energy saving trust | Motability

Report commissioned by Motability:

EV design & disability inclusion

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Executive summary

One in five people in the UK live with a disability. It is predicted that by 2035, the number of disabled drivers or passengers will increase to 2.7 million; with many reliant on car travel to support their independence, freedom and wellbeing. With the sales of new petrol and diesel vehicles due to end in 2030, it is essential that this transition to electric vehicles (EVs) is accessible to all.

Previous research has focused on the accessibility of EV charging infrastructure, however a key area of concern that has received less attention is the accessibility of the vehicles themselves. This research focuses on exploring the barriers to accessible EV design for disabled consumers, with a spotlight on Wheelchair Accessible Vehicle (WAV) users. Recommendations are provided to address these barriers and to support disabled users and stakeholders in the automotive industry.

To understand the range of vehicle design challenges faced by disabled people, surveys were conducted with WAV users and dealerships, alongside five in-depth user interviews. To explore the main barriers to vehicle design 12 interviews were undertaken with representatives from relevant stakeholders within the automotive industry. Desk research was also conducted to provide necessary context and explore global trends and current practice in vehicle design.

Findings highlighted that the requirements of disabled consumers are not sufficiently considered in the production of mass-produced vehicles, with WAV user survey respondents raising concerns about finding suitable EV models for their unique needs.

One key finding is the trend of increasingly complex electronically controlled vehicle systems. Without sufficient user engagement, new features may not work for disabled people. From an industry perspective, adapters and converters experience uncertainty over the compatibility of new technologies and features with their products.

The findings also identified the placement of the battery and the charging socket as key accessibility design concerns for EVs. EV battery location is particularly challenging for the conversion of smaller vehicles to eWAVs.

Insights from the adaptation and conversion industry highlight limited engagement with vehicle manufacturers. Therefore, a key recommendation is to foster engagement amongst these stakeholders, to promote collaboration and cultivate productive business relationships. Another key recommendation for stakeholders in the conversion and adaptation industry is to work together with the wider specialist automotive industry to develop and establish guidelines on accessible design principles.

Support from the UK Government is key. This includes funding for an upskilling of the workforce in the wider specialist and low volume vehicle sector to improve safety while working on EVs. Another recommendation is to amend the ZEV mandate, which will force vehicle manufacturers to sell a certain proportion of EVs in the lead up to 2030, by offering more certificates for WAV base vehicles to incentivise the production of suitable vehicles for conversion. Furthermore, it is suggested that the UK Government strengthen the Plug-In Car Grant, a government scheme to incentivise EV uptake for eWAVs, by improving the financial support available to make them more affordable for disabled users.

1. Introduction

1.1. Purpose of this report

The UK Government has proposed a ban on the sale of new petrol and diesel vehicles by 2030 and will phase out the sale of new hybrids by 2035. According to the Society of Motor Manufacturers and Traders (SMMT), electric vehicle (EV) sales are accelerating rapidly, with figures for 2019 to 2021 showing a 587% increase.1 With the adoption of EVs picking up pace, it has never been more important to consider whether everyone has the same opportunity to make the switch to low carbon transport.

This rapid and ambitious transition has implications for disabled drivers and passengers. Currently, the number of disabled drivers or passengers in the UK is around 2.45 million.[2] With this number of disabled drivers or passengers being predicted to increase to 2.7 million by 2035[3] and its likelihood to grow as our population ages,[4] it is crucial to ensure that this significant group aren't left behind. This is particularly vital regarding the unique design challenges of EVs.

The barriers for disabled people getting an EV and using charging infrastructure have both been explored in depth by other Motability funded research such as Ricardo's report 'Electric Vehicle charging infrastructure for people living with disabilities'[5] and the 'Going Electric?'[6] report by the Research Institute for Disabled Consumers. However, a key area of concern that has received less attention is the accessibility of the vehicles themselves. Accessible vehicle design is key to satisfying the growing demand for EVs in the UK market. Disabled motorists will play a major role in the transition, in part due to the Motability Scheme,[7] which has over 600,000 customers.

To address this issue, Motability, the national disability charity, commissioned Energy Saving Trust to conduct the research outlined in this report. This work focuses on exploring the barriers to accessible EV design, with the view to providing insights and recommendations on potential solutions. Energy Saving Trust is an independent, not for profit organisation dedicated to promoting energy efficiency, low carbon transport and sustainable energy use to address the climate emergency. Energy Saving Trust is an expert in the EV market and in the delivery of programmes to support equitable transport decarbonisation across businesses, local authorities and fleets.

Many of these programmes are delivered on behalf of the Department for Transport, Office for Zero Emission Vehicles and Transport Scotland. As an independent and impartial organisation addressing the climate emergency, Energy Saving Trust is well placed to undertake this research and to provide actionable insights and recommendations for government and industry.

1.2. Terms and definitions

Motability, the Charity, Motability Operations and the Motability Scheme

It is important to note that the term 'Motability' is often used to refer to what are in fact three separate entities: 1) Motability, the national disability charity, which owns and oversees the Motability Scheme, 2) the Motability Scheme; and 3) Motability Operations, the independent commercial company that the charity contracts to run the Scheme on a day-to-day basis. Given these three play different roles in the transition to EVs, references throughout this report are specified to the entity in question.

1. Motability, the Charity

Motability, the Charity, has a vision that no disabled person should be disadvantaged by poor access to transportation. The Charity sets the strategic policies and direction of the Motability Scheme and oversees its performance to ensure that it continues to meet the needs of disabled people.

Oversight of the Motability Scheme and the Scheme itself continue to be the main method by which the Charity strives to achieve its vision, although an increasing element of its grant-making is beyond the Scheme and it is also investing steadily in its innovation and research activities. The Charity has begun an in-depth programme of research,[8] including listening to the views and perspectives of disabled people. It has also started to look for and generate innovative solutions[9] to meet the evolving transportation needs of disabled people.

2. Motability Scheme

The Motability Scheme enables disabled people in receipt of certain benefits, such as the higher rate mobility allowance, to use all or part of that allowance to pay for the lease of a new car, scooter or powered wheelchair. Insurance, road tax, servicing, tyres and breakdown cover are all included. The Scheme supports eligible disabled consumers to access a vehicle in an affordable and convenient way.

3. Motability Operations

The day-to-day running of the Scheme is delivered by an independent commercial company, Motability Operations, under an exclusive contract with Motability.

Electric vehicle (EV)

The term EV can have several interpretations. For the context of this report, it was exclusively looked at battery EVs (BEVs) which rely solely on electricity to operate.

Wheelchair Accessible Vehicle (WAV)

A WAV enables a driver or passenger to enter the vehicle while seated in a wheelchair.[10]

Vehicle manufacturers (OEMs)

OEM stands for "original equipment manufacturer" in the automotive industry. Although the term can refer to any company that manufactures parts for use in new vehicles, this report uses the expression to relate to the vehicle companies themselves e.g., Ford or Vauxhall.

1.3. Background knowledge

The following paragraphs provide a high-level overview of key information and considerations on disabled consumers that this report considers as relevant background knowledge.

General information on disabled people and their mobility

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 following are different types of disabilities[11]:

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

Background information about disabled drivers and passengers

Between 2020 and 2021, the number of people in the UK reporting a disability was 14.6 million. This is an increase of three million since 2010 to 2011 and represents 22% of the total population, or one in five people living with a disability in the UK.[12]

Transportation is critical to the everyday life of disabled people. It is essential to independence, freedom, and wellbeing.

Disabled drivers represent more than 5% of the driving population,[13] with the number of disabled drivers and passengers predicted to increase from 2.45 million to 2.7 million by 2035.[14] Disabled people rely heavily on car travel as it accounts for 64% of their journeys,[15] whether as a driver or passenger, making it the mode of transportation for 3 in 5 trips of disabled adults.[16] 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.[17]
- Over 20% of children in families with at least one disabled member are in poverty, compared with 16% of children in families with no disabled member.[18] This figure is now likely to be higher as the data was collected pre-COVID pandemic and pre-cost of living crisis.
- Life costs £583 more a month, on average, if you're disabled.[19]
- For almost a quarter (24%) of families with disabled children, extra costs amount to over £1,000 a month.[20]

These points are particularly relevant for some of the considerations disabled consumers need to make when switching to an EV. For example, currently, EVs tend to be more expensive than their petrol or diesel equivalent models, making EVs less accessible for disabled consumers,[21] especially if additional modifications or adaptations are needed.

1.3.1. General information on the conversion and adaptation market in the UK

The UK's conversion and adaptation market is unique due to the Motability Scheme, which has enabled disabled customers to access vehicles, in particular WAVs, at a level not seen in other European countries.[22] The strength of the UK's conversion and adaptation market is testament to the longevity and success of the Motability Scheme.

With over 630,000 people in the Motability Scheme, more than 5% of all vehicles used by Scheme customers are Wheelchair Accessible Vehicles (WAVs). Around 10% of all cars on the Motability Scheme have an adaptation, as do about 18% of all WAVs.[23]

The number of disabled drivers or passengers is predicted to increase from 2.45 million to 2.7 million by 2035.[24] As These drivers and passengers will have to switch to an EV following the ban on sales of new petrol/diesel cars by 2030, making disabled motorists a significant portion of the EV market in the UK.

WAV converters

WAVs represent a driving solution for wheelchair users by allowing them to enter the car while seated in a wheelchair.

According to Designability, a disability and design charity, WAVs are available with different combinations of access adaptations. For example[25]:

- **Ramp or lift** (at the rear or the side) for entering and exiting the vehicle when seated in a wheelchair. The wheelchair user may then travel while seated in their wheelchair or transfer onto a driving seat.
- **'Drive from'** allows the driver to enter and drive the vehicle while seated in their wheelchair, also gaining access is via ramp or lift.
- **'Up front'** enables a passenger to access an adapted vehicle from a wheelchair and travel in the front, beside the driver.

WAV converters buy a base vehicle directly from the vehicle manufacturer (original equipment manufacturer or OEM). They need the OEM's approval before changing the car into a WAV and acquiring the necessary 'type approval' to confirm the WAV is safe to go on the road (see Section 4.2.1. for more detail). A registered WAV might have a range of adaptations fitted, depending on the individual needs of the customer.

Adaptation manufacturers

There are a variety of adaptations that can make a vehicle more comfortable for a disabled driver or passenger.

Adaptation manufacturers develop and manufacture a wide range of devices. These are fitted to registered vehicles or WAVs to provide individual mobility solutions for the disabled motorist, either by themselves or by adaptation installers. They source vehicles from individual clients and businesses, such as converters or dealerships and are not direct customers of OEMs. In comparison to WAV converters, adapters do not need to acquire additional 'type approval' after adapting the vehicle, as the cars they work with are already registered (see Section 4.2.2. for more details).

1.3.2. Types of adaptations

Motability Operations[26] places these adaptations into three categories:

1. **Driving adaptations** to help with speed control, steering and signalling:
   - Push/pull device
   - Left foot accelerators
   - Electronic accelerators
   - General aids, including pedal extension and easy release handbrake
   - Signalling aids (referred to as secondary controls), including remote control devices and built-in indicator switch
   - Steering aids, e.g. steering ball
2. **Access adaptations** to allow easier access for passengers or drivers:
   - Transfer plates
   - Electric person hoist
   - Swivel seats
3. **Stowage adaptations** to easily lift a wheelchair or scooter into the car:
   - Car boot hoist
   - Roof stowage

Compared to WAVs which allow seated access to the car, adapted vehicles with stowage adaptations help the passenger to lift and store the wheelchair, not the occupant themselves, and are therefore not considered WAVs.

According to conversations with representatives from the adaptation industry, driving controls are the most common adaptation type. The most popular adaptations on the Motability Scheme are steering aids, mechanical hand controls, wheelchair stowage and left foot accelerator. Disabled motorists from our user survey also considered remote control devices and swivel seats as important.

2. Methodology

2.1. Research objectives

This project aims to identify and understandthe range of EV accessibility issues that disabled consumers face and to help facilitate an equitable transition to EVs.

The term ‘accessible’ can have several interpretations. For the context of this report, it was looked at whether the needs of people with disabilities are being specifically considered, and whether electric vehicles are built or modified so that they can be ‘accessible’ for disabled consumers.

The report provides a spotlight on the case of wheelchair accessible vehicle (WAV) users as one subgroup of disabled motorists. However, it is important to recognise that people have a diverse range of disabilities with specific and sometimes individual accessibility needs and therefore, potentially unique vehicle design barriers which are not fully addressed within this research.

While many factors need to be considered to create an inclusive and accessible transition to EVs, the focus of this report is primarily on the design of the vehicles themselves, not on other aspects of the EV experience such as information provision or charging.

Each section of the report seeks to highlight barriers for disabled consumers and other relevant stakeholders, solutions that are in progress and areas that have not yet been addressed.

To achieve the aim of this project, the following research objectives were defined:

- Explore the key global trends in vehicle design and understand their potential barriers and challenges for disabled motorists, as well as for the WAV conversion and adaptation industry, by identifying a range of accessibility issues with vehicle design.
- Identify the specific accessibility issues in EV design, focusing on the particular challenges that come from converting EVs to WAVs.
- Understand different stakeholders’ perspectives, relationships and barriers, including WAV users as one perspective within the wider population of disabled motorists and passengers.
- Identify and propose potential solutions to incentivise or influence global OEMs to think about accessible and inclusive vehicle design.
- Recommend particular positions or incentives the UK Government could be adopting to protect the conversion and adaptation market during the transition to EVs.

2.2. Research methodology

Several research methods were used to address the research objectives. Desk research, industry and user surveys, and industry interviews were conducted in combination to inform the findings of this report.

Desk research was conducted to explore the current state of EV accessibility, understand and identify global trends and current practice in vehicle design. The desk research findings frame the background to this research, providing an understanding of existing themes and helping to contextualise the accessibility issues identified in this report.

From a selective group of user survey respondents, case studies were produced to contextualise the findings from previous methods by highlighting first hand perspectives of the issues identified.

Industry and user surveys were conducted to identify and understand a wide range of experiences and accessibility issues in EV and WAV design. The results helped to quantitatively generalise important consumer issues and identify the most significant barriers.

To understand the details of specific adaptation and conversion challenges, industry interviews were carried out with specialist stakeholders. The interviews generated unique and in-depth perspectives on the UK market, government and global OEM positions and explored solutions to adaptation and conversion challenges, from which recommendations could be generated.

The following subsections provide further information on the chosen methodologies, how they were carried out and how they have contributed to the objectives and findings in this report.

Technical and policy desk research

Desk based research was carried out on relevant subjects such as information on the plug-in car grant (PiCG) for electric WAVs (eWAVs), UK policy on disability inclusion in infrastructure and vehicles, vehicle type approval process for modified vehicles, and UNE R100 battery testing and regulation. This background study was crucial to building an understanding of the technical and policy challenges that need to be addressed in order to facilitate an equitable transition to EVs.

Quantitative research

User survey

An online survey, conducted by Energy Saving Trust partner, the Research Institute for Disabled Consumers (RiDC), was sent to disabled drivers and passengers to collect data on the range of EV accessibility issues, with a spotlight on the case of WAV users. The RiDC is the leading expert in inclusive research involving disabled consumers and their consumer panel is the most extensive pan-disability panel in the UK.

