

**energy
saving
trust**

Electric vehicle adoption for disabled consumers

17/02/2022

Barriers and solutions for disabled consumers getting and using electric
vehicles

Version number 1



Executive summary

The phase-out of sales of new petrol and diesel cars and vans in 2030 means that the majority of UK consumers will be switching to electric vehicles (EVs) within a decade. This project looks to identify whether there are any specific challenges disabled consumers face when transitioning to EVs, and what can be done to overcome them. Energy Saving Trust reviewed existing literature and ran three workshops to better understand the challenges all relevant stakeholders faced.

The project evaluated two distinct areas, the process of getting an EV as a disabled consumer, and the process of using an EV. When getting an EV, the main barriers for disabled consumers included:

- **Lack of knowledge on EVs**
- **Inadequate range of vehicles**
- **Reliance, or partial reliance, on the public charging network**
- **Suitability and availability of vehicles**
- **High upfront costs of purchase or lease of an EV**

It was evident that certain disabled consumers would be disproportionately affected by the transition to EVs. Those consumers who require certain vehicle modifications such as wheelchair access have very few affordable options for EVs, with a very limited range of models. This is due to the complex regulatory and technical challenges the automotive industry stakeholders face when developing electric wheelchair accessible vehicles (WAVs).

Disabled consumers can also be negatively impacted when using an EV, notably when charging their vehicles. The key barriers for disabled consumers using an EV included:

- **Scarcity of chargepoints**
- **Chargepoint built environment accessibility issues**
- **Chargepoint accessibility issues**
- **Significant consumer behavioural change**

Consumers with mobility and dexterity disabilities, again, seem to be the most impacted by using chargepoints due to lack of consideration in the design of both chargepoints and their surrounding environment. This means that the consumers who qualify for the blue badge scheme (2.35 million) are more likely to be impacted by using chargepoints than those who do not. However, other disabled consumers can be impacted, notably those with sight disabilities or who have learning difficulties. Chargepoint operators have their own set of challenges when installing chargepoints that contribute to inaccessible infrastructure, such as restrictions in site modification and planning complexities.

Although there are many barriers disabled consumers face, there are solutions that could help overcome them. The key solutions for helping disabled consumers getting a vehicle include:

- **Getting them the right information** to allow them to make an informed decision
- Use the proposed government **mandate for EVs manufacturers** to enhance the supply of certain vehicle types to increase the availability of base models for wheelchair accessible vehicles (WAVs)

- **Consult with, and support, the professional bodies, and associations** responsible for the modification and conversion of accessible vehicles
- Consideration of **regulatory and legislative exemptions** for certain processes that are inhibiting the development of electric WAVs and certain vehicle adaptations
- **Subsidising costs for consumers** who are particularly impacted by lack of suitable vehicles through a modified mobility allowance or through the support of vehicle convertors to reduce vehicle cost

To create a more accessible charging experience for disabled consumers, there are actions required for various stakeholders including local authorities, chargepoint operators, distribution network operators, and central government. These include:

- **Increasing the number of all chargepoints across** the UK to give more options for all consumers to use, including disabled consumers, with a specific focus on accessible charging bays
- Ensuring **local authorities have disabled consumers as a focus of their infrastructure** strategy planning
- **Implement the forthcoming BSI accessible charging standards**, consult with all stakeholders throughout the development process, and support the implementation of them
- **Engage with private landowners** to ensure that accessibility considerations are taken in the private sectors' implementation of infrastructure
- **Consideration of support services** such as chargepoint assistants or clerks, like at petrol station forecourts, or roaming charging services like Charge Fairy
- **Support the development and marketing of tools and services to make finding chargepoints easier**, such as chargepoint booking or journey planning technologies

In conclusion, currently disabled consumers who have mobility and dexterity disabilities are the most affected in both the processes of getting and using EVs, especially if that consumer is reliant on public infrastructure and cannot park off-street. However, there are other disabled consumers that will also be impacted, for example those with sight impairments or learning disabilities, who may struggle to operate certain types of chargepoint interfaces. All these groups will need additional support compared to other consumers to transition to EVs.

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1. Introduction

As the UK approaches the 2030 phase-out of sales of new petrol and diesel cars and vans, it is important that we assess how all road users can make the transition to electric vehicles (EVs). This includes ensuring EVs are accessible for disabled consumers.

This Energy Saving Trust project's aim is to help facilitate an equitable transition by understanding the barriers that disabled consumers and relevant industries face in transitioning to EVs, to discover what work is being done to overcome these barriers, and to highlight where further work is required. The work will be presented to the Department for Transport to help feed into future strategy in accessible transport, although not all recommendations will necessarily be implemented.

1.1. Project deliverables

Three key deliverables were developed to help achieve the project's aim. These were:

- conduct a research study to help identify the key barriers faced by all relevant stakeholders, and to see what work has already been done, and where there are still gaps to fill
- undertake three workshops to engage with the relevant stakeholders to expose any further barriers and understand possible solutions
- further engage, where necessary, with stakeholders to get more detail on any of the barriers or solutions uncovered in the research study

This report shows the findings from the project along with summary reports from each of the workshops in the appendices. Transcripts and video recordings from the workshops will also be shared with the Department for Transport separately.

We evaluated two distinct areas during the project. First, the processes of getting an EV, and second, the process of using an EV as a disabled consumer. This approach meant we were able to capture all elements of a disabled consumers' journey of fully transitioning to an EV.

For each section, we aimed to understand what the barriers are for disabled consumers, and other relevant stakeholders. We also investigated the solutions that are being worked on, and which areas have not been addressed so far. Information from the research study, workshops, and industry engagement have been used to highlight these barriers and solutions.

1.2. General information about disabled consumers

In the UK, there are 14 million (21% of the population) (Scope, 2021) people living with a limiting long-term illness, impairment, or disability, with the most common being disabilities that affect mobility, lifting or carrying.

Other key considerations for disabled consumers include:

- Over 25% of disabled people say that they do not frequently have choice and control over their daily lives (ONS, 2011)
- 21% of children in families with at least one disabled member are in poverty, a significantly higher proportion than the 16% of children in families with no disabled member (Scope, 2019)
- Life costs £583 more on average a month if you're disabled (Scope, 2019)
- Families of disabled children on average, face extra costs of £581 a month (Scope, 2019)
- For almost a quarter (24%) of families with disabled children, extra costs amount to over £1,000 a month (Scope, 2019)

These points are particularly relevant for some of the considerations disabled consumers need to make when switching to an EV. For example, currently, EVs are mostly more expensive than their petrol or diesel equivalent models, making EVs less accessible for disabled consumers financially, especially if additional modifications or adaptations are needed. On top of this, families with a disabled member are more likely to live in poverty than families with no disabilities, meaning these additional costs could be even more impactful on the cohort's decision-making.

1.3. Different types of disability

There are a range of different types of disabilities, and it is important not to assume that one accessible solution will meet the needs of all disabled people. The International Classification of Functioning, Disability and Health (ICF) defines the following classifications of disability types:

- Mobility/Physical
- Spinal Cord
- Head Injuries
- Vision
- Hearing
- Cognitive/Learning
- Psychological
- Invisible

For new technologies to be truly accessible, each one of these areas will need to be considered throughout the design process and tested accordingly.

1.4. Information about disabled drivers and passengers of vehicles

Of those 14 million disabled people in the UK, 2.35 million access the blue badge scheme (Ricardo, 2020), which allows disabled drivers and passengers to gain access to priority parking in certain locations. These disabled consumers must meet eligibility criteria which prove that they have a disability which physically or mental affects their ability to park in a bay with no accessibility considerations.

The majority of the studies reviewed focus on these 2.35 million disabled consumers, as they already use vehicles in their lives, or at least, have done recently. Therefore, these consumers will be some of the most affected by the transition to EVs. It is still important to consider that there are still 11.8 million disabled people that will not opt, or be eligible, for blue badge status but will still potentially interact with the infrastructure. For example, consumers who have sight impairments or learning difficulties, but do not need accessible parking bays.

In general, disabled consumers, depending on their disability, can be heavily reliant on their vehicles (TfL, 2016), especially those with mobility disabilities, as it is important to their independence and care. As a result of this reliance and the potential impact of an unexpected event, many disabled consumers can be more risk adverse. This could impact their decision to opt for a new technology, such as an EV, and the charging process that is required to use one.

