur industry boundaries

If automakers start to provide charging pricing models or subscription services, a logical extension is into the customer's other forms of energy use. With greater access to customers via Plug and Charge, Automakers may begin to compete for all forms of the customer's energy use. For example, automakers could provide vehicle charging in public as well their total energy use in the home, including home vehicle charging. Volkswagen Group has already begun to signal their ambitions. Volkswagen's new brand Elli provides services for drivers complete "electric life" [14] (Figure 5). More holistically, this indicates that automakers may be able to use their driver base to develop innovative value propositions that start to blur the boundaries between automotive and electricity businesses.

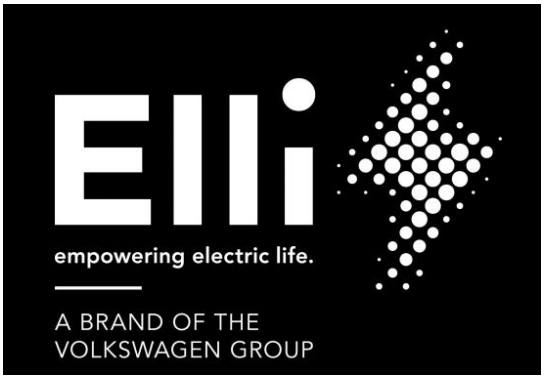

Figure 5 Volkswagen Elli "Electric Life" branding [15]

5.2 Large technology players may use Plug and Charge to capture customer data and extend their existing business models

Technology companies could choose to start investing heavily to own the Plug and Charge experience, and through this may be able to influence the underlying technology or shift momentum towards their already established technologies.

5.2.1 Vehicle charging could be managed via the technology companies in-car applications

Following a similar logic to automakers looking to utilise Plug and Charge to centralise customer control of their charging experience inside the vehicle, the large technology companies may be best placed to capitalise on this shift in customer relationship. Android Auto and Apple CarPlay are examples of technology companies going over the top of an existing industry to gain access to the customer relationship. Plug and Charge services could be an extension of these in-car experiences provided by these technology companies.

Figure 6 Apple CarPlay and Android Auto Interfaces [16]

5.2.2 Integration with existing services may provide valuable data streams

We are beginning to see indications that these technology companies see value in providing services related to the electric vehicle charging ecosystem. Google recently incorporated charging station locations into Google Maps through integrations with charging operators [17]. This service allows customers to locate chargers and check if they are occupied or out of service. By providing these services, and further integrating charging into the in-car experience the technology providers will gain access to the data flows and consumer behaviour tied to charging enabling them to either build new revenue streams or support their existing data-centric business models.

5.2.3 Ownership of the customer interaction could help develop and embed new ventures such as payment services

If the vehicle has a validated payment mechanism via the charging cable or is enabled by Apple or Google Pay, the vehicle effectively becomes a rolling payment medium. The use cases of the vehicle as payment medium extend far further than solely charging services. For example, drive through restaurant payment or car wash payment could all be managed seamlessly due to the vehicle being authorised to pay for services.

Figure 7 Google charging locations integration, Google and Apple Pay logos [17]

5.3 Electricity Utilities may use Plug and Charge to extend their customer relationship to the public space

Electricity Utilities are beginning to extend their existing offerings into the electric vehicle charging landscape. Bundled offerings, such as the OVO energy offer in Figure 8, where residential Utility customers are given access to public charging networks are emerging, particularly as a customer attraction strategy [18]. An extension and ambition of this strategy is to centrally bill customers for all of their electricity usage regardless of where the energy was consumed. Plug and Charge could help Utilities establish this offering through creating a billing mechanism where all charging use is tied to the customers single Utility account aiming to reduce overall customer effort. While this bundling and central billing offering is more suited to competitive retail electricity markets, the offering may also help regulated Utilities. If regulated Utilities are approved to own public charging infrastructure, this centralised billing could support the case for further charging assets to be added to their regulated asset bases.

Figure 8 UK Utility, OVO Energy charging bundle with Polar charging network [18]

5.4 The overall Plug and Charge business case relies on securing access to the customer relationship

Despite different approaches and motivations, it is clear there are potential business case driven opportunities emerging across the e-mobility landscape. A strong Plug and Charge mechanism has the potential to let e-mobility parties build closer customer relationships. The customer relationship is valuable as it enables direct access to customer preferences and behaviours, guiding the data owners to what new and innovative offerings to develop.

It is not entirely clear who will pursue Plug and Charge most aggressively, and what the ultimate competitive dynamics could be. Customers may benefit from a wide range of e-mobility roaming and Plug and Charge services in a competitive market. However, parties that can gain scale and resulting network effects quickly could generate large barriers to entry, creating a winner takes most effect, as a result, the need for some regulatory oversight is likely to be required to ensure drivers continue to have widespread charging options.

6 Conclusions

Plug and Charge is an exciting development in the electric vehicle charging landscape, which could improve some aspects of the customer experience. However, as laid out in this paper the underlying technology is complex and will require significant development costs. Who pays for these development costs is not yet clear. The costs may be passed through to the customer in the form of higher charging unit economics, or certain parties in the charging value chain may fund the development to support their business models.

The return on investment and underlying incentives for establishing Plug and Charge technology look to be based on securing access to the customer relationship. If any party was able to centralise the relationship of most drivers it would be a true source of competitive advantage. However, a wide range of options could emerge, creating strong competitive tension. For example, the opposite charging model to Plug and Charge such as a “no-frills” non-networked, non-membership charging offering could also be successful in certain segments.

Further assessment is required to map out the competitive landscape, market dynamics, and the overall business incentives that exist across the e-mobility value chain, particularly as the EV market continues to progress and evolve. As the e-mobility industry continues to grow and new technology is developed the competitive dynamics will be constantly changing. As a result, the need for some regulatory oversight is likely to be required to ensure drivers continue to have widespread charging options.

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Tritium designs and manufactures DC fast charging infrastructure for electric vehicles to hasten the transition to e-mobility, ultimately leading to clean, healthy and convenient cities. Our electric vehicle charging stations support the adoption and growth of low-emission e-mobility in over 25 countries around the world.