The survey was distributed to the RiDC's consumer panel, of which 470 had access to a WAV, ICE or electric vehicle. The survey was also circulated to approximately 15,000 Motability WAV customers through an online newsletter. This targeted distribution ensured high-quality responses from experienced users and a strong response rate to survey questions directly relevant to the participants' experiences.

The full data set was used for qualitative data analysis - 404 cleaned responses were used; 383 for quantitative analysis; 91 partial responses received – not all questions were mandatory. Users needed access to a WAV or an eWAV to participate. The RiDC provided descriptive quantitative survey data supported by thematic qualitative data to reinforce the survey results.

The focus of the survey was to identify user requirements for WAVs; understanding what is most important to the consumer; and consumers' perception of barriers to the transition to eWAVs.

Industry survey

An online survey was sent to the Motability dealership network to understand their experiences of selling EVs to disabled consumers and potential concerns around accessible vehicle design. Only dealerships selling eWAVs could participate - 193 responses were gathered. The survey asked a range of Likert-style questions to establish a consensus amongst dealerships as to the severity of the barriers and challenges disabled customers face when purchasing an EV. These questions were supported by qualitative responses which provided the rationale behind some of the scores given.

Qualitative research

Industry interviews

Twelve interviews with relevant industry stakeholders were held to explore and identify upcoming vehicle design trends, a range of accessibility issues with EVs for disabled consumers, and solutions to potential and existing barriers. Additionally, the interviews helped to build an understanding of each stakeholder's perspective, their relationships to each other and unique industry challenges.

These 12 interviews included representatives from small and large OEMs, the adaptation and conversion industry, UK Government, and other influential organisations listed below:

- Adaptation industry representative
- Conversion industry representative
- International OEM (x2)
- OEM of specialised vehicles (x2)
- Design & engineering company focusing on accessible products
- Provider of vehicles for disabled motorists
- European organisation that works closely with the vehicle adaptation industry
- Influential trade association in UK's automotive industry
- UK Government policy teams (x2)

A 1:1 virtual interview of up to one hour was held with each interview participant between 17 August and 23 November 2022. All interview data were anonymised to provide reassurance to participants and enable conversations about potentially sensitive topics. Each interview was recorded and transcribed for analysis, unless the participant requested otherwise. Specifically, the interviews with each of the four OEMs were not recorded and instead documented by note-taking only. This was done to provide a further level of protection and confidentiality. As a result, direct quotation from the OEM interviews is impossible.

The participants were selected using a non-probabilistic method of purposive sampling[27] via existing Motability and Energy Saving Trust networks targeting industry-specific experts. The interviews were conducted in a semi-structured style with topic guides individually designed for each stakeholder to make the most of their expertise. Topics were organised into themes and participants were guided through these, with key probes to support further exploration of each topic. This approach ensured the interview time was used effectively to gather the objective-specific information required for this research.

The responses were analysed using a qualitative framework analysis to extract and structure the information to address the research objectives as themes and create actionable outcomes. This framework consisted of five stages:

1. Familiarisation: the researchers familiarised themselves with the data to develop an awareness of the recurring themes.
2. Identifying a thematic framework: emerging themes were identified and a framework built to categorise the responses.
3. Indexing: all the data was coded according to the themes established. This identified any differences between the types of respondents and any variation of ideas within themes.
4. Charting and summarising: the findings were then summarised, and the themes and sub themes set out in order to make sense of the findings.
5. Mapping and interpretation: an analysis of key characteristics and summarisations was carried out to reflect the true thoughts of respondents in relation to the research questions.

As part of the charting and summarising stage, the following table outlines the sections detailed in this report and the contributions to them from each interview participant.

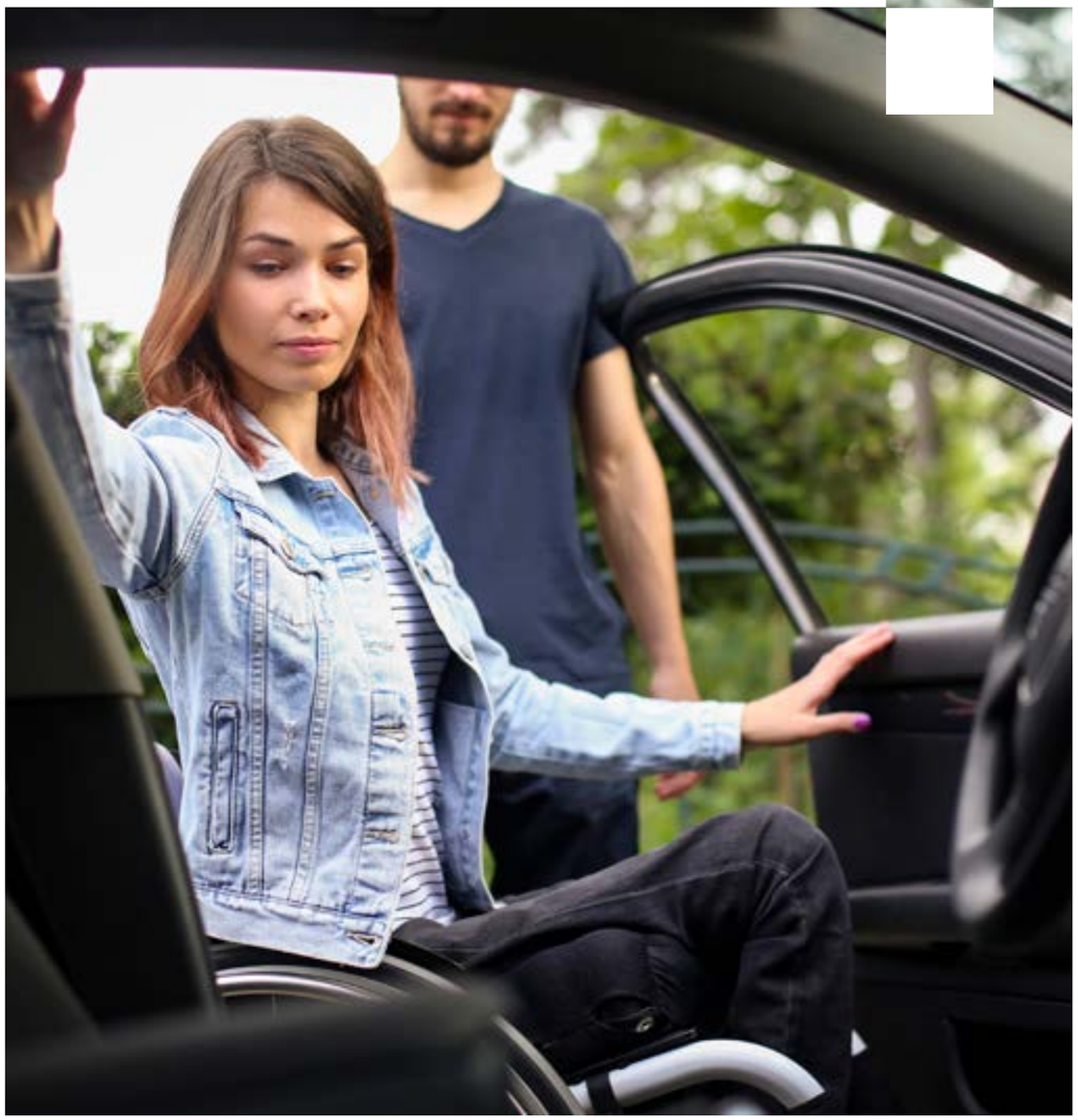
Table 1 – Simplified overview of interview participant input divided by objectives/report sections

Interview participant	Global trends in vehicle design and their potential design barriers for disabled users	Accessibility issues for EV design	Perspective of the conversion and adaptation industry	Perspective of OEMs	Best ways to incentivise or influence global OEMs	Recommendations for the UK government to protect the EV and adaptation market
Adaptation industry representative	X	X	X	X	X	
Conversion industry representative	X	X	X	X	X	
International OEM (x2)	X	X		X	X	
OEM of specialised vehicles (x2)	X	X	X	X	X	
Design & engineering company	X	X				
Provider of vehicles for disabled motorists		X	X		X	
European organisation	X	X	X	X	X	
Influential trade association		X		X	X	
UK Government policy teams (x2)					X	X

Case studies

A 1:1 virtual interview of up to 30 minutes was held with five disabled consumers or family members between 21 November and 30 November 2022 to discuss their experiences and needs when considering a WAV/eWAV.

The interviewees were selected from the user survey sample. These interviews were used as the basis of case studies, all of which are included in this report and provide additional qualitative data to support the user perspective of accessibility barriers in vehicle design.



3. Accessibility issues in EV design

The majority of existing work and research that has been carried out in the sector focuses on chargepoint and infrastructure accessibility, rather than on accessibility issues with vehicles themselves. Improving the accessibility of charging infrastructure must remain a priority to prevent disabled drivers and passengers from being disadvantaged as the UK phases out the sale of petrol and diesel vehicles.[28]

However, a new priority area has been identified by Motability, which must also be addressed to enable disabled users to participate in the transition to low carbon transport: the accessibility of vehicle design. With a growing demand for EVs in the UK,[29] accessible design is crucial to ensure there are suitable EV options available for everyone.

This section begins by providing an overview of the EV market for disabled consumers. Then, it explores the key global trends in vehicle design and highlights the potential barriers and challenges for disabled motorists and passengers, as well as for the conversion and adaptation industry. The last section focuses on a range of accessibility issues specific to EV design, highlighting the particular challenges that come from converting WAVs to electric.

3.1. Overview of the EV market for disabled consumers

With around 500,000 licensed BEVs on UK roads,[30] the current EV market is constantly growing and expected to accelerate in the coming years as ICE vehicles are phased out.[31] While the number of disabled EV users is currently below the 20% rate of disability seen within the UK population as a whole[32] Motability's research predicts that by 2035 up to 1.35 million disabled drivers will be reliant on public EV charging points.[33] There are over 640,000 customers on the Motability Scheme, all of whom will have the option to switch to an EV in the next ten years, ahead of the ICE phaseout taking effect in 2030. As a result, disabled motorists are likely to make up a significant part of the EV market in the UK.

OEMs, in the UK and internationally, are expanding their model offerings to include more affordable EVs and improve customer choice.[34] However, this increase in customer choice will not necessarily benefit disabled consumers who have specific needs and require specific adaptations or conversions. While current technology and manufacturing methods allow many popular types of petrol and diesel vehicles to be modified to disabled users' specific needs,[35] the unique structural design of EVs brings new challenges for the conversion and adaptation industry, which are highlighted in the following section. The choice of suitable EV models for disabled motorists is significantly limited in comparison to non-disabled users, particularly for WAV users[36,37] (see Section 3.3. Placement of the battery).

3.2. Vehicle design trends: accessibility issues in mass-produced cars

This section identifies global vehicle design trends and general accessibility issues in mass produced cars. The findings have been obtained from interviews with six specialists including representatives from OEMs and the adaptation and WAV conversion industry. The overarching themes from these conversations were identified as:

- New controls and features don't follow accessible design principles.
- New technologies and autonomous features don't consider disabled drivers' adaptation needs.
- Heavier base vehicles could limit the pool of available small to medium-sized WAVs.

New controls and features don't follow accessible design principles

According to our industry research, new controls and features being deployed in EVs don't always follow accessible design principles. One industry expert claimed that the ease of use and the user experience are not considered to the level needed to ensure new innovations in the automotive industry are accessible and user-friendly for disabled motorists. This seems to be the case even when they are initially intended to enhance the user experience.

Rotary and jog dial tools were mentioned as one example. A multi-function jog dial should help with fast and easy joystick navigation by enabling the user to scroll through the menu while driving. While this might be useful for some, it demonstrates a potential challenge for disabled motorists who have a physical disability and might struggle with rotating the wheel while driving or pushing buttons to navigate through menus. While there are studies that provide recommendations for accessible design, for example for digital dashboard interfaces,[38] most of these studies don't engage with disabled users. More research is needed to capture the depth of user requirements for different situations in order to define standards for accessible design principles.

''Accessibility or ease of use [for disabled motorists] will probably not have been considered to the level it needs to be and that's been quite historic in the automotive industry. They tend to produce things that kind of look great and are a bit weird but actually when you try and use them, you're like 'this is terrible."
Representative from a design & engineering company

Although specific vehicle adaptations can provide a solution to make new features accessible for disabled motorists, they add costs to the end consumer. More engagement with disabled users during the design process would reduce the need for adaptations in the first place. Studies suggest that working with a breadth of different users including disabled and non-disabled users will encourage designers to consider accessibility as a key component, rather than as an after-thought.[39] A product designer who was interviewed for this report explained that they had experienced more awareness of accessibility barriers within the automotive industry in recent years but highlighted the importance of encouraging further conversations with various stakeholders to engrain accessibility in their thinking.

New technologies and autonomous features don't consider disabled drivers' adaptation needs

Often, popular mainstream technologies are largely inaccessible for people with particular disabilities.[40] Vehicle systems are becoming increasingly electronically controlled: from heated seats and climate controls operated via LCD displays to autonomous features like lane-keeping assistance. Industry experts predict that electrification and at least partial automation will become the norm.[41]

Connected and Autonomous Vehicles (CAVs) have the potential to increase accessibility and to address key safety issues associated with human driven vehicles. Disabled motorists are likely to be one of the groups who can benefit the most from these technologies.[42] Some research into this is taking place. For example, FLOURISH, a multi-sector collaboration funded by the UK Government, investigated CAV technologies and established key design recommendations by engaging with the end-user.[43] Although accessibility considerations were provided, the focus of this project was on 'older adults' (58-90 years old). Further testing with a spotlight on disabled motorists is still required to identify CAVs' unique accessibility barriers and challenges.

As part of this research, Energy Saving Trust heard anecdotal evidence of malfunctioning autonomous features caused by adaptations. One challenge, for example, is the use of capacitive sensors and driving adaptations. The interviewed representative from the adaptation industry gave the example of a vehicle with an easy park assist. If someone is touching or holding the car's steering wheel, they cannot engage this feature. However, the vehicle's hands-off detection system registers steering aid adaptations, which some disabled users depend on, as the driver touching the steering wheel and, therefore, doesn't allow the easy park assist feature to be activated.

It is hard to predict what other potential issues might occur with increased usage of electronics and autonomy of vehicles. While OEMs are consistently improving their software,[44] these changes need to be picked up by adapters and converters. Energy Saving Trust also heard anecdotally of cases in which working adaptations stopped functioning after the vehicle received an over-the air (OTA) software update, leading to a potential safety risk for the driver/passenger(s). Although the adaptation manufacturer modified their software to adapt to the changes in the vehicle's software after the issue had been discovered, they couldn't predict it. OTA technology is becoming the norm rather than the exception[45] and might continue to interfere with specific modifications, potentially posing a significant safety risk for drivers of adapted vehicles.

Interviews with the adaptation industry indicated hope for greater transparency regarding OTA updates from OEMs to minimise the risks. They believe that improved advance knowledge about upcoming software updates will be crucial to prevent these issues. However, this information is currently not available to the adaptation industry. The question remains open about what other potential safety issues might occur in the future and how the adaptation industry can prepare for these in the absence of access to certain information, like software specifications (see Section 4.2.2. for more information).