Other key statistics for consideration in relation to the number of UK disabled consumers who may be partially or wholly reliant on the public chargepoint network include:

- 1.35 million drivers or passengers with a disability are expected to be partially or wholly reliant on public charging infrastructure (Ricardo, 2020)
- 0.93 million are unlikely to be able to charge their vehicle at home (Ricardo, 2020)
- 0.39 million unlikely to have adequate on-street charging (Ricardo, 2020)

When it comes to purchase decisions, disabled consumers, just as non-disabled consumers, have the same consistent top priorities when considering a vehicle. These include, in no particular order:

- Reliability
- Efficiency
- Cost

Nonetheless, the variety of vehicles will be narrower for many disabled consumers, as they may need to consider a broader range of additional features or even modifications to their vehicle. A survey (TfL, 2016) showed the majority of blue badge holders prioritised following considerations before purchasing a new vehicle. These include, in no particular order:

- Adjustable steering
- Characteristics of door opening for consumer ingress and egress
- Height of the car

If the consumer has a disability that requires some form of adaptation or modification, their vehicle choice will be more dependent on whether those adaptations or modifications are available for a vehicle. This could include adaptations and modifications to:

- Primary controls: accelerator and braking system modifications
- Secondary controls: steering modifications and basic vehicle function controls
- Seating
- Lifts, ramps, and powered doors
- Wheelchair access and restraints

1.5. Definition of EVs

The term 'electric vehicle' can have several interpretations. For the context of this report, we are looking exclusively at battery electric vehicles (BEVs) which wholly rely on electricity to operate. Even though this is the case, disabled users of plug-in hybrid electric vehicles (PHEVs) may face similar barriers, as PHEVs could still require consumers to interact with public chargepoints.

1.6. Benefits for disabled consumers switching to EVs

Switching to an EV for many consumers, disabled or not, can be a beneficial experience. It is important to understand what these benefits are for making the transition, specifically for the disabled consumer. Benefits include (SSEN, 2021):

- **Lower running costs:** Depending on which type of charger a consumer uses, EVs can be much cheaper to run compared to petrol or diesel vehicles
- **More reliable:** EVs require less maintenance which means less costs are incurred through repairs and the inconvenience of servicing is less frequent
- **Removes the need to use petrol stations:** use of petrol pumps can be a difficult task for some consumers, but an inconvenience for many. Depending on whether a consumer has off-street parking or not, this type of experience could be far less frequent.
- **Ease of operation:** as a driving experience, EVs can provide a simple and pleasurable option for consumers, with automatic transmissions and no need for gear changes.

2. Barriers for disabled consumers getting EVs

The majority of the literature that was reviewed during the project was focused on the usability of chargepoint infrastructure. However, before understanding what the experience of using an EV is like for a disabled consumer, we identified the importance of understanding the barriers of getting an EV in the first place.

Based on our research and workshops, we identified and categorised the key reasons why disabled consumers may not want to switch to an EV. Although many of the barriers that disabled consumers are facing are shared with other consumer groups, there are more specific barriers for certain disabled consumers.

The main barriers for disabled consumers getting an EV include:

- Lack of knowledge on EVs
- Inadequate range of vehicles
- Reliance, or partial reliance, on the public charging network
- Suitability and availability of vehicles
- High costs of purchase or lease

2.1. Lack of knowledge on EVs

Having an EV requires a fundamental shift in consumer behaviour. To be able to cope with that change, consumers, including disabled consumers, must have all the necessary information to allow them to gain confidence that an EV is the right decision for them. This point becomes even more crucial when the consumer group is more likely to have a high dependency on their vehicle and is possibly more risk adverse as a result.

We investigated the ways in which disabled consumers can find information about getting and using an EV. When looking at digital options, information on EVs seem to be available through several different publications and email and newsletter subscription services. The information provided ranged in detail but did cover the key topics of range and charging. Examples are shown in **Table 1**. Although most of the publications were for all consumers, there were some outlets that were disabled consumer-focused.

In addition to this there are also in-person options for accessing information, such as through dealerships, leasing companies, or second-hand car sales dealers.

Table 1 – Sources of digital information for consumers on EVs.

| Publisher type | Example companies/organisations |
|----------------------------------|--|
| Vehicle manufacturer websites | VW, Ford, and all other manufacturers reviewed |
| Leasing companies | Evans Halshaw, Lex Autolease |
| Breakdown service providers | AA, RAC |
| Chargepoint operators | Pod Point, BP Pulse |
| Independent or impartial advice | Energy Saving Trust, Go Ultra Low, Zap-Map, Next Green Car, Which?, Transport for London (TfL) |
| Automotive focused media | Autocar, Car Buyer, Auto Express, Carwow |
| Energy service providers | EDF, Octopus Energy |
| Disabled-focused consumer advice | Motability, Motaclarity |

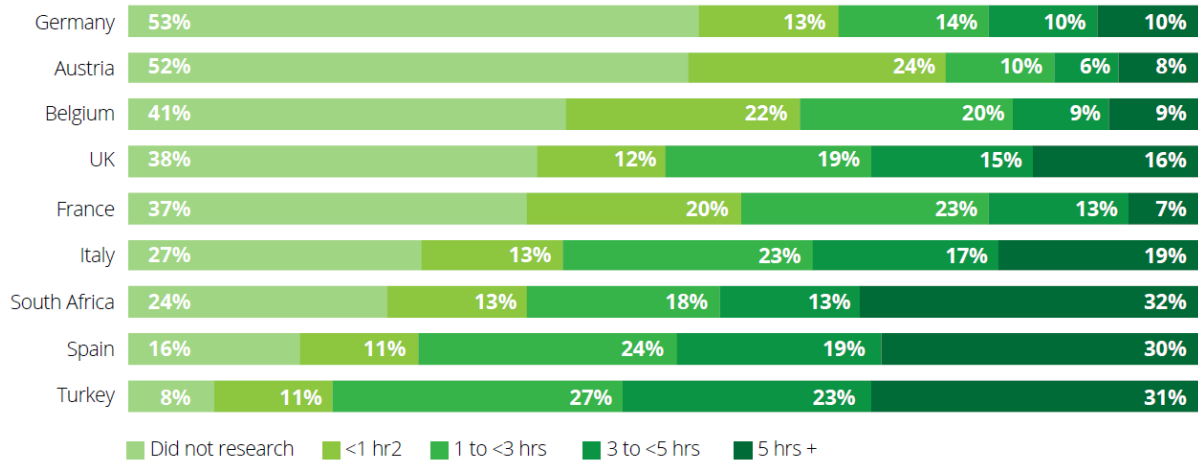
Even though there is information available, the research still shows there is a lack of understanding around EVs. This could be for the reasons below.

2.1.1. Lack of research into EVs

A recent survey showed that in the UK 50% (Deloitte, 2021) of consumers did no, or less than an hour of research into financing options prior to acquiring their current vehicle, as shown in **Figure 1**. However, we can likely assume that disabled consumers will spend more time researching, as there could be more considerations for them to have to take when choosing their vehicle, depending on their disability. Regardless of this, only spending a couple of hours researching will likely not allow a consumer, who has no prior knowledge of EVs, to make an informed purchasing or leasing decision. This means a large proportion of disabled consumers are not up to date or knowledgeable on EVs.

This was validated when the cohort in the disabled consumers' workshop had many questions and concerns about charging (how to charge, where to charge and how much it costs), vehicle availability (available models, second-hand market, and availability on Motability) and reliability (battery life and range).

Figure 1 – Time spent by consumers in researching finance options prior to acquiring their current vehicle



2.1.2. Information around purchasing or leasing vehicles is complex already

Autotrader’s ‘car buyer’s report’ emphasised consumers often misjudge how complex acquiring a vehicle in general is. The report estimates there are nearly 30 ‘jobs’ that need to be completed by consumers, as shown in **Figure 2**.

Figure 2 – Jobs that need completing to acquire a vehicle (Autotrader, 2019)

| Needs | Budget/finance | Validating choices | Buy |
|---|---|--|--|
| “What do I need?” | “What can I afford?” | “Is it right for me?” | “I’m ready” |
| <input checked="" type="checkbox"/> Size of vehicle | <input checked="" type="checkbox"/> Monthly repayment | <input checked="" type="checkbox"/> Expert reviews | <input checked="" type="checkbox"/> Find a trustworthy local dealership (dealer reviews) |
| <input checked="" type="checkbox"/> Brand | <input checked="" type="checkbox"/> Understanding finance jargon e.g. APR | <input checked="" type="checkbox"/> Owner reviews | <input checked="" type="checkbox"/> Visit dealership |
| <input type="checkbox"/> Specification | <input type="checkbox"/> Servicing costs | <input checked="" type="checkbox"/> Is it easy to drive? | <input checked="" type="checkbox"/> Test drive |
| <input type="checkbox"/> Trim level | <input checked="" type="checkbox"/> Tax | <input type="checkbox"/> Will it fit in the garage? | <input checked="" type="checkbox"/> Negotiate deal |
| <input checked="" type="checkbox"/> Car type | <input type="checkbox"/> Insurance | <input type="checkbox"/> Do I need any add-ons? | <input checked="" type="checkbox"/> Prepare for haggling? |
| <input checked="" type="checkbox"/> Fuel type | <input checked="" type="checkbox"/> Fuel economy | <input checked="" type="checkbox"/> Seek advice from friends / family / forums | <input checked="" type="checkbox"/> Check documentation / service history |
| <input type="checkbox"/> Warranty | <input type="checkbox"/> Purchase or lease? | | <input type="checkbox"/> Understand warranty / gap insurance |
| | <input checked="" type="checkbox"/> Part exchange value | | |

For an EV, this list of jobs increases when a consumer needs to consider charging and range, and how that will impact their daily routines. This adds further dimensions to their research, taking

more time and reducing the likelihood of a purchase or lease. Additionally, disabled consumers who require specific adaptations, vehicle types, or modifications have further elements of complexity to consider, compounding the issue.

2.1.3. Lack of trust in information at dealerships

Although online information is going to be critical to inform all consumers about EVs, a recent survey showed that 74% of UK consumers would still prefer to purchase their next vehicle in person (Deloitte, 2021). Further to this, over 80% of consumers experience the following three 'consumer pain points' (Autotrader, 2019) during the process of purchasing or leasing a vehicle:

- Worried about being 'ripped off'
- Not knowing whether to trust a dealer
- Not knowing if information is accurate

The first point was exhibited in the disabled consumer workshop when one attendee said he did not like going to dealers as they "would try and sell you anything". This is concerning when combined with the fact that 74% want to purchase their vehicle in person.

2.1.4. Untailored information

Although there is information on EVs and how to charge them, there are very few ways for a consumer to understand how that information applies to them online. Tools that allow users to input their driving routines and understand what using an EV would look like are not commonplace – although they do exist through platforms such as Zap-Map, as shown in **Figure 3**.

Figure 3 – Example of a cost calculator that can give a more realistic indicator of owning an EV (Zap-Map, 2021)



The representative from Motability in the automotive workshop said that there had been numerous EVs returned by consumers, due to the vehicle not fitting to their lifestyle. For these examples, it is possible that the information given at the point of sale did not allow the users to truly understand what owning an EV was like. This could be because of salespeople not providing detailed or tailored information for customer.

2.2. Lack of range

Lack of vehicle driving range was consistently seen as a barrier for disabled consumers across all studies reviewed. This is a common concern across all consumers; however, certain disabilities mean that running out of charge could be even more concerning (TfL, 2016). Examples of these could be a disabled consumer who requires specialist care and being stranded could be a severe risk to both their physical and mental health.

In addition to this, the consumers who require modification to their vehicles, or need to stow heavy medical equipment or wheelchairs, could have their range reduced further. This would penalise those specific disabled consumers more than others.

2.3. Reliance on public chargepoints

Most EV owners will need to use the public chargepoint network all or some of the time. There were many issues identified with public chargepoints listed in the research, including:

- **Scarcity of chargepoints:** the perception that there are no chargepoints in a consumer's area
- **Time to charge:** charging can sometimes take a long time, depending on the speeds, demonstrating a barrier for disabled consumers who have disabilities that result in unpredictable episodes or who need access to amenities at short notice
- **Number of operators:** the wide range in operators means that consumers must learn how to use several different technology platforms which could result in some having difficulties using the chargepoints (SSEN, 2021)
- **Chargepoint and built environment accessibility concerns:** a consumer study showed that many different types of chargepoint are not accessible for a range of disabilities (RIDC, 2020)

More detail on the specific barriers to chargepoints usage will be discussed in the 'Using an EV' section. These issues are widely discussed in the media, which can compound the issue of disabled consumers not believing EVs are suitable for their lifestyle.

2.4. Lack of suitable vehicles

The limited choice of EVs is a key practical barrier to disabled consumers' uptake of EVs. For disabled consumers that do not have any specialist considerations for their vehicle there is more choice compared to those that do.

However, many disabled consumers have a wider range in their specific needs for their vehicle due to the many different types of disabilities. Generally speaking, disabled consumers could have one of three requirements for their vehicle:

- **Non-specialist vehicle considerations:** some disabled consumers have specialist requirements for their vehicles, such as large boot, higher ride height, and wider door frames to meet their needs
- **Vehicles with adapted controls and components:** These vehicles are for those whose disability requires specific adaptations of the car to meet their needs, such as modifications to steering control, pedal, seats, and hoists
- **Wheelchair accessible vehicles (WAVs):** These allow a wheelchair user to access the vehicle, whilst situated in their wheelchair, and require substantial modification to the base vehicle

Those disabled consumers that do need vehicles with certain characteristics to meet their needs may be able to use their mobility allowance to lease or purchase a vehicle through the Motability scheme. For comparison, currently in the UK, there are 141 available pure EV models (UK EV database, 2021). On Motability there are currently 90 (Motability, 2021), although there are currently no electric WAVs on the scheme. This impacts those who qualify for the enhanced rate of the mobility components of the personal independence payment (PIP). It is worth considering that there will still be some disabled consumers who do not qualify for the Motability scheme yet still require specialist vehicles.

2.4.1. Adaptations and modifications for EVs

The vehicle adaptations firm Ergomobility highlighted that not all adaptations are available on EVs yet. There are two reasons for this. Firstly, adaptations can only be developed once the vehicle has been released, so that the systems can be integrated into the vehicles and tested for functionality. With EV models being released regularly, not all adaptations may be available on them yet compared to petrol and diesel models that have been around for longer. Hence, consumers' choice is limited.

In addition to this, retrofitting equipment into vehicles can be more technically challenging due to the added complexity of working with high voltage systems, where there is potential risk for severe injury. As a result, there are longer development times for certain modifications, like hand accelerators, and higher costs.

The representative from the European Mobility Group (EMG) raised a key point in the automotive stakeholder workshop. Although not unique to EVs, they had a concern that new driver assistance systems, such as lane departure warning and haptic feedback, will not necessarily

work for a range of disabled consumers and may even need to be deactivated to allow the necessary adaptations to function correctly.

These modifications must also be done after the base vehicle's type approval, the certification process to prove a new vehicle meets the relevant performance and safety standards. This means the modified systems will need certifying again, resulting in higher costs and longer development times for certain adaptations.

2.4.2. WAV conversions for EVs

An area of particular concern is the availability of electric WAVs on the market. Currently, on Motability there are 648 model variants of petrol or diesel WAVs (Motability, 2021). However, there are no electric WAVs. There are examples of electric WAVs that have been produced on small scale, including: Brotherwood's Nissan e-NV200 (UK), Volta Mobility's Vauxhall Vivaro-e (UK), and Tripod Mobility's Kangoo ZE (Netherlands).

Traditionally in WAV conversions, fuel tanks and exhaust systems are often re-engineered to allow access ramps to be retrofitted into the vehicle, and to lower the vehicle floor to allow the occupant to comfortably fit in the vehicle.

In an EV, instead of fuel tanks there are batteries. These high-voltage systems can be potentially incredibly dangerous for both those re-engineering them, and the end user of the vehicle. This is a key issue for conversion and adaptation firms, as they are not currently permitted to modify these systems due to safety concerns. This results in the following potential issues:

- Occupants have to sit above the batteries, which could mean the roof needs to be modified
- Occupants sat above the batteries will be susceptible to more vehicle roll, inducing motion sickness and discomfort
- Access ramps may not be able to be retrofitted, reducing vehicle choice further
- Larger vehicles must be opted for, which incurs higher costs and may not be appropriate for urban environments

There are several other issues that were identified by the automotive stakeholder group, which include:

- Lack of convertible base models mean that the options for WAV converters to choose from is limited
- Regulation for type approval of vehicles and battery testing (ECE-R100 testing specifically) cause lengthy and costly development of new WAV conversions
- Costs are ultimately higher for electric WAVs as a result of these barriers, which are either absorbed by the manufacturers, or more likely passed on to the disabled consumer
- Lack of information sharing between battery and vehicle manufacturers, and WAV converters means development are often longer and costlier, especially for EVs where new skills may be required

2.5. Costs

We can expect to see price parity between EVs and internal combustion engine (ICE) vehicles by 2025-27 (Transport and Environment, 2021). Until then, however, EVs will mostly be more expensive for consumers. This means that for the next four to six years, those who rely on the Motability scheme could need to pay more for their vehicle if they choose to go electric, depending on the model.