''[OEMs] are not prepared to give sufficient good information or a sensible interface for the electronics to be plugged into.''
Representative from a European organisation

''20 years ago, it was very mechanical. Now, you are dealing with a lot of electric. So, we need them [OEMs] to be as open as possible with us to allow us access [to electronic/systems].''
Representative from the conversion industry

As vehicles become more technical, the interviewed experts predict that OEMs will become more reluctant to share information with the WAV and adaptation industry to ensure a safe and appropriate handling of their products (see more information in Section 3.3.). This attitude would align with the EU's decision to review new EU cybersecurity rules to ensure safer hardware and software[46] (see Section 4.2.2.). These changes will likely also impact the UK, despite its decision to leave the EU, as OEMs tend to operate on a continental and global scale. According to a representative of the adaptation industry, there are concerns that these developments and new technologies will affect the compatibility of their products which need to engage with a vehicle' software. This will limit the pool of available adaptations for disabled motorists and passengers, potentially leaving some disabled consumers unable to access a vehicle that addresses their specific needs.

''The changes in the cyber security laws are likely to make our life much more difficult.''
Representative from the adaptation industry

Heavier base vehicles could limit the pool of available small to medium-sized WAVs

On average, cars sold in the European Union and UK have increased in weight by 15% since 2001.[47] According to industry experts, switching to electric adds at least 200 kilograms per vehicle. This might prove a challenge for the WAV industry as a representative revealed that converting a car adds additional weight to the vehicle. Performance characteristics, such as travel range, are influenced by the total weight of EVs.[48] Taking into consideration the weight of other passengers and/or adaptations, as well as wheelchairs, converted WAVs with heavy base vehicles could exceed the permissible maximum weight. While this is less of an issue for medium and large-sized vehicles, the pool of suitable small-sized vehicles, which are the preferred choice for WAV consumers,[49] could be limited.

According to interviews with a selection of OEM representatives, some OEMs are working to reduce the weight of their vehicles by developing weight-saving technologies to balance out the heavy EV batteries. In accordance with this, one interviewed representative of the conversion and adaptation industry does not consider this global vehicle trend of heavier base vehicles to be a major barrier to vehicle accessibility due to new innovations on the horizon. However, it is not clear yet when these weight-saving solutions will be available on the market.

3.3. Accessible EV design barriers

The expertise of eight interviewed industry stakeholders, in addition to comprehensive desk research, helped to identify specific accessibility barriers for EV design. Key contributors to this section are interviewed representatives of the conversion and adaptation industry and representatives from an engineering and product design company.

Three key design barriers emerged after an analysis of themes from the sources above:

- Placement of the battery limits available adaptations and conversions.
- Inability to drill holes at EV battery location is particularly problematic for small WAVs.
- Position of the charging socket does not guarantee accessibility for individual needs.

Placement of the battery limits available adaptations and conversions

A key challenge to converting and adapting EVs compared with ICE vehicles is the position of the battery, according to all the relevant experts interviewed. Following Tesla's lead, most OEMs place the large batteries needed for an EV, along with the necessary safety and cooling equipment, under the vehicle floor between the vehicle's two axles.[50] This position is necessary to give the vehicle a low centre of gravity, which improves overall stability while enhancing handling and performance.[51] However, this position is also exactly the raised area under the rear seat, where adapters and converters would normally drill holes for ramps and access adaptations.

Interview participants agreed that any adaptation that requires drilling into the floor of the vehicle becomes increasingly difficult and problematic because of the battery placement. This includes installing swivel seats, boot hoists and restraint systems, which are typically required for a WAV conversion.[52] User survey participants highlighted swivel seats (27%), electric hoists (25%) and pedal modifications (10%) as important when considering an adapted vehicle purchase.

One industry interview participant highlighted the example of pedal guards to demonstrate how this issue is not only affecting the conversion but also the adaptation industry. Pedal guards are a necessary driving aid, for drivers who suffer from muscle spasms in their legs, which risks feet becoming trapped or dislodged from the correct controls[53] (see Section 1.3.2. for more details on different adaptations). They are fitted by drilling through the floor of the vehicle, normally where the battery packs are located and might therefore not be available on certain EVs. Ultimately, the location of the battery poses a major issue for a broad range of people with accessibility needs.

> **''A pedal guard or something similar is always going to be necessary, but drilling through the floor of a vehicle is becoming problematic.''**
> **Representative from the adaptation industry**

Inability to drill holes at EVs battery location is particularly problematic for small WAVs

To convert a vehicle for wheelchair access, the necessary headroom needs to be factored in.[54] According to conversations with a WAV converter, small WAVs usually require a lowered floor design for more interior space allowing a comfortable upfront position for the driver. One converter highlighted this as especially important for motorists with spinal injuries and those whose disability requires the use of a posture-optimised wheelchair. Our user survey (see Section 4.1.1.) further underlined the importance of sufficient head space and upfront seating to allow proximity to carers should any medical needs arise.

> **''I would say just because of the nature of what we do [...] the main challenge is [the placement of the battery] as well as general space in the vehicle.''**
> **Representative from the WAV industry**

An eWAV generally has a higher floor level to accommodate the battery, which can limit the head space and make it much more challenging for small EVs to be converted for wheelchair access.[55] A representative of the conversion industry revealed that around 90% of small to medium-sized eWAVs need ramps, which are essential for some wheelchair users to get in and out of the vehicle.[56] For rear entry ramps, this involves cutting part of the rear to lower the floor, which is where the batteries are located. Medium to large models, which usually don't feature lowered floors, will not face this issue to the same extent. However, most WAV customers prefer a smaller vehicle in length and width. This is reflected in the models available on the Motability Scheme with around 70% of all new WAVs on their fleet being categorised as small.[57] The disabled users surveyed and interviewed (see Section 4.1.1) further highlighted a preference for driving WAVs that are small enough to easily manoeuvre, yet big enough to suit their needs and fit not only their wheelchair, but all their equipment.

> **"I am genuinely concerned about where the battery will go as I need a good head height to fit in my current WAV but the floor has been lowered into the space where the battery is in the electric version of the vehicle I have now and my head is only 2cm from the roof. Hopefully a workaround will be found quickly."**
> **User survey respondent**

Converters relocating the battery themselves could be one solution. While this is theoretically possible, our interviewees suggest that it is unlikely to be feasible for all players in the conversion industry. This could be because smaller organisations are more likely to be affected by resource constraints (see Section 4.2.1.). Any planned modification to the battery location must go through heavily regulated and stringent testing, before being certified by the relevant OEM (see Section 4.2.1.). One converter stated that they "are prepared to invest sizable sums of money to get [the OEMs] letter of approval" and implied that the whole process is not only extremely costly but also time intensive. They also revealed that some OEMs might not consider such a modification that will change the vehicle structure (see Section 4.2.1.).

Another solution could lie with OEMs, who could solve the issue of battery placement and address the barrier for WAV conversions at the start of the design process. For example, LEVC is a vehicle manufacturer and retailer of EVs in the UK, specialising in producing accessible taxis.[58] One spokesperson explained that LEVC's designs, including the battery placement, ensure wheelchair accessibility from the beginning of the design process. This allows them to manufacture pre-approved and ready-to-go WAVs, which don't need an additional post-build conversion. LEVC is a great example of inclusive vehicle design. Although their production predominantly focuses on wheelchair accessible taxis that are Extended Range Electric Vehicles (EREVs) rather than full BEVs, it is reported that LEVC has plans to go fully electric.[59] According to an interviewed industry expert, WAVs would likely make up less than 1% of a traditional OEM's production line. Due to the relatively small WAV market, it is unlikely that larger, more traditional OEMs will see a financial business case to start producing these vehicles themselves, as their decisions are highly driven by market value (see Section 4.2.3.).

Position of the charging socket does not guarantee accessibility for individual needs

The new BSI standard on accessible public chargepoints, PAS 1899,[60] was launched in October 2022. While this new standard aims to address the accessibility of public chargepoints, the charging experience will remain a challenge for some users if a charging socket is not placed in an accessible location on the vehicle itself.

''We can improve the experience of charging as much as possible with the charger end. But if the vehicle socket is not particularly accessible and is not located in a position that suits the individual's needs, then it doesn't really matter how accessible the charger is.''
Representative from a design & engineering company

While there is no commonality of the charging socket location between different makes and models, Designability has summarised the most and least common positions of charging sockets in the following graphic[61]:

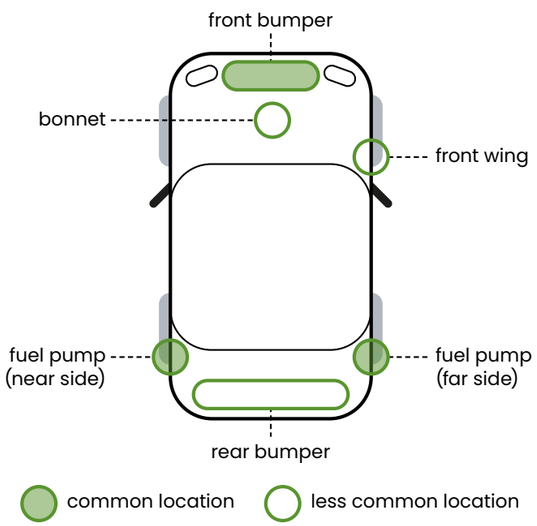


Figure 1 – Vehicle charge socket locations (Designability, 2021)

Requirements for socket placement differ depending on the disability of the potential user and a universally approved accessible charging socket design has not yet been agreed. If a disabled motorist has specific access needs, their priority will be parking in an orientation that allows them to get in/out of their vehicle, enables someone else to get in/out or allows them to access the boot. The fixed position of the charging socket can influence disabled motorists' charging experience, depending on the position of the charge point.[62]

For example, a wheelchair user, who accesses their vehicle from the back, wants to charge their EV in a parking space with the charger in front of them. If the charging socket is located at the back of the vehicle, they might have issues with cables being too short or too heavy to carry. In this situation, a front socket location would be more accessible. If a wheelchair user accesses their vehicle from the driver's seat, they might need to park slightly away from the kerb to transfer onto a level surface but could struggle finding the space to manoeuvre their wheelchair. In this scenario, a charging socket on the side would be preferable.

"If we purchased an eWAV it would be useful to have the charge port at the back of the car, as we need to reverse into our driveway so our son can exit away from the roadside."
Case study participant

In Designability's Scoping and Discovery report on accessible EV charging,[63] they provide additional examples of challenges caused by a conflict between the required parking orientation and the charging socket location.

Three of the five case study participants interviewed as part of this research highlighted the ideal location on their vehicle for a charging socket. This varied from the rear of the vehicle to the side and the front, depending on where the wheelchair ramp was located and how they entered a parking space.

According to a product designer who specialises in accessibility,[64] an ideal solution to the problem would be to install multiple charging sockets to allow more flexibility for different needs. It would also give chargepoint operators more flexibility when installing their chargepoints and allow for shorter, lighter, cheaper and more sustainable cables. Interviews with adaptation manufacturers suggest that the installation of multiple sockets is likely to be challenging and potentially infeasible for the adaptation industry.

''Most people aren't going to start messing around with those, and certainly not for the amount of money that somebody might be prepared to pay for it.''
Representative from the adaptation industry

However, this could potentially be addressed by OEMs at the initial design stage. In May 2022, General Motors filed a patent for an EV with dual charging ports.[65] The battery pack is split into two modules that could lead to charge sockets on opposite sides of the vehicle. It is unclear when or if the technology will come to market.

The first step to finding a solution could be to produce guidelines for accessible charging socket design. Guidelines could ensure that vehicles are not designed in isolation of the charging system and consider the different requirements of disabled users.

This is particularly important as it's not just the position of the charging socket that demonstrates a barrier to disabled motorists. After conversations with an organisation that has carried out significant research on accessible charging, it has been identified that the height and physical design of the socket are important factors in ensuring accessibility:

- **Height:** a socket might be too high or too low to reach for some users.
- **Physical design:** the overall design and presentation of the charging socket might not be suitable for certain disabled motorists. Mechanisms to open the socket flaps or remove the socket's dust cap could be a barrier for users with limited dexterity. The visibility into the socket might be another barrier if users cannot see where to plug in the cable.

Engaging with disabled consumers in the process of identifying specific barriers and developing these guidelines is key.[66] Although out of scope of this research, extensive user research with disabled people themselves is highly recommended to ensure an accurate user perspective is captured and considered. Other stakeholders, including OEMs and product designers, need to ensure that a realisable solution can be created. Motability and/or Motability Operations could be a facilitator of these conversations between user and industry needs.

Disregarding charging considerations and modifications that require drilling through floors, adaptations made to EVs are likely to be similar to those made to non-EVs, albeit dependent on the vehicle make and model.[67] Hence, it is crucial to not just address EVs unique vehicle design barriers in isolation, but in conjunction with these more general accessibility challenges of mass-produced cars.

4. Challenges for the user and the industry in the transition to accessible EVs

This chapter focuses on the perspectives of relevant stakeholders by exploring their relationships and unique challenges. The findings contribute to identifying potential solutions to overcome accessibility issues in vehicle design and provide important industry context to the design barriers identified in Chapter 3.

This section focuses on the perspectives of the following stakeholders:

- Disabled motorists and passengers
- Conversion industry
- Adaptation industry
- OEMs

The primary sources for the section on disabled users come from surveys and case studies, which engaged directly with disabled people and specialised dealerships. The sections on the conversion and adaptation industry were developed from interviews with different industry representatives and experts, as outlined in Section 2.2.

The following infographic provides a high-level overview of each stakeholder (Figure 2). The blue arrows symbolise the communication between each of them.

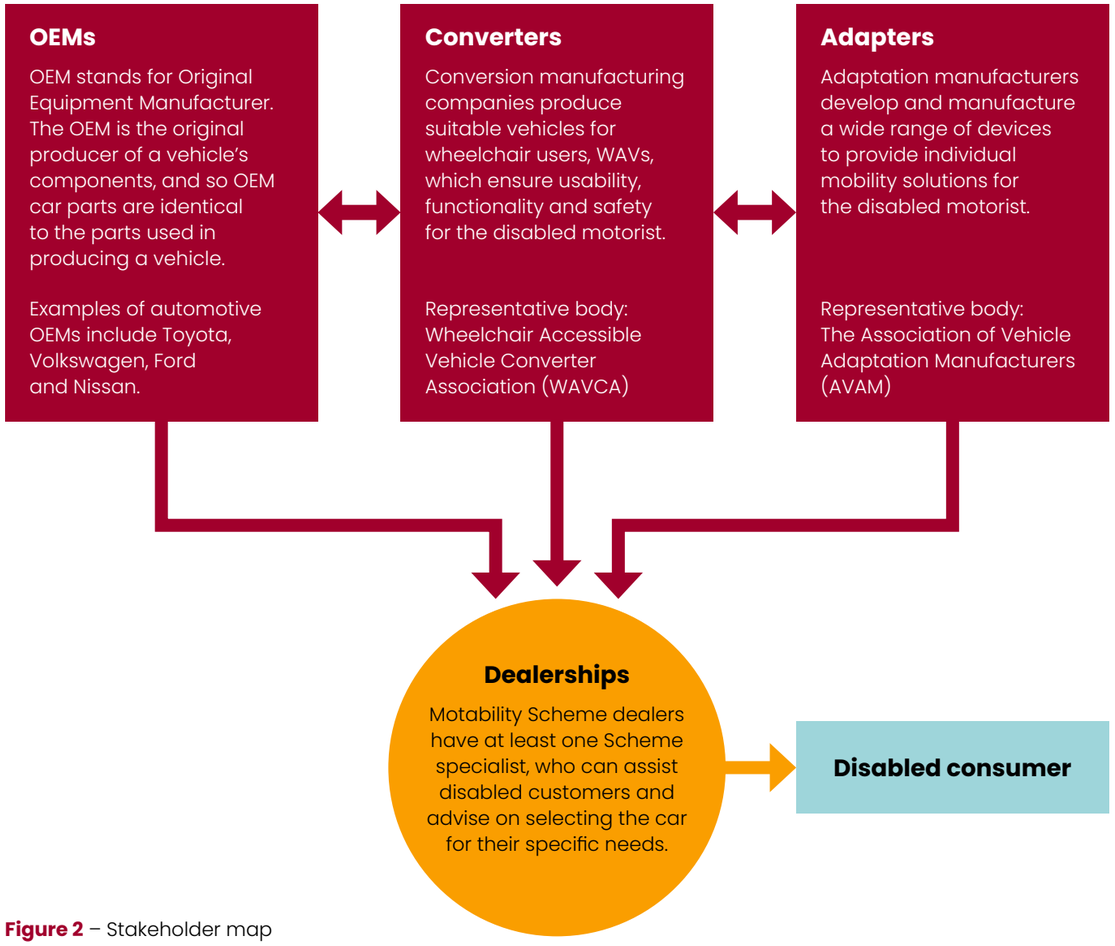


Figure 2 – Stakeholder map

4.1. Barriers for disabled consumers

This section identifies specific barriers for disabled consumers when considering the transition to an EV. In line with this report's spotlight on WAV users, findings are primarily based on data from the user survey, which focused on WAV users in the UK. Case studies provide further context of disabled motorists' experiences and concerns, and the industry survey and desk research support the main user survey findings.

Disabled consumers face various challenges when transitioning to EVs. For example, disabled consumers can be negatively impacted when using an EV, notably when charging their vehicles.[68] These barriers need to be addressed alongside vehicle design to improve accessibility overall and support an equitable transition. Although out of this report's scope, some of the key barriers to disabled people using an EV have been identified as followed[69]:

- Scarcity of chargepoints, specifically accessible chargepoints.
- Accessibility issues with the built environment around chargepoints.
- Accessibility issues with the chargepoints themselves.

4.1.1. User survey

The Research Institute for Disabled Consumers distributed an online user survey to their consumer panel.404 cleaned responses were used, 383 for quantitative analysis, of which all respondents own or lease a WAV and are based in the UK.

The key profile of user survey participants is as followed:

- The majority of respondents **lived in a town** (45%) followed by rural areas (36%).
- Most respondents were **above the age of 45** (72.7%), 26.6% are in the 18-44 age bracket.
- The annual income of most respondents is between **£10,000-18,000**(37%), followed by £18,000-£35,000 (21.6%).
- 90.5% of user survey respondents used the **Motability Scheme**.
- 80% of respondents **lease their WAV**.
- 9% of respondents lease or own an **eWAV**.

User survey:
What is your current living situation?

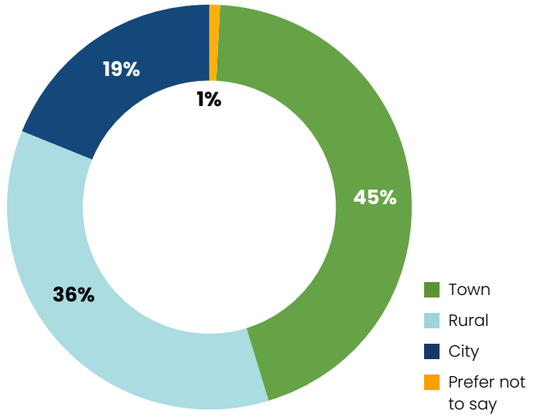


Figure 3 – User survey respondents' location

User survey:
Gender: How do you identify?

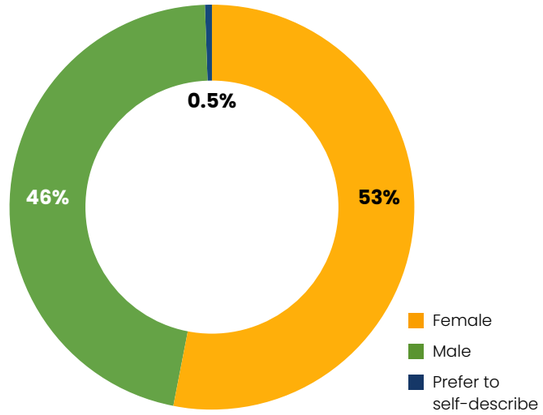


Figure 4 – User survey respondents gender identity

User survey:
Do you own or lease a Wheelchair Accessible Vehicle (WAV)?

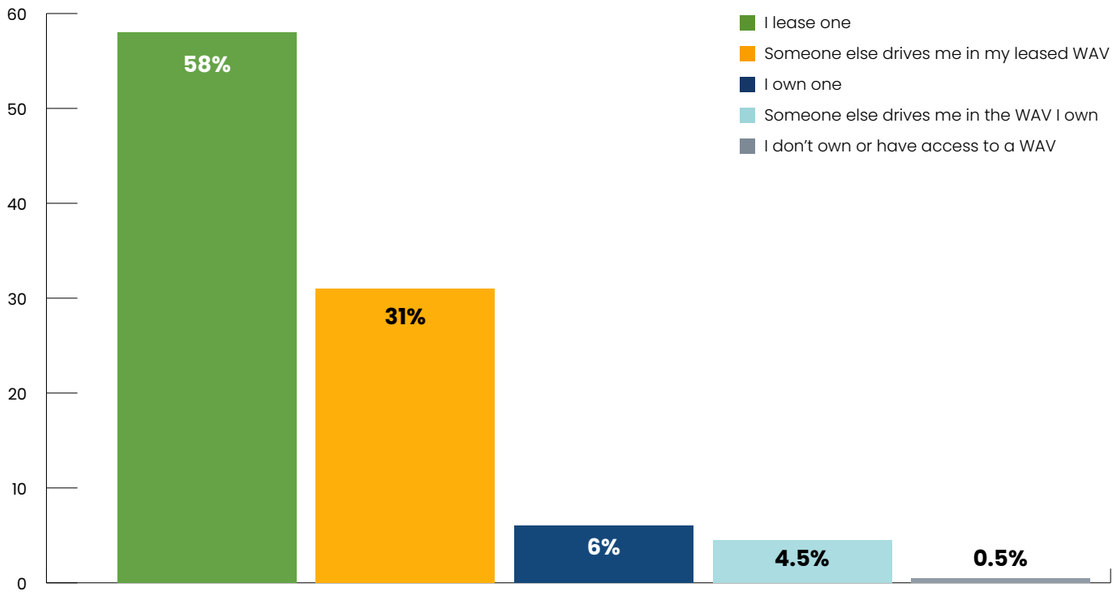


Figure 5 – User survey respondents vehicle lease or ownership

Participants were asked to indicate which potential barriers were most significant to them when considering driving an EV in the future (see Figure 6). The key barriers to purchasing an eWAV from the user perspective are:

1. Driving range (60% very significant)
2. Costs (54% very significant)
3. No Availability of suitable models (54% very significant)

The 'other' category responses for barriers to purchasing an eWAV included: how challenging eWAV repairs would be, concerns about the location of seat positions for wheelchairs and previous experiences with being told there were no eWAVs available for their required adaptations.

User survey:
Potential barriers which might influence your decision to buy an electric WAV in the future

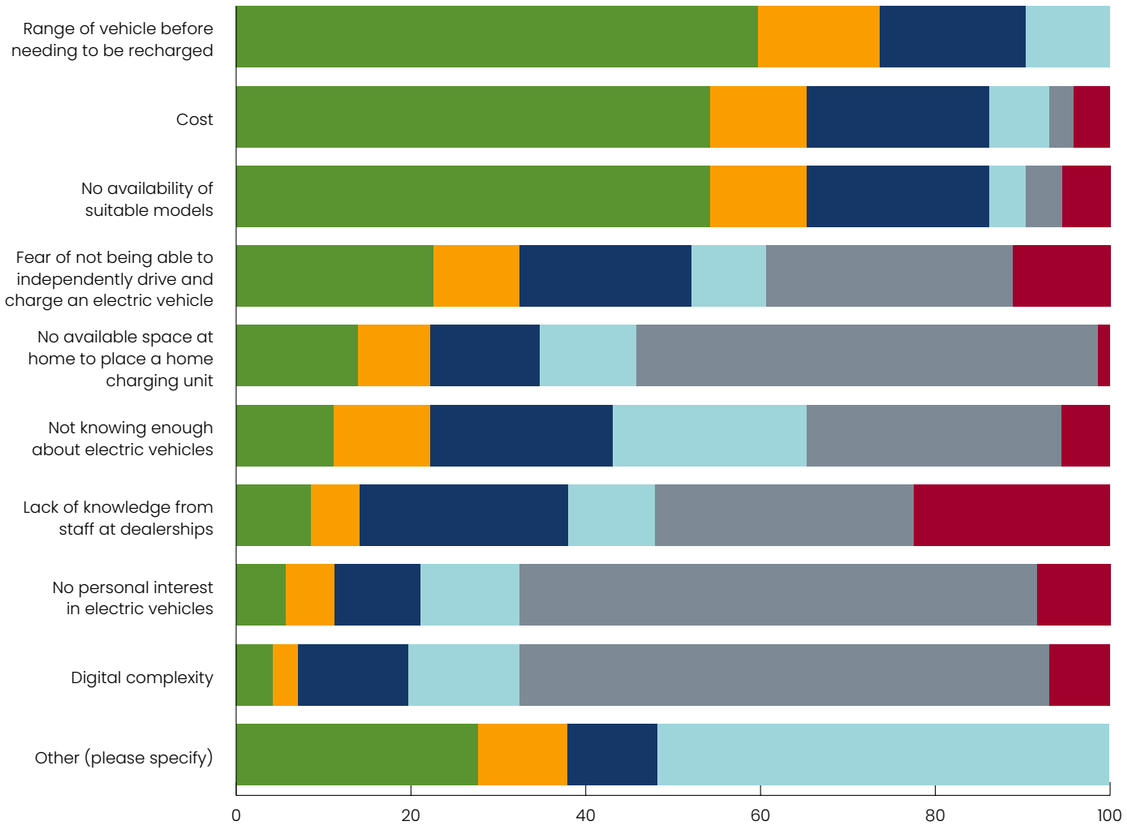


Figure 6 – Potential barriers which might influence respondents' decision to buy an electric WAV in the future

The concerns expressed in the user survey align with previous research carried out by Energy Saving Trust on the challenges that disabled consumers face when transitioning to EVs.[70] The following section looks further into the most significant barriers to purchasing an eWAV that have been identified by these surveys. It should be noted that although respondents of the user survey face such barriers, a quarter of them still plan to get an eWAV as their next vehicle while 9% already lease or own one, indicating a general interest in the transition to EV.

User survey:
Have you ever considered driving an electric WAV?

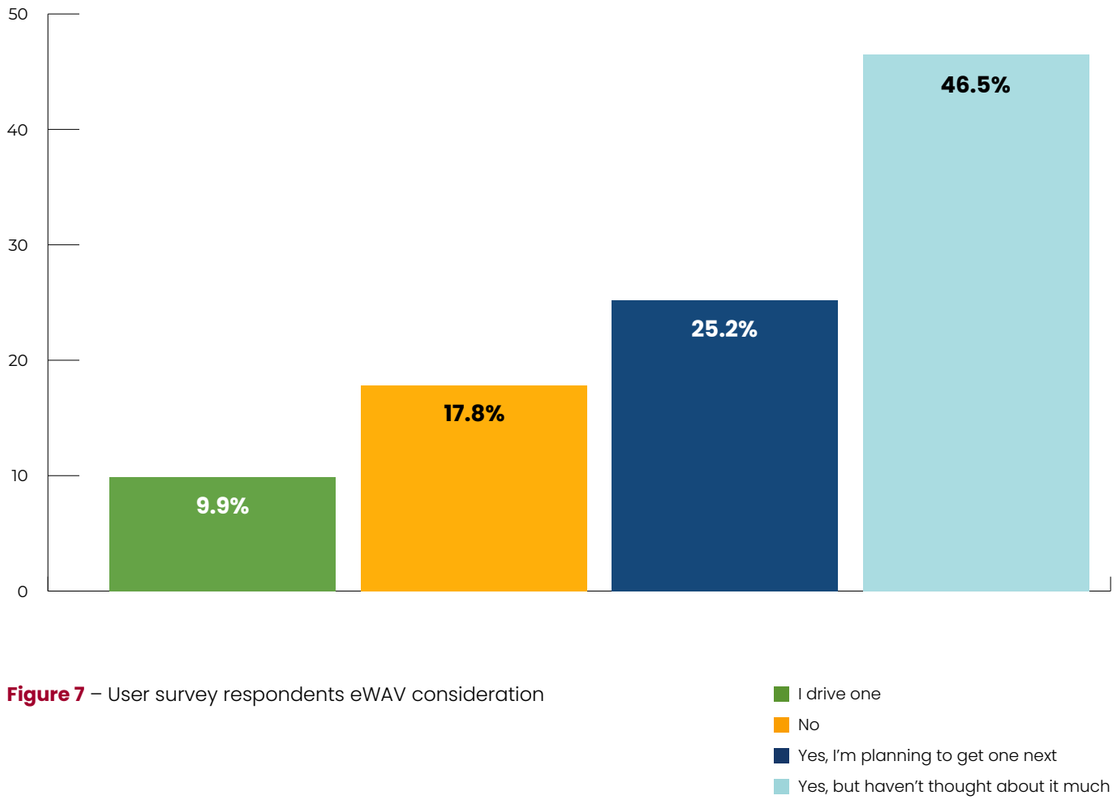


Figure 7 – User survey respondents eWAV consideration

User key barrier: Driving range

User survey respondents considered driving range the most significant barrier to purchase, with all respondents perceiving it as somewhat significant and 60% as very significant. Respondents stated that they wanted precise driving range information to plan journeys, which is important for providing confidence when travelling and reducing range anxiety. According to the survey respondents, there is a pressing need to understand the range per charge, particularly for those who live in rural areas and have mobility impairments that prevent them from recharging the vehicle should it run out of power. Lack of ability to access public chargers when travelling alone was also raised in the case studies. If vehicles have inadequate range, then consumers will be more reliant on the public charging network.

"As I have limited hand function, using home or public charging would be difficult, potentially impossible."
Case study participant

For all five case study interview participants, their WAV is their primary source of transport and 36% of user survey respondents live in a rural area. This gives an insight into why having precise information may ease range anxiety where daily journeys could be a significant distance.

"An electric car would suit us as we typically make short journeys, but range is important as the closest city is 20 miles away."
Case study participant

There were concerns that the extra weight of equipment such as large, powered wheelchairs, in addition to the vehicle size, could be a potential power drain, reducing driving range and adding to range anxiety. As studies suggest that range won't be impacted by weight as significantly as feared,[71] this implies that some potential customers need additional information and support to ease their concerns, which is a barrier highlighted by dealerships completing the industry survey (see Section 4.1.2.).