This issue will be particularly crucial for those who require modifications or WAVs as these vehicles can already cost more to purchase. One WAV converter from the automotive stakeholder workshop estimated WAVs to be 30-40% more expensive than the base vehicle for an ICE vehicle. This doesn't include the issues of EV WAVs being more expensive to convert. This will mean that those with mobility disabilities will be faced with potentially higher costs, even compared to those with other disabilities.

3. Solutions for disabled consumers getting EVs

Although there are certain barriers disabled consumers face when transitioning to EVs, promisingly, there are several solutions that have been identified to overcome them. The following section looks at some of these, while specific solutions for range and chargepoints will be looked at in more detail in the second section of the report, 'Using an EV'.

3.1. Increasing knowledge on EVs

Increasing knowledge on EVs will need to happen at multiple different parts of the vehicle purchasing or leasing process. There are three main areas where information is needed.

3.1.1. Giving information prior to disabled consumer research

Disabled consumers need engaging with before they have begun their research for their next vehicle. This could be through targeted email campaigns from their trusted sources of information, such as Motability, or other disabled consumer-focused publications. The content should focus on myth busting common misconceptions around EVs, such as unrealistic range of vehicles. Having information actively shown to consumers will allow them to begin their research from a more informed start point.

3.1.2. Promotion of tools and calculators for disabled consumers

There is a range of different online tools that can be used to show consumers how much they could save in fuel and tax and journey planners that show where chargepoints are. These should be more explicitly marketed as sources of information for disabled consumers so that a realistic assessment of owning an EV can be made.

3.1.3. Ensure information is available in-person

Generally, consumers have a desire to see their vehicle before they commit to buying (Deloitte, 2021). Hence, the point of sale can be considered as one of the most important places to supply disabled drivers with appropriate information on whether an EV would be a suitable choice.

Two examples of schemes that operate on this principle include the Electric Vehicle Approved (EVA) dealership scheme and the Motability dealership specialists. Motability specialists at dealerships are often considered one of the most trustworthy sources of information, specifically for disabled consumers. In the UK, there are over 4500 dealerships with Motability specialists. These specialists are trained periodically to be able to consider all the specific needs of disabled consumers and, are therefore capable of finding the best vehicle for them.

Figure 4 – The EVA dealership scheme helps ensure dealers have knowledge in EVs



The EVA scheme, endorsed by the Office for Zero Emission Vehicles (OZEV), Energy Saving Trust and the National Franchised Dealers Association, is in place to ensure that specific dealership has been audited to be able to provide adequate information on EVs at the point of sale or lease. This means they can tailor information about how the EV could fit into the consumer's lives. There are approximately 200 dealerships across the UK, however, the scheme does not include an element that looks specifically at the unique experience of disabled drivers. It is clear to see that, compared to Motability specialists, EVA dealerships are far less common.

Combining the training and practices of both schemes may be crucial to ensure that Motability specialists can provide the relevant information to the dealerships, so the disabled consumers who go there get all the specific information they need to make an informed purchase decision.

In addition to that, SSEN's study recommended that extended vehicle trials and EV experiences could be a positive way to ensure that the consumer fully understood how an EV could integrate into their lives. Examples of 'try before you buy' schemes currently include TryEV. This impartial platform brings EVs to your work or home for test drives with a trained professional to answer any questions (TryEV, 2021), although there is no reference to any accessibility focus.

3.2. Suitability and availability of vehicles

The number of EVs on the market will rapidly increase over the coming years, especially as costs of manufacturing come down due to the economies of scale of production. However, there are other ways in which more suitable vehicles can be brought to disabled consumers.

3.2.1. Mandate of EVs for manufacturers

The recently proposed government zero-emission vehicle (ZEV) mandate on the number EVs sold by manufacturers presents a great possibility to increase the number of specific types EVs. To maximise this opportunity, an element of accessibility could be considered on models, for example to ensure that multi-purpose vehicles (MPVs) are also included in the mandate. These vehicles are particularly useful for converting to WAVs, which could lead to an increase in the number of EV WAVs.

The government has committed to a running a consultation for a full regulatory proposal for cars and vans in 2022 to seek views on how the ZEV mandate can incentivise the switch to zero emission in vehicles with specific use cases, such as WAVs.

3.2.2. Support for conversions and adaptations firms

Another large barrier that needs to be overcome is the technical complexity of converting EVs to WAVs. These adaptation and conversion industries have called for more support from vehicle and battery manufacturers to help them tackle these challenges. This could be done through access to more information on vehicles prior to release to allow the industry to stay up to date on conversions and adaptations.

Technical training and upskilling the staff in working on high voltage systems will also help these companies to work on EVs and to bring products to the market quicker, and therefore, ultimately facilitating more suitable vehicles for disabled consumers where modifications are required.

3.2.3. Regulatory and legislative exemptions and changes

Certain regulations and processes, such as type approval and R100 battery testing, could be review to allow more leniency for certain modifications and conversions, whilst still ensuring the necessary safety precautions can be taken. Although safety should always be a core consideration throughout engineering processes, certain exemptions could result in the faster development of accessible EVs. Ultimately, consultation with the bodies shown in Table 2 would allow for an in depth understanding of how these regulations could change.

Table 2 – Key stakeholders in facilitating an accessible transition to EVs

| Organisations | Description |
|--|---|
| Wheelchair Accessible Vehicle Converters Association (WAVCA) | UK's national body for converters |
| Organisation Europeenne des Constructeurs de Vehicules Accessibles (OECVA) | OECVA is the trade association for European constructors of wheelchair accessible vehicles. |
| European Mobility Group (EMG) | A European body for all adaptation and converters |

3.3. Reducing costs

The purchase and leasing cost of EVs is falling, with price parity estimated to be four to six years away. During the transition to that parity point, certain financial incentives could be put in place. Currently, Motability already offer free home chargepoints installation or free access to BP Pulse's network of public chargepoints, although it is important to consider that not all disabled consumers are eligible for the Motability scheme.

It could also be possible to amend the mobility allowance to reflect the higher costs of EVs until that point of price parity is reached.

There is also the plug-in vehicle grant which now discounts up to £1,500 off the price of a zero-emission car with a purchase price less than £32,000. Vehicles being converted to wheelchair accessible retain the previous grant rate of up to £2,500 for vehicles priced under £35,000.

4. Barriers for disabled consumers using an EV

This section investigates the barriers that disabled consumers face when using an EV. This subject matter has been under more scrutiny and the majority of the literature reviewed was focused on these barriers. As a result of this, positive steps have already been made to develop accessible charging standards that allow chargepoint providers to produce more accessible chargepoints, in more accessible environments.

Some of the key barriers for disabled consumers using EVs are:

- Scarcity of chargepoints
- Chargepoint built environment accessibility issues
- Chargepoint accessibility issues
- Consumer behavioural change

4.1. Scarcity of chargepoints

Fundamentally, there are not enough chargepoints in the UK for all consumers to sufficiently transition to EVs. Although there are approximately 25,000 chargepoints listed by the Department for Transport and Zap-Map, many of these are London-centric and certain areas in the UK have considerably less provision, particularly more rural ones. Having to rely on a sparse network of chargepoints could make planning journeys difficult for consumers in general. There are also consistent reports of chargepoints often being out of service, or already occupied – something that was confirmed by a user in the workshop.

4.1.1. Barriers for local authorities

Local authorities face a number of barriers when it comes to developing EV infrastructure strategies and implementing chargepoints. The two fundamental barriers are:

- Lack of expertise in EVs and the requirements for an effective strategy that considers the needs of all consumers
- Lack of resource available to develop and implement a strategy

This has resulted in slow deployment across parts of the UK and has led to the perception of there being an inadequate chargepoint infrastructure amongst consumers.

4.1.2. Planning complexities

There are complexities to the planning of chargepoint implementation for several stakeholders, including distribution network operators (DNOs), chargepoint operators, and local authorities.

Many district authorities do not have the highways permission to install chargepoints on-street, meaning they must rely on car park locations or wait for the county authority to implement chargepoints. This can result in less tailored strategies where local issues aren't considered as well as well as smaller projects confined to a limited number of publicly owned car parks.

DNO connection point locations are one of the key factors in determining where public infrastructure can be installed, meaning some areas could be left behind if the grid infrastructure cannot cope with the additional load.

Planning permission for chargepoint operators can be difficult to get, especially in more densely populated areas, where there is more chance for someone to object. There is a conflict of interest for some disabled consumers; although they want accessible infrastructure, more street furniture can often be detrimental to the streetscape's accessibility credentials.