"I'm concerned my powered wheelchair and sports chair will increase the weight, increasing running costs and reducing mileage."
Case study participant

User key barrier: High upfront costs

By 2027, it is expected that the prices of EVs and ICE vehicles will be equal, reaching a state of price parity.[72] However, until then, industry expert suggests that EVs will mostly be more expensive for consumers. This is due to factors such as their higher research and development costs compared to conventional cars, higher manufacturing costs and the high cost of lithium-ion batteries.[73] This issue will be particularly apparent for those requiring modifications and adaptations to their vehicle or WAVs because modified vehicles generally have a higher upfront cost than commercial vehicles. Accordingly, 54% of user survey respondents identified cost as a very significant barrier for the uptake of eWAVs. Affordability is linked with accessible transport as these additional costs create an economic barrier to accessible, low carbon transport options for disabled consumers.[74] These barriers must be overcome to ensure equal access to these forms of transport.

The role of the Motability Scheme in providing financial access to vehicles for disabled consumers is outlined in Section 1.2. The Motability Scheme enables eligible disabled people to use all or part of their higher rate mobility allowance to pay for the lease of a new car, scooter or powered wheelchair, with insurance, road tax, servicing, tyres and breakdown cover all included. The Motability Scheme and the option to apply for further grants from the Motability charity provide affordable access to vehicles. The Scheme is key to improving quality of life for disabled consumers by providing affordable access to vehicles, which improves user access to healthcare and education.[75]

Rather than leasing, the Plug-in car grant (PICG) offers financial support for purchasing an eWAV. The PiCG is a government grant that aims to encourage the uptake of new EVs.[76] The PICG was introduced in 2011 and ended in June 2022 for personal cars. The focus has shifted to WAVs, taxis, vans, trucks, motorcycles and mopeds.[77] This is discussed further in Section 5.7.

User survey:
Which of the following funding sources did you use when acquiring your most recent vehicle?

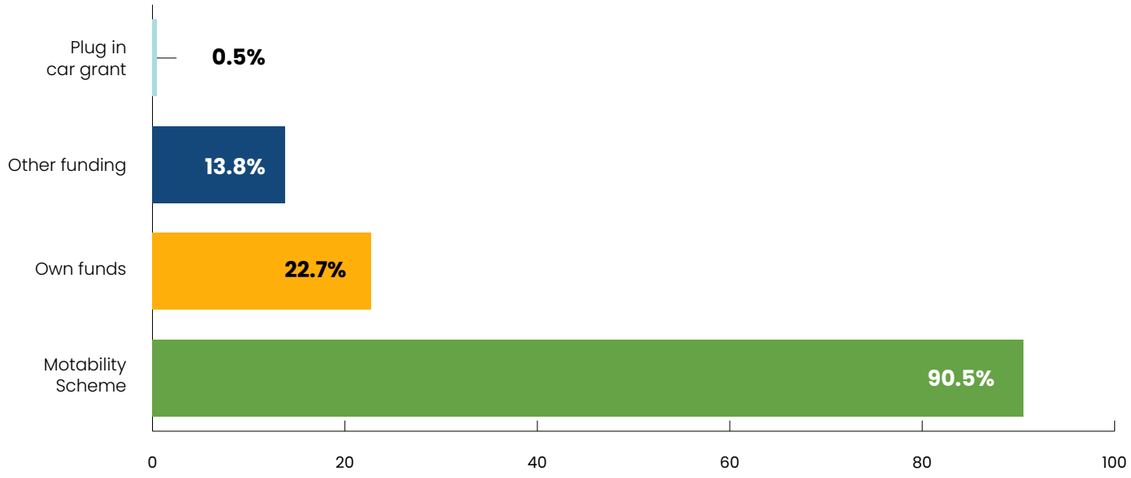


Figure 8 – User survey respondents funding sources

The user survey asked respondents about which funding sources they used when acquiring their most recent vehicle, while allowing multiple answers (see Figure 8). Most respondents used the Motability Scheme (90.5%) to fund their vehicle. This could also relate to the fact that almost 90% of respondents lease a car, indicating the Scheme's popularity and wide reach. Own funds were used by almost 23%, while around 14% of respondents used other funding sources. In the open answers, respondents most often mentioned Motability Scheme-related grants provided by Motability the charity and loans from friends or family.

The survey included a follow-up question, asking respondents why they did not make use of the PiCG. Over half of the survey respondents (51%) said they were unaware that the grant exists, while 19% of those who were aware of the PiCG stated that there were no suitable vehicles available for them.

User key barrier: Availability of suitable models

A key practical barrier to disabled consumers' uptake of EVs is the limited choice of vehicles, being at least a significant barrier to 85% of respondents.

Disabled consumers typically have a wider range of specific vehicle requirements compared to those without disabilities. This limits the number of suitable vehicle options.

User survey:
Please provide us with more details on your current WAV model

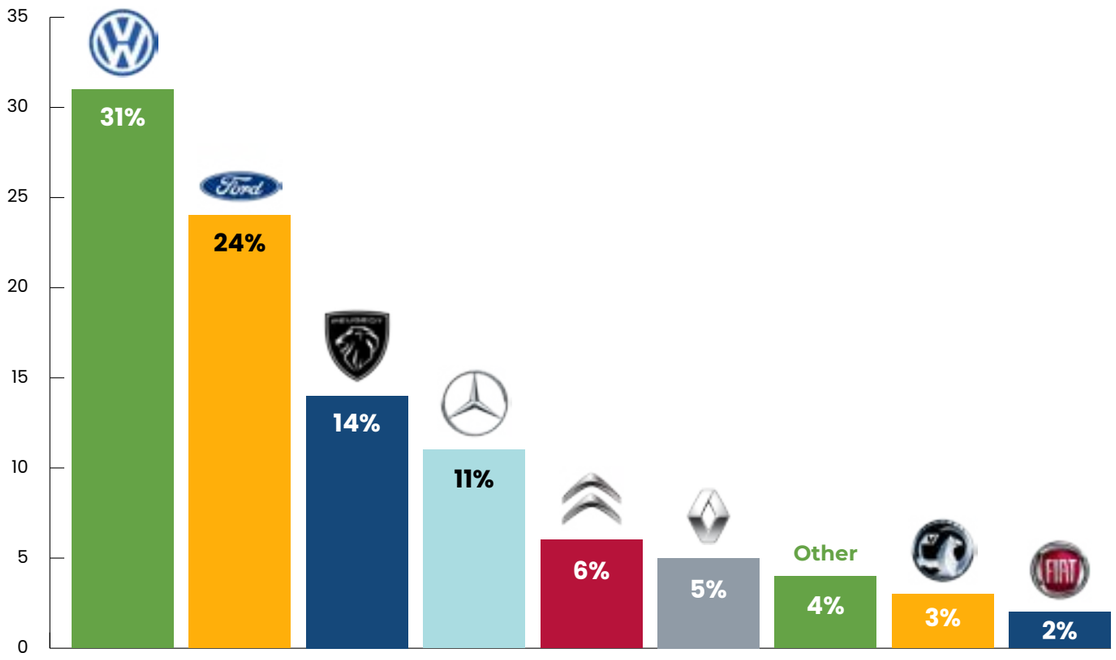


Figure 9 – User survey respondents manufacturer choice

User survey respondents' most popular choice of WAV manufacturer is Volkswagen (Figure 9). Case study participants vehicles also reflected this, stating their Volkswagen, Ford and Mercedes models provided adequate space for equipment, including a mobile hoist, toilet chair and carer or passenger seats. One participant explained that their vehicle options were limited in order to match their requirements and an electric option with the same adaptations was not presented to them.

> **"The focus is all about what my son needs so this narrowed down to a small number of cars."**
> **Case study participant**

The size of the vehicle is important as a larger vehicle may impact confidence whilst driving and may require parking in a different location.[78] Most users who took part in the survey commented that the current size of their WAV was as big as they are willing to drive, and they questioned whether an EV of a similar size could accommodate their equipment.

> **"Our current hire vehicle is so large our PA won't drive it and it's difficult to park outside our house."**
> **Case study participant**

Another common concern is the head height not being sufficient for taller wheelchair users. As this barrier is already prominent with ICE vehicles, users were particularly concerned about this with regard to eWAVs and their higher floors due to the battery placement, and were unsure whether this barrier is actively being addressed by OEMs.

> **"Head room is important as I'm tall. There aren't many WAVs that have enough headroom to sit upfront and sit comfortably."**
> **Case study participant**

4.1.2. Industry survey

Energy Saving Trust produced an online survey that Motability distributed to its dealership network, 193 responses were received. Dealerships had to sell eWAVs to participate.

To compare the barriers identified through the user survey results, dealerships were asked to identify the most common reasons why consumers do not purchase an eWAV (see Figure 10). The findings from the industry survey align with the user survey; range anxiety and costs are important reasons why consumers do not purchase an eWAV. In addition, dealerships perceive the limited knowledge of the consumer on EVs as another barrier, with 31% rating it as a common reason for their customers to decide against buying an EV.

Industry survey:
On a scale of 1 -5, where 1 = not common and 5 = very common, how common are the following reasons for disabled consumers to NOT buy an EV?

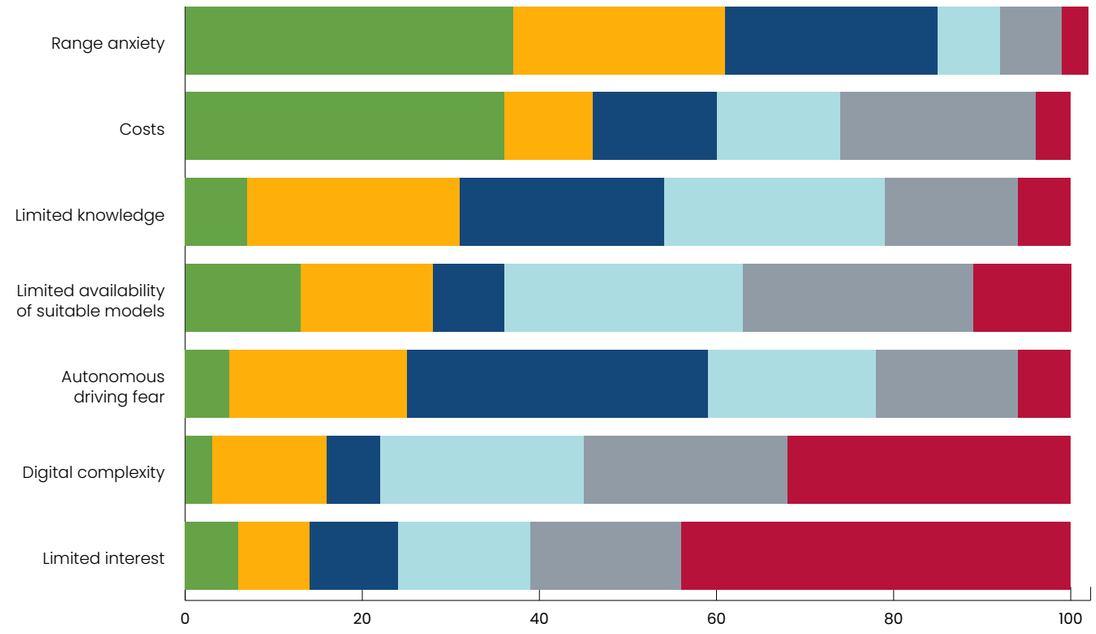


Figure 10 – Industry survey: Common reasons why disabled consumers do not buy an EV

To gain insights into potential causes of user barriers, industry survey respondents were asked how a set of variables differ when selling EVs in comparison to ICE vehicles (see Figure 11).

Respondents felt that consumer support and advice differ most, with 59% stating more is needed when selling EVs. Findings also highlight that more supply chain issues (47%) occur and time is needed until a purchase is completed (42%) when selling an EV in comparison to an ICE vehicle. Respondents further stated that consumers are less interested in EVs (59%) than they are in ICE vehicles.

Industry survey:
Compared to selling diesel/petrol cars, how do the following points differ when selling EVs?

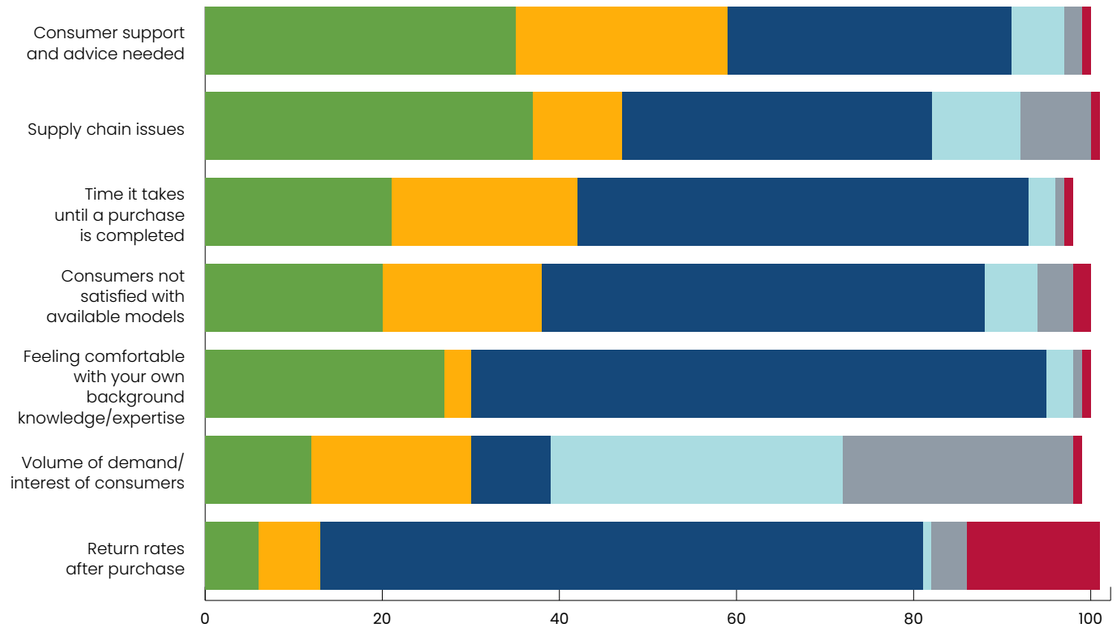


Figure 11 – Industry survey: Common aspects that differ when selling EVs compared to selling diesel/ petrol cars for industry survey respondents

User key barrier: More consumer support and advice needed for EVs

Owning and using an EV requires some changes in behaviour, primarily around charging. Disabled consumers must have all the necessary information to ensure that making the switch will be the right decision for them. However, industry survey respondents perceived limited knowledge as a common barrier for consumers' purchase of EVs (30%), indicating there is either a lack of awareness or insufficient publicly available guidance for disabled users on this topic. Developing, identifying, and raising awareness of information that is available is crucial to ensure that the end consumers can acquire the necessary knowledge independently. For example, there are comprehensive guides on the Motability Scheme website to assist with the transition to an EV.[79]

Disabled consumers who require specific adaptations, vehicle types, or modifications have additional elements to consider when deciding if an EV would be appropriate for them. With 72% of users surveyed having considered driving an eWAV as their next vehicle, findings suggest that disabled consumers are generally enthusiastic about switching to electric. However, they need support in identifying whether an eWAV could work for them. Multiple case study participants expressed that they struggled to find models through their own research and reported that it is not always mentioned as an option in dealerships. Three out of five case study participants said an electric option was not mentioned once they had gone through their adaptation requirements.