A combination of all these factors means that installing a chargepoint can take a number of months.

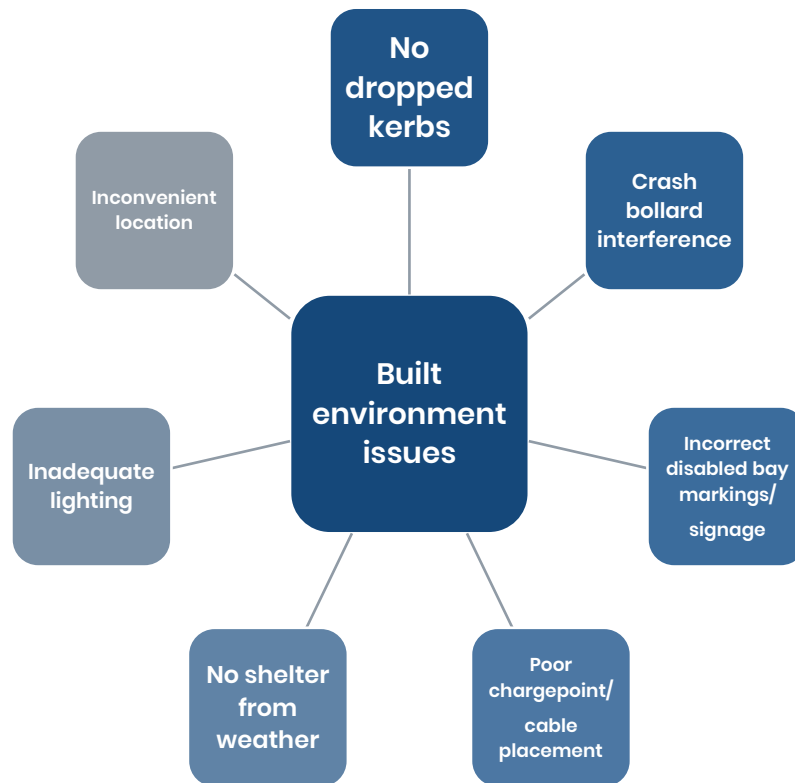
4.1.3. Costs

Chargepoint installation can be expensive, depending on the speed of chargepoint and the location. One of the largest contributors to that cost is the electrical connection cost, which, depending on the location, can make projects completely financially infeasible. Consequently, regions where upgrades to the grid are required could be left with inadequate provision of chargepoints.

4.2. Chargepoint built environment accessibility issues

Particularly the built environment around the chargepoint itself has been identified as an area of concern for certain disabled consumers, most notably those with mobility and dexterity disabilities. Some of the key issues raised in the various studies, and consumer workshop are shown in **Figure 5**

Figure 5 – Most common accessibility concerns around chargepoints’ built environment.



Stakeholders in the chargepoint operator workshop identified the following barriers to achieving accessibility in the built environment.

4.2.1. No design standards

The industry welcomed the principle of the new BSI accessible charging standards for both chargepoints and their built environment. This was consistently noted as a barrier for chargepoint operators as there are limited resources on what constitutes an accessible chargepoint.

4.2.2. Issues with sites and land ownership

Some chargepoint operators, especially forecourt chargepoint providers such as BP Pulse, are in a position where they own both the chargepoint, the immediate environment, and the surrounding areas. This gives them flexibility to find an appropriate solution for that chargepoint.

However, many chargepoints are retrofitted into areas which are not owned by the chargepoint operator, limiting what chargepoint operators can change in the surrounding environment. This was raised by a chargepoint operator who have partnerships with supermarkets. They were constrained to standard bays due to the lack of influence in the parking policy for the site and landowners not wanting to lose any further bays.

A similar issue is occurring with local authorities and on-street chargepoint providers. Chargepoint operators also raised the point of who should have responsibility for certain

elements of the installation, such as dropped kerbs, which may not have been required previously in an on-street location.

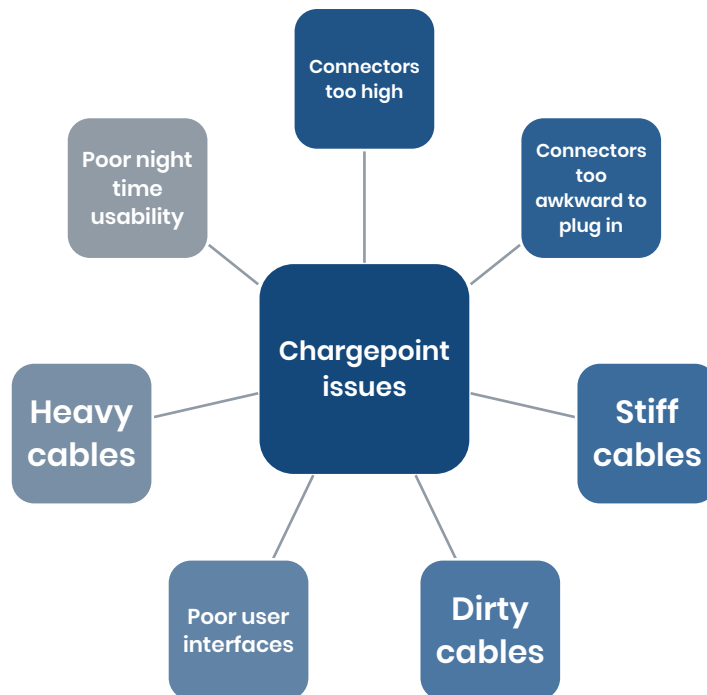
4.2.3. Costs

The profit margins on chargepoints are very small and return of investment will take many years. Consequently, if chargepoint operators are not explicitly requested to implement accessible features around their chargepoint, it is likely that they will not do so by themselves to save costs. The additional costs that are required for accessible chargepoints also may include the cost of dropping kerbs or having adequate shelter or lighting.

4.3. Chargepoint accessibility issues

Chargepoints themselves have a range of issues, which make them not accessible for all users. Some of the most common of these are shown in Figure 2.

Figure 6 – Most common accessibility concerns around chargepoints.



These challenges impact different disabled consumers from those who are visually impaired, to those with mobility and dexterity disabilities. Currently, there are two key elements to consider about why chargepoints aren't accessible:

4.3.1. Lack of common design standards

The fundamental reason for this lack of consideration is the absence of specific chargepoint design standards. Positively, all the chargepoint operators in the workshop welcomed the

forthcoming accessible charging standards from the BSI, saying it would help each of them align designs to meet the needs of more consumers.

Although chargepoint operators claimed that they did consider reach zones and appropriate heights for wheelchair users, this did not always result in an accessible solution. For example, the connector may be at the correct height to the base of the chargepoint, however, this doesn't include the additional height of the kerb or the fact that a wheelchair user cannot physically get close enough to the chargepoint due to a crash barrier. This highlights the importance of chargepoint-specific standards, that consider all the possible use cases.

It is important to recognise that it is not just a physical accessibility problem, but also a digital one. Consumers in the workshop, and in the studies reviewed, often remarked at the complexity of the different digital platforms. Complex payment systems, poor user interface designs, illegible displays were all referenced as issues.

4.3.2. Not all chargepoints can be accessible

Something that was identified in the workshop by BP Pulse was that it will not be possible to make all chargepoints 100% accessible for all consumers. This is due to the technical restrictions of delivering power to vehicles and logistical limitations of chargepoint sites. For faster charging, thicker cables with integrated cooling will be required, making charging inevitably challenging for certain users.

4.4. Consumer behavioural change

Using chargepoints themselves does pose accessibility issues for certain users but so does having to plan to use them and integrating them into the routine of travelling. There were several areas where disabled consumers would have to change how they travel.

4.4.1. Time to charge

The time taken to charge vehicles is another issue for all consumers but exacerbated for disabled consumers. Depending on what speed charger is being used, consumers could be forced to wait anywhere between 30 minutes and several hours for their vehicle to be charged. If it is the latter of those times, considerations need to be made about where that individual can either wait, or how they get home from where their vehicle is being charged. This time adds to issues around suitability of locations for public chargepoints and whether they have sufficient amenities for consumers to wait at. For certain disabilities, services, such as toilets, or shops could be a necessity, which many chargepoints may not be able to provide.

One major concern that was identified in the consumer workshop was the fact that those disabled consumers that required care could be particularly penalised by this additional time taken to charge. This is due to the care costs that will be incurred during that waiting period. Those consumers who were fully reliant on public chargepoint infrastructure are affected the worst as they will spend more time at chargepoints that they may not be able to operate themselves. Understanding what financial impact this could have on a consumer were not identified in any of the previous studies.