"When I chose a vehicle six months ago, an electric option was not presented to me. However, I would lease an eWAV if the barriers listed can be overcome."
Case study participant

"I did extensive research to find electric WAVs and were told there were none available. The one that was available was not on the Motability Scheme and was no longer being produced."
Case study participant

Only 10% of industry survey respondents feel less comfortable with their own knowledge or expertise in selling EVs in comparison to ICE vehicles. This might indicate that it is not a dealership's lack of confidence in advising their customers to switch to EVs but possibly the limited availability of eWAVs that is affecting whether EVs are discussed with customers as an option. Almost half of the industry survey respondents said that they experience significantly more supply chain issues with EV compared to ICE vehicles.

"Biggest issue is lead times our brand has had to pull the only electric car we had on the scheme due to too much demand and not enough supply; this is affecting retail and business leasing. As a result, sales of EVs dropped considerably due to excessive wait times."
Industry survey respondent

4.1.3. Case Studies

The following pages contain five case studies from disabled consumers or family. Participants discuss their experiences and needs when considering a WAV/ eWAV. The interview participants were selected from the user survey sample.

The case study interviews provided additional insight into why WAVs are important to users. For all five of the case study participants, their vehicles were their primary source of transport, due to the amount of equipment they need to take when they travel and because less planning is required beforehand compared to using public transport. They provide a reliable source of transport for hospital appointments, school runs and social events. The factor of having personal transport for safety was highlighted numerous times, as a constant means of fast transport should a medical emergency occur.

Case study 1

Steve is based outside of Burton-upon Trent in the East Midlands. He has a high spinal cord injury and is a full-time wheelchair user.

His wheelchair accessible vehicle (WAV), which is leased under the Motability Scheme, is Steve's main mode of transport. It is more convenient and faster than public transport, particularly as Steve lives in a rural area.

Steve currently drives a Mercedes Sprinter, which allows him to enter, exit and drive the vehicle while remaining in his powered wheelchair. When choosing this vehicle, the most important requirements were access, comfort, and economy.

When it comes to transitioning to an electric wheelchair accessible vehicle (eWAV), one of Steve's main concerns is adequate range. His daily journeys between the university and hospital where he lectures and teaches, and weekly journeys to church and social events require long range.

The current design of home and public charging doesn't meet the accessibility requirements Steve has for his limited hand function. Therefore, it is fundamental for Steve to have confidence in being able to complete a journey on one charge without having to stop.

Potential adaptations to digital interfaces are another key concern. Steve estimates that he cannot currently use 60% of his Wav's functions. For example, the touchscreen for the radio and small manual buttons on the steering wheel is completely inaccessible.

When his current vehicle was chosen 6 months ago, an electric option was not presented to Steve. However, he is willing to lease an eWAV if the barriers listed can be overcome, and if Motability assists with providing information on costs when his current lease ends.

Case study 2

Richard lives in Cambridgeshire with his family. One of his sons has cerebral palsy and is a full-time wheelchair user. Their family car is a Ford Tourneo that has been made wheelchair accessible (WAV).

This is their fifth car with Motability, they spoke with the team and car dealerships about what vehicles were available on the Motability Scheme this year. They hadn't heard of the plug-in car grant scheme and as far as they were aware there were no eWAVS once they had narrowed down what adaptations were needed for their son. Overall, he would have preferred petrol, but the suitable model is diesel.

As they live in a rural area the car is used for all journeys, including hospital appointments and general errands. He mentioned that an electric car would suit them as they typically make short journeys, but range is also important as the closest city is 20 miles away. Their key design concern is how the floor will be lowered if the battery is located there. A reasonable size with ramp access, equipment space and passenger seats for the family are also important.

If they purchased an electric WAV it would be useful to have a charge port at the back of the car, as they need to reverse into their driveway so their son can exit away from the roadside. This location would allow safe exit/entry and easy access to charge. For charging they are concerned whether the property layout will be a challenge when having a home charger installed.

They would like to hear about other disabled users' experiences with eWAVS before their lease runs out in five years to assist with the transition.

Case study 3

Charlotte lives in Nottingham with her husband, they both have muscular dystrophy and complex medical needs.

Their primary modes of transport are two Volkswagen Caddy Life wheelchair accessible vehicles (WAVs) which they use at least five times a week. This car has upfront seating, allowing Charlotte's personal assistant (PA) to be aware of any seizures she may experience whilst driving. Travelling by car instead of public transport, adds an element of security should a medical emergency occur, providing the quickest way home.

Despite good public transport links in the area, it is difficult for Charlotte and her husband to access them. Even wheelchair accessible taxis are unsuitable due to the size of their powered wheelchairs.

In the future, a medium-sized vehicle that can accommodate two wheelchair users and a mobile hoist would be preferred. Charlotte is also concerned about not being environmentally friendly when using two vehicles. They did consider an electric WAV (eWAV), however, the choice is currently out of their hands as there are no available vehicles that meet their size and adaptation requirements.

Both Charlotte and her husband are open to having an EV in the future. However, they would want education and reassurance on how to access and use charging infrastructure.

One of the couple's current vehicles is a hire car following a road incident. This is a considerably larger minibus, which their PA is not comfortable driving and is difficult to park outside their house. In order to avoid these challenges, it is important that WAVS/eWAVS are available in a range of sizes.

Their experience highlights the stowage limitations of current vehicle models and concerns around the size of eWAVs/WAVs. This has prevented the couple from being able to travel together in one vehicle to voluntary work, conferences and social events. They hope these challenges will be addressed ahead of the purchase of an EV in the future.

Case study 4

Tom lives in a small town in Dorset with his wife and four children. Tom is a C5 quadriplegic and wheelchair user. A Volkswagen Transporter wheelchair accessible vehicle (WAV) is their main mode of transport. Despite some local buses, public transport is inaccessible for Tom because of the amount of equipment he needs to take with him.

The family car is used multiple times a day for the school run, holidays, children's activities and social events. Multiple passenger seats, upfront seating and sufficient head height are essential because Tom is a tall wheelchair user.

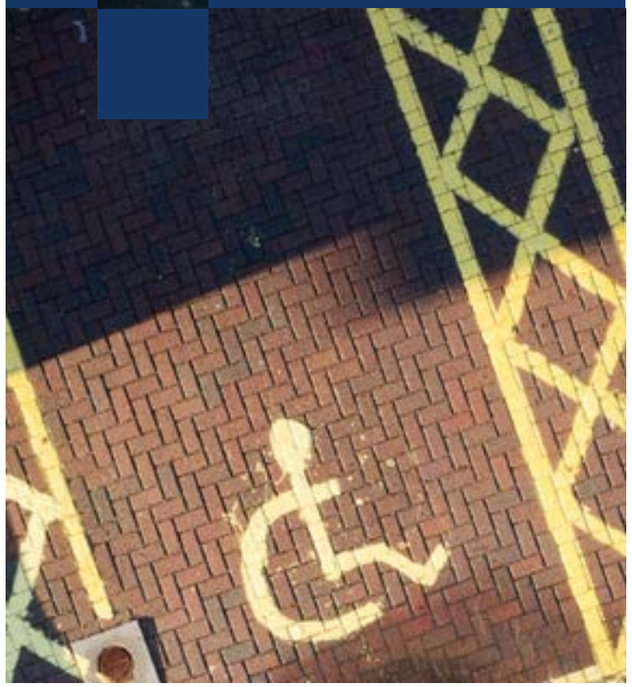
When Tom sourced a new vehicle last year under the Motability scheme, there were no electric wheelchair accessible vehicles (eWAVs) big enough to accommodate his family and all the necessary equipment.

A major vehicle design concern is access – the floor has been lowered in all of Tom's previous vehicles. This is beneficial for reducing the ramp gradient, accessing the vehicle easily and safely and lowering the wheelchair user's centre of gravity, thereby increasing comfort. However, EV batteries are typically located under the floor of the vehicle, making wheelchair accessibility a concern.

The charging socket placement is not a major worry for Tom because he has a carer and his wife to assist with charging, but the ideal placement would be the front or side of the vehicle.

Tom hopes that when the five-year lease on his current vehicle ends, there will be a variety of eWAVs with suitable adaptations available. He also hopes that funding will remain available to help financially with the transition to an EV.

Case study 5



Lottie is based in Sheffield and has a physical disability, epilepsy and bipolar. She typically uses her wheelchair accessible vehicle (WAV) daily and drives the vehicle herself, unless she has recently had a seizure. Lottie lives in a rural area where there are few pavements and many steep hills, making her car essential for all journeys.

Lottie plays a wide variety of sports on a daily basis, so being able to store her sports chair in the vehicle is essential. In her current vehicle, Lottie is unable to transfer from her wheelchair to the driver seat inside the vehicle, which has made the vehicle increasingly difficult to use. This will no longer be an issue when her new vehicle, the Mercedes Sprinter, arrives. However, as this vehicle is much larger than her current one, Lottie is planning to have additional driving lessons for the new lease vehicle to help build her confidence.

She was not aware of a suitable electric WAV (eWAV) when she ordered the Mercedes Sprinter but would love an EV in the future if the running costs are affordable and if she could be confident that it could work in her life. Lottie is concerned that her powered wheelchair and sports chair would increase the weight of the vehicle and lead to higher running costs and reduced mileage. Another key concern is the size of the vehicle. It would need to be similar to the Mercedes Sprinter or smaller because the Sprinter is the maximum size Lottie is comfortable driving.

Due to the distance between her parking space and house, charging would be an issue. Lottie has discussed concerns around the accessibility of public chargers with friends and they are particularly worried about parking bays not being wide enough for drivers to exit in their wheelchair, meaning they would be unable to charge in public places without assistance.

Lottie is hopeful that when her five-year lease is up, there will be an electric Sprinter available because this model provides all the required adaptations and necessary space.

4.2. Barriers for the WAV conversion and adaptation industry

This section presents the perspective of converters and adapters by exploring the nature of their industry, their unique industry challenges and stakeholder relationships. Besides OEMs, which produce specialised vehicles, converters and adapters are the main producers of vehicles for disabled consumers with specific needs and requirements and are therefore essential actors to ensure accessible vehicles are available.

The following two sections are predominantly shaped by conversations with representatives of the conversion and adaptation industry, serving as the primary source material.

Additionally, findings supported by other stakeholders' views on the industry, including OEMs, a provider of vehicles, and a European organisation that works closely with the vehicle adaptation industry and advocates for disabled motorists' mobility, contributed to this section. This report acknowledges the complexities and diversity of the conversion and adaptation industry and strives to avoid oversimplifying its participants. The objective is rather to identify and emphasise potential barriers through a systematic research approach that includes expert interviews, yielding professional insights and experiences. It is recognised that a broader and more inclusive analysis is required to fully capture the diverse perspectives and challenges faced by the industry and its actors.

Table 2 – Key insights of the conversion and adaptation industry

Key insights from the conversion industry
▪ Level of OEM's collaboration depends on individual working relationship with converters.
▪ Limited access to electronics and pre-production vehicles can lead to inconveniences for the disabled consumer in terms of user experience and waiting times.
▪ Getting OEM approval to convert a vehicle is a necessity and can be difficult to obtain.
▪ New, unsuitable base vehicles limiting choice for converters and users.
▪ The Wheelchair Accessible Vehicle Convertors Association (WAVCA), as a united body of conversion manufacturers, has some influence on legislation and regulatory frameworks.
▪ Vehicle supply chain issues are threatening converters' businesses.

Key insights from the adaptation industry
▪ Limited engagement with OEMs due to the nature of the industry.
▪ Legislation on post-registration adaptations causes concerns about consistency of quality standards.
▪ Inability to discover complications with a specific adaptation pre-installation.
▪ New EU legislation may not consider the adaptation industry and disabled users' individual needs.

4.2.1. Specific barriers for WAV converters

Conversion manufacturing companies produce suitable vehicles for wheelchair users, WAVs, which ensure usability, functionality and safety for the disabled motorist or passenger. It is important to understand this industry's unique relationships and challenges in order to propose recommendations on how to incentivise OEMs and other stakeholders to address vehicle design barriers.

Level of OEMs' collaboration depends on individual working relationship with converters

Converters aim to foster long-term relationships with OEMs in order to build trust in the quality of their services, which they hope, in turn, will help them gain access to product information. The extent and variety of information shared differs greatly across OEMs. The interview with a representative from the conversion industry implied that the level of collaboration depends on establishing an individual working relationship with an OEM.

They highlighted the importance of two determining factors: the volume of cars purchased and the ability to showcase high quality business and exacting standards.

Official accreditations, such as the ISO 9001 for quality management[80] or the BS 10125 for vehicle body repair,[81] could be one gateway to gain OEMs' confidence in a converter's professional and technical standards. According to our conversations with a WAV manufacturer as well as international OEMs, holding a nationally recognised accreditation makes it much easier for a converter to engage with OEMs and obtain the information needed. Some OEMs have developed their own converter approval programs, which help to ensure the quality standards of their verified converter network. Ford, for example, developed a Qualified Vehicle Modifier Programme (QVM),[82] ensuring that any accredited converter operates to the same standard as they do.

> **'I believe that being our level and with our experience [OEMs] are happier to collaborate with than they might be some other converters. I can understand why [OEMs] would be nervous sharing that data with maybe someone that's not the [having the same] skills.''**
> **Representative from the conversion industry**

Limited access to electronics and pre-production vehicles can lead to inconveniences for the disabled consumer in terms of user experience and waiting times

As mentioned previously, the availability of information concerning a vehicle's software and electronics is limited. This makes it difficult for the conversion industry to seamlessly adapt certain features in line with the vehicle's original design for an enhanced user experience. The interviewed WAV converter gave the example of a docking station, which is necessary to secure a wheelchair to the vehicle as if sitting in a seat. Instead of having the docking station functions integrated to the vehicle's LCD display, converters must add separate buttons or switches onto the vehicle's dashboard so a user can secure their wheelchair in place. Without access to the vehicle's electronics, it's impossible to build on OEMs' technology and make necessary WAV modifications compatible with a vehicle's original design.

> **''We get all the CADs and everything, but then at the moment, we've not really had the requirement but going forward with when we transition to EVs, then it'll be much more important. So, it's about making sure that [OEMs] are open to collaborating with us on that front.''**
> **Representative from the conversion industry**

Furthermore, there appears to be no commonality amongst OEMs in terms of which types of pre-production vehicles they share and at which stage of development. According to our interviews, some OEMs share pre-production vehicles and give converters early access to CAD drawings, whereas others don't share any of this information before launching their new vehicle. The lead time to develop a new WAV is generally between six to nine months. Converters typically require four to five vehicle body shells to fit and test a wheelchair in situ, plus three to four pre-production vehicles to develop a new WAV. If OEMs haven't shared any pre-production vehicles with the industry, converters must wait until the standard version of a new vehicle is available at dealerships before starting the development phase. Consequently, they are only able to release the WAV version significantly later than the original. This delay means that they can't benefit from the OEMs' marketing campaigns and also results in customers having to wait longer for the WAV version to become available.

According to the interviewed representative of the conversion industry, access to pre-production vehicle information and body shells becomes even more important when converting EVs, as the requirements to obtain a letter of no objection from the OEMs becomes more stringent, as explained in the paragraph below.

Getting OEM approval for converting a vehicle is a necessity and can be difficult to obtain

All WAVs in the UK and the EU are required to be tested and approved prior to registration, either through National Small Series Type Approval (NKS), EU Whole Vehicle Type Approval (EWVTA) or Individual Vehicle Approval (IVA),[83] to ensure vehicle safety and environmental standards are met. However, before a WAV can go through this process, conversion manufacturers must obtain approval from the OEM for features which are modified during the conversion process,[84] usually evidenced in form of a 'Letter of No Objection' (LONO).