4.4.2. Planning journeys

In comparison to consumers without a disability, planning a journey ahead of time can be crucial for consumers with certain disabilities. In alignment to their risk aversity, anxiety of disabled consumers can be more common and more impactful (TfL, 2016). Typically, there are three main considerations of disabled consumers when planning a journey:

- **Route Planning:** including time of day, traffic density, roadworks, range of car, charge level, location of accessible chargepoints, wireless coverage, range margin of safety
- **Practical considerations:** including overall time of journey, electrical devices reducing battery life such as wheelchair hoists and heated seats
- **Contingency planning:** including chargepoints along alternative routes, phone signal coverage, and to access local amenities

The planning itself is complicated through a lack of easily available and reliant information on accessible chargepoints. Typically, drivers are not used to seeing disabled EV chargepoints and may therefore assume EVs are not suitable for them. Hence, it is crucial to support the cohort with information services that can overcome this barrier, otherwise travelling will become more complex through use of an EV.

5. Solutions for disabled consumers using an EV

There are a range of solutions to the barriers identified in the study. The SSEN Enable EV project highlighted many of these and who held the responsibility for them (SSEN, 2021). The following sections list the solutions along with considerations for each.

5.1. Scarcity of chargepoints

To increase the number of chargepoints, a complex set of solutions will be required, whilst engaging with several stakeholders.

5.1.1. Local authority strategy

Local authorities will have to consciously integrate accessibility considerations into their infrastructure strategies. As a first step, examples of effective strategies must be understood, so their lessons learned can be used to educate other local authorities. Although there will not be a single solution that works for all authorities, it is crucial to collect and to share examples from across the UK about how to successfully implement more accessible infrastructure to expand the shared knowledge.

Using organisations such as the Local Government Association (LGA) or others who directly engage with local authorities might prove useful of promoting good practices. Further, engaging with local authorities, such as Durham County and Oxfordshire County Council, who have already considered accessibility in their implementations of infrastructure, could be a good way of understanding local authority barriers as well as possible solutions.

5.1.2. Engagement with DNOs

DNOs will need to work alongside local authorities and chargepoint operators to understand where upgrades and reinforcement will be required to reduce the costs of installations. UK Power Networks (UKPN) have done excellent work in mapping where their vulnerable consumers are, which includes those with disabilities, to ensure that energy can be delivered to those areas in a cost-efficient manner. This work needs to be replicated across the UK so that all disabled consumers, especially those in areas of no off-street parking can have access to chargepoints.

5.2. Built environment and chargepoints accessibility issues

Looking more specifically at the chargepoint accessibility issues, there are several areas that need to be addressed.

5.2.1. Design standards

Fundamentally, the proposed BSI accessible charging standard for both, chargepoints and their built environment, will make future chargepoints more accessible. However, there are several considerations highlighted from the research to make.

Firstly, the standards need to include all digital and physical aspects of chargepoints and their environment, including signage. This will ensure that all interactions can be made more accessible, not just the physical elements.

End consumers need to be consulted throughout the development of the standards. All disabled consumers have their own unique experiences and needs when it comes to travel. The best way to ensure that the design standards are truly accessible is to test a design on a wide range of people with different needs.

It isn't just the end consumers that need consulting, both the automotive and chargepoint industries need to be engaged throughout the process, so that the standards can be implemented feasibly by operators.

5.2.2. Engaging with private landowners

Landowners are going to play an increasingly key role in the widespread rollout of chargepoints. The recent consultation on the 'Future of transport regulatory review' (UK Government, 2021) showed how private landowners could be required to install certain numbers of chargepoints in the future. In addition to the number of chargepoints, this could be an opportunity to impose what type of chargepoints should be installed, with minimum quotas of accessible chargepoints being a part of the obligation.

In addition to this, landowners will also need to consider how their locations support the needs of all their customers, especially disabled ones. This could include the implementation of shelters or places to rest whilst vehicles are being charged.

5.2.3. Support services

Chargepoint operators and landowners also need to develop solutions for those consumers who will need some form of support for their charging needs. This could include assistance services at chargepoints, much like the existing support provided by petrol stations. This is particularly relevant for forecourt chargepoints and motorway service operators (MSOs). Moto, the MSO, said that they would consider implementing a similar service for their chargepoints at their sites, however, this could be applied to all MSOs in the UK to enhance the support for the inevitably heavy cables of rapid chargepoints.

5.2.4. Removing the need to plug-in

Research often referred to the promise of wireless induction charging as a solution for not having to plug in your vehicle at all. Currently, induction charging is being trailed by several chargepoint operators and vehicle manufacturers, including Connected Kerb, Char.gy, BMW, Nissan, Qualcomm, Plugless, and WiTricity. Even though the technology is in development, it is still not widely available yet. The main barriers for the widescale adoption of inductive charging currently are:

- Lack of standardisation
- Complexity of system, retrofitting into vehicles
- Lack of vehicles with technology installed as standard

An alternative concept is to bring charging to consumers who do not want to use public chargepoint infrastructure (SSEN, 2021). One concept, called Charge Fairy, uses a specialist vehicle that will come and charge your vehicle overnight for a fee. Services like this could be adopted by councils for their particularly vulnerable constituents. This could follow a similar model to the 'Dial-a-ride' services provided by TfL (TfL, 2021), where particular members of the public could qualify to become a member of the service.

5.3. Consumer behavioural change

Accessing the right information is going to be the key enhancer to helping consumers shift their mentality on travel in an EV. For the planning elements of the journey, there needs to be a wide range of information on what available chargepoints there are, and whether they are accessible for the individual consumer.

5.3.1. Finding the right chargepoints

Many new EVs have integrated technology to show where chargepoints are. EVs enabled with Google software, such as the Volvo XC40, now have functionality to automatically incorporate chargepoints into your planning. This is a feature that already exists within Tesla vehicles. Having these systems as standard in vehicles would remove the need for much of the planning a consumer currently needs to do. Engagement with the automotive industry through the Society of Motor Manufacturers and Traders (SMMT) could highlight what strategies manufacturers have in this area. Although this does not solve the issue about whether that chargepoint is accessible, it does remove steps from the complex planning process.

There are also app-based versions of this type of software, like Zap-Map, however there is still limited information about that actual chargepoint in terms of accessibility. Having a formal grading system of accessibility for chargepoints could be a good way of simplifying whether that specific chargepoint could work for the individual. An alternative way would be to have a more open reviewing system of infrastructure that would allow users to comment on the accessibility of the chargepoint. Examples of this exist for other amenities or places, such as Euan's Guide (Euan's Guide, 2021) and AccessAble (AccessAble, 2021) websites.

5.3.2. Booking ability

One of the psychological barriers identified in the research was the fear of not being able to charge at a chargepoint and having to find an alternative. Source London's business model allows users to book a charging slot up to 30 minutes in advance. Having the ability to book would ensure that disabled consumers would always be able to plan where they were charging. Further trials are being run in Brighton and Hove for bookable chargepoint spots.

Other platforms, such as Bookmycharge or Co-Charger, also use booking features, however, this is for booking other consumers' home chargepoints. This could be a beneficial solution for many consumers who may have more space to manoeuvre around a vehicle. However, it would not be possible to guarantee this and as these are private residences, the disabled consumer is at risk of booking something that is not suitable for them.

6. Conclusion

There are many barriers faced by disabled consumers throughout the process of getting and using an EV. Disabled consumers have many of the same challenges that other consumers face but some will have further barriers to consider. The subsets of disabled consumers that are most impacted by getting an EV include:

- Those who require specialist adaptations or modifications to their vehicles, especially those who require a WAV, where EV versions are in very limited supply
- Those who qualify for a blue badge and will require a disabled bay to charge
- Those who are from low-income backgrounds
- Those who will rely on on-street chargepoint

For many disabled consumers, switching to an EV could be positive experience but they have not accessed the right information to be able to demonstrate this. It is therefore imperative that these consumers who can feasibly use an EV are given the correct information to make an informed decision to purchase or lease an EV.

Appendix A Stakeholder workshops overviews

Alongside the literature review and research, three workshops were also held along with a fourth dissemination event. The workshops were designed to better understand the barriers that various stakeholders faced, as well as discussing potential solutions too.

Each focus group was designed to include stakeholders across three key areas:

- Automotive industry stakeholders
- Chargepoint operators
- Disabled consumers

The dissemination event discussed the findings with stakeholders from central government and other influencing organisations. A topic guide was developed for each workshop to ask specific questions to the attendees, with the intention of guiding the conversation to uncover the barriers that particular group had.