A WAV with a LONO retains the original OEM warranty after the vehicle has been converted.[85,86] As a result, all OEMs require detailed insights into planned vehicle modifications, technical assessments, and rigorous testing before considering issuing a LONO to conversion manufacturers. With the trend of vehicles becoming increasingly electronically controlled (see Section 3.2.), OEMs requirements are likely to be more stringent as vehicle modifications become more technically challenging.

''We've just done our first eWAV, [...] and we had to send [the OEM] all the drawings of what we were planning to do around relocating the battery. And then we had to send the vehicle to Paris to go through ride and handling tests for them to basically look over it before they would give us that letter of no objection. So, it's pretty stringent and I said that that suits me because it is more technically challenging [...], and at the end of the day, a wheelchair user shouldn't be any less safe in their vehicle than someone who's able bodied so it should go through the same rigorous testing.''
Representative from the conversion industry

When a converter has to structurally modify the base vehicle to convert it to a WAV, obtaining a LONO becomes even more difficult. Most ICE vehicles only require cutting a section out of the back of the vehicle to lower the floor, fit ramps, or lifts. However, conversations with a WAV converter revealed that, due to the design of some ICE vehicles, they would need to cut out the whole floor to be able to carry out the modifications needed to produce a WAV version. While these modifications are expensive but theoretically possible for ICE vehicles, they would dramatically change the structural integrity of the vehicle. This issue is compounded further when the vehicle in question is electric due to the additional technical challenges of working with high voltage systems and the placement of the battery. In order to protect their brand and reputation, some OEMs won't consider these changes, dismissing a possible WAV version of their vehicle.

''They've got to protect their own brand. So, some of them, if you do severe changes, they just don't really want to engage on it. And I can understand to be honest. [...] I think a big part of it is reputational damage to make sure that if [OEMs] are spending 800 million euros developing a vehicle and giving it a seal of approval, they don't want [a converter] who's going to spend 100 grand changing it to then all of a sudden say, yeah, [the new version] is just as good [as the original].''
Representative from the conversion industry

In addition to the Type Approval process, the Publicly Available Specification (PAS) 2012,[87] a standard for WAVs set out by the British Standards Institute (BSI), provides additional guidelines to encourage high levels of safety testing and best practice in WAV design. The PAS 2012 has been adopted by Motability Operations as a required accreditation for a new WAV to be accepted on the Scheme.

New, unsuitable base vehicles limiting choice for converters and users

According to a representative from the conversion industry, OEMs often release new base vehicles that are unsuitable for conversion, including OEMs who have previously sold and produced vehicles for the WAV industry.

Ford is one of the most popular OEMs for the respondents of the user survey (see Figure 9). One WAV industry representative referred to the Ford Tourneo Custom, which they described as ''one of the most popular vehicles in the WAV market just now''. Ford will launch a fully electric version of that vehicle in 2023.[88] However, according to this representative, the new model will only have rear-wheel-drive, which makes it traditionally unsuitable for WAV conversion.

''I can totally understand why they've done it from a commercial vehicle point of view, but it basically means that that vehicle is redundant as far as a fully electric WAV goes. [...] I would love to be able to say 'You should have thought of our industry before you decided that' but the reality is that [the WAV market] is so so small, [OEMs] are not going to make that sort of decision for a handful of vehicles a year in the grand scheme of things.''
Representative from the conversion industry

The lack of suitable models and limited choice of vehicles has been identified as one of the key practical barriers to the uptake of EVs by disabled consumers (see Section 4.1.1.). While the Ford Tourneo is just one example of an EV being unsuitable for a WAV conversion, it is important to ensure that other new and popular models become available for disabled consumers, to ensure an equitable transition to EVs.

Despite these challenges, there are examples where OEMs have ensured that their product can continue to be offered as a WAV. The interviewed representative from the conversion industry referred back to Ford, which developed a special AdBlue Tank to allow modifications to the rear floor.[89] They also spoke about the Volkswagen Caddy, which comes with a specific WAV axle made by the OEM, enabling converters to use this model. While it is hard to determine the key factor that motivates OEMs to make decisions in favour of the industry, WAVCA, a trade association for manufacturers of wheelchair accessible vehicles, aims to encourage and promote the interests of the WAV industry in the UK.

WAVCA, as the united body of conversion manufacturers, has some influence on legislation and regulatory frameworks

Over the last few decades, WAVCA has worked on engaging with regulators and other stakeholders to ensure the UK WAV industry can continue to meet the needs of wheelchair users. It demonstrates a good example of the leverage a united industry voice can have on legislation and regulatory frameworks. Conversations with a WAVCA member have been the foundation for the following paragraph.

WAVCA helped to shape appropriate regulatory concessions and adjustments for WAVs. For example, they managed to obtain certain exemptions from "full vehicle" crash tests for WAVs because the crash test dummies used are not representative of wheelchair users. Advocating for high safety and environmental standards, they also strengthened the regulations in areas where they felt that the needs of wheelchair users could be better addressed, and safety improved. For example, WAVCA lobbied for, and helped, draft the requirements currently set out in both the EU and GB type approval schemes[90] relating to the strength and positioning of anchorages for wheelchair tie-downs and occupant restraints. As previously mentioned, they supported the development of the BSI PAS2012 standard[91] by developing testing requirements to allow the "crash" testing of cars with a test wheelchair weighing up to 200kg, this went beyond the minimum requirements set out in previous regulation.

Recently, WAVCA engaged with stakeholders and regulators in the wider service, maintenance and repair sector in its recent response to a government consultation on post-registration modification of motor vehicles.[92] The primary aim of the consultation was to look at ways of safeguarding the type approval specification of road vehicles once they have been registered and entered service.

This is to ensure that disabled consumers can retrofit the best and most appropriate equipment to their vehicles to meet changing medical needs, and the government is still currently considering its response. However, WAVCA has demonstrated some influence within UK and European bodies in the past. By uniting their voice with other stakeholders from the specialised vehicle sector, they could be a key factor to motivating regulator and OEMs to make decisions in favour of the industry.

Vehicle supply chain issues are threatening converters' businesses

In 2022, the automotive industry experienced massive supply chain issues worldwide, resulting in long manufacturing lead times.[93]

> **''At the moment, I think there are maybe 5,000 to 6,000 customers who have ordered an ICE WAV who are waiting to get it. […] Our number one priority right now is trying to get the OEMs to give us allocation to make sure that we can fulfil the orders that we've taken from customers who are in a lot of cases desperate to get their WAV.''**
> **Representative from the conversion industry**

When interviewing a representative from the conversion industry, it was highlighted that the limited supply of suitable ICE vehicles for conversion is not only a critical issue for customers that need a vehicle but also for the conversion manufacturers themselves. This is because the issues with the supply of suitable vehicles to convert and sell, impacts their cash flow, making it more challenging to cover business operating costs.

Securing enough ICE vehicles to satisfy customer demand appears to be a key priority for the conversion industry, especially when ICE vehicles remain the only option for many customers currently (see Section 4.1.2.) This is supported by the findings of the industry survey (see Section 4.1.2.), as 59% of Motability dealership respondents perceived that customers are less interested in eWAV compared to ICE vehicles. Survey respondents cited the barrier of high upfront payments and long lead times for eWAV purchases.

> **"Going forward is kind of a twofold. You know, ICE [vehicles are] going to be the answer for a while on WAVs because of all the reasons I said at the start in terms of customer challenges and infrastructure. It's critical for [converters] to get some product or sadly some of them won't survive in the next few months because there are costs and there is no income. And then going forward it's a combination of continuing to offer ICE [vehicles], […] but at the same time making sure there's a range of electric WAVs available for those where the solution works for them.''**
> **Representative from the conversion industry**

While the focus of this report is understanding the barriers to inclusive EV design, it's important to highlight the continued need for ICE vehicles in the absence of equivalent EV models and the challenges faced by the conversion industry. According to conversations with a WAVCA representative, the association has been exploring ways to enable a continued supply of ICE base vehicles and appropriate incentives for the manufacturers of those vehicles to continue to supply them, without adversely affecting the CO2 limits under which those manufacturers must operate.

4.2.2. Specific barriers for adapters

Adaptation manufacturers are important stakeholders that provide individual mobility solutions for people with additional needs and requirements. Similarly, to the previous section, this section aims to detail some of the industry's unique relationships and challenges in relation to adapters. An understanding of the barriers faced by adapters and their specific needs is crucial to propose the best ways to support them, and ultimately, work towards promoting accessible EV design.

Limited engagement with OEMs due to nature of the industry

In comparison to converters, it appears more difficult for adapters to form a strong working relationship with OEMs. According to interviews with four experts outside of the adaptation industry, adaptation manufacturers tend to be small businesses with self-employed individuals who install adaptations at dealerships.

> **'Many [adapters] are quite small and really coming for the first time to the concept of quality management systems.''**
> **Representative from a European organisation**

While converters are direct customers of OEMs, adapters typically source their vehicles from individual clients and businesses, like converters or dealerships, and therefore have no or limited direct involvement with manufacturers, which results in difficulties obtaining technical information.

> **"They [OEMs] don't take the adaptations industry seriously enough […] So, if we put a question in, we might get an answer [from the OEMs], but nine times out of 10, we won't."**
> **Representative from the adaptation industry**

According to multiple stakeholders interviewed for this report there is a lack of motivation for OEMs to engage with single adaptation businesses. While around 10% of the Motability Scheme fleet cars have an adaptation,[94] the adaptation market is still comparatively small on a global level.

''[Adapters] are not acknowledged. [OEMs] are very reluctant to consider the possibility of adaptation at all. [The adaptation industry] is a small sector of their international market and is not interesting for them unless [OEMs] are obliged to [engage with them] at the political level.''
Representative from a European organisation

Overall, the adaptation industry appears to struggle to gain influence or establish direct channels of communication with OEMs. However, just like WAVCA, the UK's adaptation industry recently combined forces to build their influence within the wider automotive industry. The Association of Vehicle Adaptation Manufacturers (AVAM) was founded in 2019 and is the trade association representing the adaptation industry in the UK. Its objective is to improve safety and training across the industry and to work collaboratively to pool industry resources. AVAM ensures that all of their members hold the ISO9001 certification, specific standard documents developed for adaptation manufacturers, and are currently working on establishing an auditing process to elevate industry standards.[95] Through AVAM, the UK's adapters have a unified voice and greater collective influence within the automotive industry. As a relatively new organisation, there is opportunity to increase the level of influence it has in the industry and with OEMs over time.

Legislation on post-registration adaptations causes concerns about consistency of quality standards

Unlike converters, adapters don't have to get OEM approval for vehicle adaptations. A representative from the industry explained that there are two important components of the legal approval framework for adaptations:

1. Products must be approved by the Driver and Vehicle Standards Agency (DVSA) as an adaptation.
2. Adapters must ensure that their products do not compromise the vehicle's original type approval as they are dealing with vehicles which are already registered.

For adaptations that comply with the legal framework, our industry representative clarified that there is no need to obtain any additional type approval after an adaptation is fitted to the car. However, a representative also explained that some individual adaptation installers have their own quality assurance processes in place.

''Anything has to be within this framework, or [DVSA] will not give consent to it. [There needs to be] a tacit and implicit consent being granted because [the adaptation] is seen to be safe [and accords] to good engineering principles. That is a very subjective approach. […] There is no uniform guidance at the moment to the individual countries on post-registration adaptations and conversions. And it may even differ between different inspectors within the vehicle inspectorate.''
Representative from a European organisation

Conversations with OEMs revealed that this process causes concerns about the consistency and quality of the installation itself, making OEMs reluctant to share information with the adaptation industry because they want to ensure that their own standards are maintained. Other interviewed stakeholders, who are generally supportive of the adaptation industry. In the following instance, a representative from the conversion industry expressed their understanding of OEMs' position.

''There's no OEM approval. The guys that are even fitting [the adaptations], they can go and do a day's training and all of a sudden, they're fitting a hoist or whatever.''
Representative from the conversion industry

The concerns caused by a lack of standards for post-registration adaptations might increase when dealing with EVs. For example, the Health and Security Executive (HSE) clearly outlines the importance of appropriate and special training to allow technicians to work safely with EVs and refers to the Institute of the Motor Industry (IMI) Level 3 as an appropriate qualification.[96] While the 'IMI Level 3 Award in Electric/ Hybrid Vehicle System Repair and Replacement' equips learners to work safely with high voltage systems,[97] it is not a legal requirement for technicians and adaptation installers to obtain this qualification.

A lack of standards and legislation also affects the wider maintenance and repair sector, which may not have received the appropriate training or guidelines necessary to handle adaptation manufacturers' products safely.

''We will gradually have to move towards higher regulation of the dealers and maintenance companies around the country to be able to work to a higher set of standards than what some of them currently do, and I think that there may be a need to frame that in the future.''
Representative from a European organisation

The wider maintenance and repair sector appears to share similar concerns and challenges with adapters and converters. As previously mentioned in Section 4.2.1., actors from the maintenance and repair sector recently engaged with WAVCA to respond to a government consultation on post-registration modification. However, a full assessment of the maintenance and repair sector's shared and unique barriers is out of scope of this report.

Inability to discover complications with a specific adaptation pre-installation

Generally, adapters get access to new vehicle models once they are publicly available. There is limited access to vehicle information provided by OEMs due to reasons explained previously. Adapters are therefore unable to anticipate challenges with specific models in advance.

''Unfortunately, it is very much often the case when it comes to adaptations that the first time you find a problem is when somebody breaks something, or something doesn't work.''
Representative from the adaptation industry

The core service offering of adaptation businesses is providing disabled customers with a customised set of adaptations to support individual requirements. As highlighted by interviews with an industry representative, these changes often require interacting with the vehicle's electronic system, to which adapters aren't granted access. Overall, there are a range of challenges experienced by the industry because of a lack of information and early insight.

''The adaptation industry and to some extent the WAV industry are highly innovative companies, that's the reason they have to be able to problem solve to an individual's requirements. And so, a number of things will be managed despite the difficult circumstances at the day-to-day level.''
Representative from a European organisation

Adapters might experience some unexpected issues during installation, as some base vehicles are not suitable for certain adaptations. The interviewed industry representative gave the example of a specific model that many adapters struggled to fit steering aids to. They explained that trying to fit steering aids could 'break' the vehicle's steering wheel, presumably by interfering with the sensors fitted to it, making the model unsuitable for this adaptation. Besides the fact that the adaptation industry had to wait until this vehicle was available at dealerships before discovering the issues with the steering aids, this lack of early insight also demonstrates a potential challenge for the end-consumer: Motability customers who might have ordered this vehicle up to 12 months in advance, and have a driving license code which requires them to have this specific adaptation fitted to their car, were not able to receive this model. These prolonged waiting times can be a significant problem for disabled customers, particularly if they are dependent on a car for mobility.

Another critical issue is adaptations that start malfunctioning post-installation. One example, already highlighted in Section 3.2., involved an over-the-air update that interfered with the adaptation's software, stopping the secondary hand-control features and leading to a potential safety risk for the disabled motorist.

''[OEMs] are not prepared to give sufficient good information [to the adaptation industry] or a sensible interface for the electronics to be plugged into and so on. This is a small sector of their international market and really it's not interesting for them unless they're obliged to at the political level.''
Representative from a European organisation

Potential safety risks could increase as software and electronics advance, particularly if there continues to be a lack of information available on vehicle software specifications and electronics, including over the air updates done by the OEMs. Ultimately, information is key for the industry to minimise the risk of experiencing unknown issues with adaptations after they have been fitted and ultimately, to secure the safety of drivers and passengers.