1. Automotive industry stakeholder workshop

The automotive sector plays a pivotal role in the supply of EVs across the UK for all consumers. The range of models and their battery sizes will play a significant role in the uptake of EVs. For certain disabled consumers, a vehicle may need to meet specific requirements, such as wider door openings, larger boots, modifications to controls, or a conversion to a WAV.

The research highlighted the impact of transitioning to EVs for vehicle control adaptations and modifications, as well as full conversions to WAVs. For the workshop, we wanted to include representatives from these different areas of the automotive industry. **Table 3** shows the attendees for the first workshop.

Table 3 – Attendees of the automotive stakeholders workshop

| Organisation | Industry |
|------------------|--------------------------|
| Autochair | Adaptation/WAV converter |
| Motability | Vehicle supply |
| OECVA | European WAV association |
| Brotherwood | WAV converter |
| Volta Motability | WAV converter |
| LEVC | Vehicle manufacturer |
| Braun Ability | Adaptation/WAV converter |
| Vauxhall | Vehicle manufacturer |

| | |
|-------------------------|------------------------|
| VCA | Vehicle certification |
| WAVCA | UK WAV association |
| European Mobility Group | Adaptation association |

The following sections show the key barriers that these stakeholders face in their ability to supply suitable vehicles for disabled consumers, particularly those who require adaptations and modifications to their vehicle.

1.1. Barriers for automotive stakeholders

1.1.1. Poor provision of information for consumers

The representative from Motability commented on how consumers are not being made aware of the full experience of using an EV, with some having sent vehicles back. They emphasised the importance of dealerships and leasing organisations in providing the right information to consumers so that they can make an informed decision.

1.1.2. Regulation

Vehicle regulation is complex due to the stringent safety standards that need to be met. For vehicle adaptation and modification companies these regulations can be restrictive for the types of modifications that can be made.

One of the main challenges is that these companies take a base model vehicle, which has passed all the necessary certification and regulatory checks and modify a function within it. This will mean that the modified vehicle could need re-approving. These tests can be incredibly expensive for the firms and can slow down the development of new vehicle modifications.

The two most affected areas for this constraint are:

- Developing electric WAVs, as the battery needs modifying to accommodate the wheelchair ramp.
- Regulations prevent some advanced technologies such as automatic steering or haptic feedback from being disabled which can reduce the availability of certain adaptations that can currently be found in the market.

1.1.3. Lack of available base EV models for conversion industry

Adaptation and conversion firms also had concerns about the availability of suitable EV models for various adaptations and conversion. Their concerns were:

- There are generally lower numbers of EV models compared to petrol and diesel models, although they did accept that this was improving

- There are lower numbers of small vans and multi-purpose vehicles (MPVs) which are often required for WAVs, but also disabled consumers who need easy ingress and egress in and out the vehicle
- The EVs that are available and suitable for conversion are often larger and have smaller ranges, which compounds the issue of range anxiety among certain disabled consumers

1.1.4. Technological challenges

Automotive manufacturers face their own challenges in developing EVs, with the main focus being to increase vehicle battery range and expanding the available number of models. However, adaptation and conversion firms have their own specific technological challenges, including:

- There is a lack of specialist technical and safety skills, especially in high voltage systems and EV vehicle architecture, making development of specialist EVs slow
- The industry is reliant on EU safety standards, which are becoming more stringent and technologically complex. Although this is beneficial for consumers in general, it means more complexity for the adaptation and conversion industries, slowing down development
- There is an unknown impact on power drawn from equipment, such as hoists or powered ramps, however testing is beginning among the converters

The most fundamental challenge WAV converters are experiencing is the placement of the vehicles' batteries. To allow a disabled passenger to sit in a comfortable position in the vehicle, most WAVs have their floors lowered to accommodate the wheelchair and the ramp. However, a lowered floor will mean the vehicle's battery must be either:

- Reduced in size, therefore reducing the range
- Left in place, and position the wheelchair occupant higher in the vehicle, removing the need to lower the vehicle floor, but increasing the roll effect for the passenger and decreasing comfort

Leaving the battery in place may mean that converters must use much larger base vehicles, which can be more expensive and not fit for purpose in cities for consumers. However, modifying the battery has its own complexities, such as needing battery testing (ECE-R100 testing) and buy-in from battery cell manufacturers, which can be difficult.

1.1.5. Lack of industry support and collaboration

The WAVCA and OECVA representatives raised the point that there was a lack of support from vehicle manufacturers in supplying crucial information to the conversion and adaptation industries. Although there are shared portals for data, these aren't detailed enough to allow the development of EVs based on the current knowledge level of converters.

Manufacturers of vehicles and batteries do have their own challenges, however, in being able to supply the correct data. This is due to reputational and safety risks associated with modifying complex components of the vehicle system. One converter, who has developed one of the UK's

only EV WAVs, struggled with agreements from the vehicle manufacturer, however, did come to a final agreement.

The general argument from the converters and adaptors was that their industry was not being heard and that vehicle manufacturers and regulations were making developing specialist EVs difficult.

1.1.6. Costs

In general, EVs have higher upfront costs of purchase than petrol or diesel equivalents. However, as a result of the technical complexities of converting WAVs to electric, there are higher development costs due to battery modification, and the required battery testing. One attendee estimated that WAV conversions are 30-40% more expensive than their base vehicle models. These costs will ultimately be passed down to the consumer or absorbed by the WAV converter.

1.2. Solutions

The technical challenges face by the WAV conversion industry are complex and no clear solutions were discussed in the workshop. However, there were some ideas for next steps to tackling the barriers.

1.2.1. Exemptions

To help ease the requirement for electric WAVs, some attendees suggested making WAVs or highly specialised vehicles exempt from clean air zones (CAZ) and low emission zones (LEZ). This would reduce initial demand for electric WAVs and give converters time to upskill their workforce and develop necessary technical solutions to overcome the issues around battery placement. This would support disabled consumers who do not have off-street parking and who would be most impacted by having an EV.

There could also be exemptions for certain adaptations and conversions from a certification and testing perspective. If those regulatory barriers were modified, development could reduce in cost and increase in speed.

1.2.2. Collaboration

Having a greater level of collaboration between the key stakeholders will be crucial for the successful development of electric WAVs and specialist vehicles. It will require better data exchange between battery cell manufacturers, automotive manufactures, and the adaptation and conversion industries. The Society of Motor Manufacturers and Traders (SMMT) could play a key role in facilitating those relationships and ensure that the voice of the industry is heard, and the needs of disabled consumers are understood.

1.2.3. Financial support

Financial support for different stakeholders could be one of the methods for supporting the early stages of electric WAV conversions. There could be two key mechanisms for support:

- Subsidies for certain vehicles with higher costs, like WAVs, to allow them to still meet the safety specifications and meet manufacturers desired standards, without penalising the end consumer
- Support upskilling the converters and adapters industries in EV specific areas such as high voltage systems and EV powertrains

2. Chargepoint operator stakeholder workshop

The second workshop was designed to understand chargepoint operators' barriers for being able to implement accessible chargepoint infrastructure at scale. **Table 4** shows the attendees of the workshop.

Table 4 – Organisations that attended the workshop

| Organisation | Company description |
|---|--|
| Source London | On-street and residential chargepoint operator for London, with a booking system |
| BP Pulse | Rapid hubs, on-street, and residential chargepoint operator |
| Connected Kerb | On-street and residential chargepoint operator |
| Scottish and Southern Electricity Networks (SSEN) | Distribution network operator (DNO) |
| Joju Charging | Rapid hubs, on-street, and residential chargepoint operator |
| Moto Services | Motorway service operator (MSO) and rapid hub host |
| Pod point | On-street and residential chargepoint operator |

2.1. Barriers

There were three main groups of barriers that the CPOs faced. Fundamentally, the main issue for disabled consumers is that there are not enough accessible chargepoints across the UK. Therefore, many of the barriers that were discussed in the workshop were for the wider challenges CPOs encountered during their rollout of infrastructure.

2.1.1. Planning

There are several areas with the planning of infrastructure that has slowed down the widespread of all chargepoints, and accessible ones. Barriers include:

- High electrical connection costs and grid capacity constraints can limit sites for chargepoints
- The process of applying for a connection point can be time consuming and delay projects
- Available funding for chargepoints can take time to obtain, and many local authorities cannot afford to chargepoint networks without the funding
- Planning permission from local authorities on chargepoints, coverings, and other built environment factors play a large role in holding back the speed of implementation

- Ideal spots for rapid hubs are normally in fierce competition and have their own individual constraints that might make fitting chargepoints difficult

2.1.2. Built environment and site challenges

CPOs were made aware of some of the most common accessibility failures for a chargepoints built environmental. For some of the issues, such as lack of dropped kerbs, there is still debate around who is responsible for these built environment elements, the landowner, or the CPO. There are potentially high-cost implications for some of the accessible features including shelter, lighting, toilets, and larger bays. As profit margins for chargepoints are relatively small, CPOs may not add all the features to every site if they are not required to.

Many CPOs install their chargepoints in existing car parks, where they do not necessarily have the ability to change parking bay layout or alter the streetscape. These restrictions can result in standard bay widths with no additional space for disabled bays. For on-street chargers, there is a similar issue, whereby the streetscape often defines what type of parking arrangement is possible.

2.1.3. Chargepoint accessibility challenges

The overarching barrier for chargepoint operators is that there is no design standard in place to allow them to ensure their designs are fully compliant with the needs of disabled consumers. This applies to both the physical design of the chargepoint as well as the interfaces consumers use to interact with the chargepoint.

There are some design features that will not be able to change. One operator mentioned that to be able to deliver the high power of a rapid, or ultra-rapid chargepoint, cables need integrated cooling. This will mean that cables will be stiffer and more challenging to use for consumers with mobility or dexterity disabilities. They mentioned this wouldn't be able to change until there was a breakthrough in charging technology that allowed different cooling methods, or a wireless charge.

2.1.4. Lack of guidance

Some CPOs said they do put at least one rapid chargepoint in an accessible hub, however, as there is no guidance on what is 'accessible' for a chargepoint, it doesn't mean that it will be accessible for everyone. This would be helped with an accessibility 'rating' for chargepoints so that consumers know what to expect when arriving at an 'accessible' chargepoint.

2.2. Solutions

Fortunately, with the introduction of the new BSI accessible charging standards planned for 2022, many of the built environment and chargepoint design barriers will be resolved. The CPOs were very receptive to the standards and welcomed their guidance to enhance their products' design.

All the CPOs said that they wanted to be a part of the development process for these standards and that consultation with industry would be essential for a successful standard that could be realistically implemented. They also believed that having other stakeholders, such as the automotive manufacturer industry, was important to ensure that issues such as socket location on vehicles was also discussed.

Although having design standards will be important, the integration of accessible chargepoints into infrastructure plans will be critical. This will require landowners, local authorities, and CPOs to pledge to increase the number of chargepoints that meet the minimum standards for accessibility.

CPOs that offered forecourt charging solutions agreed that support services could be offered, such as assistance with charging from attendants. Where this wasn't possible, having digital support options for users who require certain accessibility features could also be beneficial, such as a suggestion for the nearest chargepoint with certain features.

3. Disabled consumer workshop

The disabled consumer workshop was attended by eight consumers, with a range of disabilities. **Table 5** and **Table 6** shows the details of the attendees along with the questions that were asked during recruitment. This workshop was designed to hear more about the personal experiences disabled consumers had with using EVs or about their perceptions of using an EV.

As well as trying to understand the consumer journey for getting and using an EV, we also presented certain barriers that had been identified in the study to gauge whether these were already known by disabled consumers, or if there were any other barriers.

Table 5 – Details of attendees in the workshop

| Question | Count |
|--|-------|
| 1. Do you hold a blue badge? | |
| a. No, but I regularly drive someone who does have a blue badge | 1 |
| b. Yes | 8 |
| 2. If yes, which of the below describes you | |
| a. You cannot walk at all (require a wheelchair at all times) | 1 |
| b. You find walking very difficult due to pain, breathlessness or the time it takes) | 5 |
| c. You cannot walk without help from someone else or using mobility aids) | 2 |
| d. You have a severe disability in both arms and drive regularly, but cannot operate pay-and-display parking machines | 2 |
| e. You are constantly a significant risk to yourself or others near vehicles, in traffic or car parks | 1 |
| f. You struggle severely to plan or follow a journey | 1 |
| g. You find it difficult or impossible to control your actions and lack awareness of the impact you could have on others | 0 |
| 3. What type of vehicle do you or your driver, drive? | |
| a. Petrol, diesel, (non-plug in) hybrid | 7 |
| b. Plug in hybrid | 0 |
| c. Pure electric | 2 |
| 4. Does your vehicle have any specialist requirements? | |
| a. Yes, my vehicle needs to be a wheelchair accessible vehicle (WAV) | 3 |
| b. Yes, a large boot space for medical equipment (e.g. hoists, folded wheel chairs, other walking aids, excluding WAVs etc). | 6 |
| c. Yes, my vehicle requires specialist modifications to allow me to drive. | 1 |
| d. No | 0 |
| 5. Do you have any experience with electric vehicles? | |

| | | |
|-----------|--|---|
| a. | No, none | 3 |
| b. | Yes, some experience with electric vehicles, e.g. you have been in an electric vehicle | 2 |
| c. | Yes, significant experience with electric vehicles, e.g. you drive one | 4 |
| 6. | Where is your vehicle parked overnight? | |
| a. | In a private driveway | 6 |
| b. | In a private car park | 2 |
| c. | On the street/public highway | 2 |

Table 6 – Age and gender of attendees

| Attendee | Age | Gender |
|----------|-----|--------|
| 1 | 56 | F |
| 2 | 34 | M |
| 3 | 53 | M |
| 4 | 25 | F |
| 5 | 38 | F |
| 6 | 70 | F |
| 7 | 46 | M |
| 8 | 71 | M |

3.1. Barriers

3.1.1. Costs

The attendees in the workshop mostly agreed that EVs were too expensive currently, and they wouldn't be able to afford one. There were not only concerns about the upfront costs, but also the potential long-term costs of battery replacement, even though many disabled consumers lease their vehicles and therefore wouldn't need to consider this cost.

One attendee, a wheelchair user, said there would be other costs for them to consider. In the situation where a consumer who needs assistance to use public chargepoints, there will be an additional cost, which could be up to hours of waiting depending on the type of chargepoint used.

3.1.2. Lack of knowledge on EVs

Although some attendees did have some knowledge on EVs or even used one themselves, several lacked knowledge on EV terminology, equipment, processes, and real-world experiences of owning an EV. One attendee, who owns an EV, warned the group to consider buying an EV

properly first, as their experience has been difficult as they weren't made aware of some of the challenges that using an EV could pose.

When asked where they gathered their information, the consumers mostly said that they gathered it online or at a dealership. One attendee who recently did some research into EVs said that they were surprised at how much the cost had come down and range had increased since they had looked previously.

3.1.3. Concerns about charging and range

Consumers had a number of concerns about charging and range from their experience with chargepoints or based on the information that was presented in the workshop. The top issues were:

- Complexity of charging process, including the chargepoint interfaces
- Chargepoints often being out of service
- Inaccessibility of chargepoints and their built environment, and lack of clarity about which chargepoints were accessible
- Chargepoints being placed in disabled bays and increasing competition for other disabled consumers
- There is disproportionality more chargepoints in the South East of the UK compared to the North
- Safety concerns for disabled consumers who may need to use their vehicle for a medical emergency
- Having to rely so heavily on technology for planning journeys

As a result of these concerns, several attendees in the workshop said they would prefer to have a hybrid vehicle first, to wait for these issues to be solved or improved on.

3.2. Solutions

A range of solutions to some of the barriers were also discussed, with the following being the most important for the attendees for the workshop:

- Using disabled-focus publication houses, like Motability, to provide information on the real experience of owning an EV
- Use targeted emails to push content towards consumers, rather than just waiting for the consumer to do the research
- Provide additional financial support for those who have mobility disabilities and require specialist modifications to their vehicle, especially those in wheelchairs
- Ensure forecourt chargepoints can offer some form of physical assistance to disabled consumers who require support charging their vehicle

- Continue to consult solutions with disabled consumers and give those consumers a platform to share their opinions

4. Dissemination event

The final workshop was the dissemination event, which presented the key findings of the project to the key stakeholders show in **Table 7**. The structure of the workshop gave the attendees and opportunity to comment on the key findings to try and see if any further conclusions could be made. There was little additional information gathered in this session, although it did strengthen certain aspects of the findings.

Table 7 – Attendees for the dissemination event

| Organisation | Description |
|--|--|
| Department for Transport | Consumer experience team |
| Society of Motor Manufacturers and Traders (SMMT) | Environmental team |
| UK Power Networks | EV team |
| Consultant | An independent accessibility design consultant |
| Allied Mobility | Vehicle converter |
| Wheelchair accessible vehicle converters association (WAVCA) | UK body for WAV converters |
| Disabled persons transport advisor committee (DPTAC) | Government committee |

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