New EU legislation may not consider the adaptation industry and disabled users' individual needs

Currently, the EU is in the process of proposing a new Cyber Resilience Act, which introduces mandatory cybersecurity requirements for products with digital elements.[98] It aims to protect consumers and businesses from hardware and software products that can pose potential cybersecurity risks. However, as the adaptation industry must modify vehicles and software to the individual requirements of their customers, they are concerned the new legislation doesn't include appropriate concessions and adjustments required for their work.

''The cybersecurity laws have a real possibility that they could actually discriminate against the disabled driver, and that to me can't happen.''
Representative from the adaptation industry

The representative from the adaptation industry explained that these concerns stem from the fact that most driving adaptations, especially secondary controls (e.g., indicators, lights, wipers, etc) require interfacing with (connecting to) the vehicle software. They are particularly concerned that the new Cyber Resilience Act will make it illegal to connect to a vehicle's communication system.

Although WAVCA had some success in achieving legal concessions for the WAV sector (see Section 4.2.1.), AVAM is still comparatively young, founded as recently as 2019, and yet to build up its influence. However, organisations like the European Mobility Group (EMG) add leverage to the adaptation industry's limited influence on a European level. The EMG aims to ensure that the needs of disabled drivers or passengers are considered when it comes to new legislative proposals. They also engage with European decision makers to raise awareness and increase knowledge.[99]

Conversations with a European organisation implied that new legislation is on the horizon, which could potentially impact the adaptation industry. This highlights the importance of having a strong and unified voice for the industry.

''[Besides cybersecurity], we're also finding difficulties as [the EU] is getting on to other parts of legislation which are involving the ongoing maintenance, and availability of information on incident management of vehicles. There is proposed legislation on driver behaviour coming forward. They are saying that's the next thing we are working on. Now that will almost certainly start by being based on a standard human being part of the HMI, the human machine interface. But what if you're a non-standard person?''
Representative from a European organisation

Overall, adapters will need to find innovative solutions to work around any new legislation. This potentially introduces more challenges into the process of providing individual mobility solutions for disabled motorists and passengers.

4.2.3. Barriers for OEMs

This section aims to provide an understanding of OEMs' perspective and drivers for decision making to identify the best ways to encourage them to consider accessible vehicle design. The findings in this section were surmised from the research conducted and most significantly influenced from interviews with four OEMs, two of whom produce commercial vehicles on an international scale. This report acknowledges the broad and diverse nature of the vehicle manufacturing industry and does not intend to generalise OEMs with its findings, rather to identify and highlight possible barriers, based on experts' experiences and opinions gained from the research method.

These are summarised as follows:

- Decisions are highly driven by market value on an international scale.
- Multiple departments are involved in the decision-making process of developing a new model.
- NDAs must be given out on a one-to-one basis to protect brand integrity & intellectual property.
- OEM's show a growing awareness of D&I and CSR but this is often directed internally or does not include provision for disabled users.

Decisions are highly driven by market value on an international scale

In the UK, the conversion and adaptation market is a relatively large sector and possibly the most vibrant market of its kind in Europe. However, many OEMs are large-scale international businesses and have to consider all markets when building a new vehicle. On an international scale, the conversion and adaptation markets are not comparable in size to other sectors which impacts the business case when it comes to inclusive design.

According to interviews with different OEMs, there is a trend of changing commercial strategies from being primarily driven by high volume low margin vehicles, to lower volume high margin premium vehicles.[100] With current supply shortages,[101] this strategy appears more desirable, but it's unclear how long-term and widespread this will be amongst OEMs.

Although being driven my market value on an international; scale, OEMs have to adjust their decisions in line with legislation and regulatory frameworks. For example, in the UK, one of the regulatory mechanisms being introduced to encourage the sale of Zero Emission Vehicles (ZEV) is the ZEV mandate. Though the details of the regulation are still being finalised, this new regulation could be a potential driver for OEMs to produce more eWAV base vehicles.

ZEV Mandate

The ZEV (zero emission vehicle) mandate is part of the UK Government's Net Zero Strategy, and its purpose is to directly reduce the impact of road transport emissions on the environment by ensuring that manufacturers are preparing for the UK's 2030 ban on new petrol and diesel car and van sales.

Manufacturers will have to sell a certain proportion of electric vehicles (EVs) in the lead up to 2030 and ZEV sales will be converted into certificates. Manufacturers will be required to hold a certain number of certificates at the end of each year in relation to the total number of vehicles they've sold. There will also be targets for CO2 emissions to regulate non-ZEVs.

The scheme will include provisions for the trading of certificates, which will allow manufacturers to buy and sell ZEV certificates between them. There will be two separate certificate systems – one for cars and one for vans – with no cross trading due to the differing stages and availability of zero emission technology for each vehicle type.

A technical consultation period was held between 7 April and 10 June 2022 to seek stakeholder views on the proposed design features of the mandate. The feedback is currently being analysed and the full regulatory proposal will be published imminently and then the final consultations will take place ahead of the introduction of the mandate in 2024.

Multiple departments are involved in the decision-making process of developing a new model

When considering how to encourage inclusive design amongst OEMs, understanding their decision-making process is helpful context to support engagement and influence decision making. Based on one interview with a large OEM, it seems that they consider three main voices within their company before making the decision to develop and launch a new vehicle model: marketing, engineering and finance. There needs to be buy in from all three departments to influence the OEM's decision-making on a large scale.

One OEM explained the decision-making process as follows:

- The marketing team identifies what customers want in a car to guarantee demand. Their input could affect considerations around range, size, general design, comfort and digital features.
- Whether or not the marketing team's suggestions are achievable is determined by the engineering department. This team identifies whether the new design features can be produced, what the development costs would be and what the timelines would be before the new model can be launched on the market.
- Finally, the finance team needs to ensure there is enough market value for the new model.

Other OEM interviewees implied that communication across departments can be limited. As can be the nature of large, global companies, they are not always aware of what other departments are doing and how these are influencing vehicle design decisions. Having a broad base of business contacts is key to finding the right person to reach out to about accessible design principles and who has influence further down the line. One of the interviewed OEM representatives holds a management position specific to conversion development, which shows that some OEMs do have dedicated teams to enhance and streamline communication to the conversion industry.

NDAs must be given out on a one-to-one basis to protect brand integrity & intellectual property

For many companies, intellectual property protects important business assets beyond just ideas or concepts. These assets may play a critical role in the company's core services and long-term success.[102] In line with that, OEMs demonstrate caution about sharing commercially sensitive data. OEM representatives revealed that they are generally very reluctant to share any information related to software and interfaces. In addition, OEMs' current or future product plans that are not in the public domain are usually unavailable to share with the conversion and adaptation industry.

OEMs need to ensure that any modification to their base vehicle meets their own standards to protect brand integrity. Interviewed OEM representatives reasoned that, although the warranty of a malfunction in a conversion or adaptation does not sit with the OEMs, any incident involving their vehicle is a risk to reputation and the brand. Trust in a business' capabilities and quality standards is therefore a pre-requisite before OEMs will consider sharing product specifications with the adaptation and conversion industry. This becomes even more vital when dealing with EVs and advanced software that requires additional training and a higher skill level to work with safely.[103] As a result, OEMs are likely to become more cautious around releasing and sharing information.

A non-disclosure agreement (NDA) is the standard mechanism to enable information sharing with converters and adapters. However, each individual adaptation or conversion business requires an individual agreement. One OEM representative said there is a large number of businesses with competing products, which adds significant administrative burden in arranging individual NDAs. The interviewee implied that this is part of the reason why OEMs prefer to collaborate with high-volume customers.

OEMs show a growing awareness of D&I and CSR but this is often directed internally or does not include provision for disabled users

Published material from the most popular suppliers of small WAV base vehicles in the UK, Peugeot, Citroen, Vauxhall, Fiat, Ford and Volkswagen,[104,105,106] has been reviewed.

Their internal Diversity and Inclusion (D&I) policies tend to be strong[107] but are not directed externally (e.g., reflecting on the role their products play in encouraging D&I in wider society).

While all the major OEMs engage in Corporate Social Responsibility (CSR) or Environmental, Social and Governance (ESG) practices, these strategies and goals rarely mention disabled users. For example, Volkswagen's CSR agenda includes 'Health and Community Wellbeing, and through its community trust it supports 'people with disabilities' but such an explicit reference to supporting disabled users was rare. References to improving accessibility and mobility options tended to translate into making EVs more affordable[108] or pursuing new business models, which focus on connectivity or mobility-as-a-service rather than reflecting the needs of disabled users.[109]

The fact that all major OEMs are increasingly incorporating positive D&I, CSR and ESG practices into their corporate strategies provides an opportunity for Motability and other stakeholders to influence these policies, especially if existing positive examples can be showcased as good practice. There are significant opportunities for growth and brand development for OEMs that take a lead on this agenda by building on their existing CSR, ESG and D&I strategies.

From the interviews, it was identified that some OEMs think the scale of the conversion and adaptation market is too small to drive changes in the overall design approach, especially once vehicles are ready for the mass market. This reinforces the importance of adapters, converters and other interested stakeholders, such as Motability Operations, working collaboratively with OEMs to understand what inclusive design principles can be incorporated early in the vehicle design process.

5. Solutions and recommendations

The unique position occupied by converters and adapters in the UK appears to only be understood and recognised by a small circle of stakeholders. In order to support these industries, Motability, Motability Operations and the UK Government more generally should take a pro-active approach to overcome industry barriers together. This is especially important with regard to the strong benefits that the adaptation and conversion market offer to disabled consumers, such as improved mobility and independence.

The development of accessible transportation options is crucial for creating a more inclusive and equitable society for disabled individuals. The efforts of Motability, Motability Operations and the UK Government will play a key role in realising this goal.

This section details potential solutions and recommendations to overcome the challenges related to accessible and inclusive vehicle design. It also recommends particular positions the UK Government could be adopting to protect the conversion and adaptation market during the transition to EVs.

This research has identified the following actions as crucial to ensuring equal access to EVs for disabled consumers:

- Facilitate conversations between WAV converters, adapters and OEMS.
- Establish guidelines on accessible design principles in collaboration with disabled users and the wider specialist automotive industry.
- Highlight the benefits of incorporating inclusive design and engagement into existing D&I, CSR and ESG strategies.
- Build trust with a higher set of industry standards and regulations.
- Greater engagement of UK bodies in EU working groups.
- Use the ZEV mandate to incentivise the production of WAV base vehicles.
- Strengthen the Plug-in Car Grant to support customers with higher upfront costs for EVs.

5.1. Facilitate conversations between WAV converters, adapters and OEMs

Missing engagement with OEMs has been identified as a key barrier for both the adaptation and the conversion industry. In particular, adapters struggle to establish any form of communication with OEMS. Motability Operations is the UK's largest supplier of adapted vehicles and WAVs, as well as being a high-volume customer of OEMs, so its voice is more likely to be heard by OEMs and to carry more weight compared with individual adapters or converters.

Motability Operations has a wide pool of industry contacts, which they should use to facilitate business introductions and set up shared meetings, supporting adapters and converters in establishing meaningful relationships with OEMs. Motability Operations' initiative, support and representation in relevant conversations with OEMs will help to focus attention on the needs of adapters and converters and can foster trust between all involved stakeholders.

5.2. Establish guidelines on accessible design principles in collaboration with disabled users and the wider specialist automotive industry

Missing guidelines on precise design principles are a common theme of Chapter 3 on accessibility barriers for vehicle design. An interview with a design and engineering company implied that often, only a small subset of vehicle attributes must change to make the base vehicle suitable for conversion or adaptation. Early engagement on the inclusive design of new models with converters, adapters, users and other relevant stakeholders, e.g., engineering firms, will enable the automotive industry to agree on key principles.

Motability Operations is best placed to gather the industry's precise needs by having pre-existing relationships with many of these stakeholders, and work on this issue together with the Motability charity, which has a research and innovation function focused on disabled people's requirements and transport accessibility. As MO are the UK's biggest supplier of adapted and converted vehicles, they can also push for OEM engagement and support.

''Most of the accessible design features are really quite achievable. It's not like you're changing the whole product. Some in the EV industry and some in other industries just have to know how to provide a good user experience.''
Representative from a design & engineering company

As a starting point, Motability Operations and the charity should gather precise requirements for accessible design guidelines from its certified converter and adapter networks. While the charity has connections to design companies like Designability, which can contribute to the process with engineering expertise, Motability Operations can also make use of its network of dealerships. Motability Operations and the charity can work together to gather insights and feedback from the disabled people they serve, making sure that the disabled user is engaged in the process from an early stage. Going forward, Motability the charity should set up a working group in which to test design principles with users, who can represent a wide breadth of different disabilities, ensuring the guidelines are truly accessible.

Motability Operations could also engage with the wider specialist automotive industry to increase its influence through a collective approach. Conversations with interviewed industry stakeholders suggested it is likely that other industries that modify vehicles have similar design requirements for OEMs' base vehicles, so there is potential to develop joint design principles. The UK has the world's most diverse low volume and specialist vehicle sector.[110] Together MO and the charity can raise awareness of the considerable contribution provided by specialist and low volume manufacturers and the challenges they are facing. This will support a business case for why OEMs should adopt accessible design guidelines.

In addition, the Society of Motor Manufacturers and Traders (SMMT) is an influential partner that should be considered for the development and publication of accessible design principles. They not only have a wide reach within the automotive sector but have previously demonstrated an interest in the industry through the publication of a report on the UK's low volume and specialist vehicle manufacturers.[111] SMMT could act as a point of contact between the specialist automotive industry and OEMs. For example, they could support in sharing key accessible design principles with major OEMs that are taking part in their EV Technical Working Group,[112] ensuring that it reaches the right people.

5.3. Highlight the benefits of incorporating inclusive design and engagement into existing D&I, CSR and ESG strategies

All OEMs have been making positive strides in terms of CSR strategies and are increasingly motivated by a desire to have a positive impact. Likewise, most OEMs are increasingly aware of the need to embed D&I and strong ESG practices in their business.[113,114] Raising awareness of accessibility issues may not be enough to encourage OEMs to focus their CSR efforts on inclusive design. The positive impact of a strong CSR strategy on brand reputation cannot be underestimated, with growth opportunities available to OEMs that show leadership in this area. As there are currently no large OEMs with strong external D&I policies[115,116] and very few that explicitly reference increased accessibility for disabled consumers[117,118] as part of their CSR or ESG strategy, there is an opportunity for brand differentiation.

To help make the case for inclusive design elements as standard, Motability Operations could look to initially collaborate with OEMs that are already more engaged with the conversion and adaptation industry. For example, in 2019, Vauxhall launched a TV advert in collaboration with Motability to build awareness of the Motability Scheme.[119] Motability Operations could build on this collaboration with a new campaign, especially as this OEM is working closely with them and is making strides to strengthen its CSR and ESG strategies.[120]

A strong, external D&I strategy, promoted via a social media campaign, could lead to a more positive brand image, particularly for younger consumers, who hold significant purchasing power and place importance on consuming products they consider as ethical.[121] An example of where this has worked was the Motability charity's influencing for an accessible EV charging standard (PAS 1899):

''[The PAS 1899] generated lots of traction. There are people that are going out on the street and disabled EV users recording their experiences and putting onto social media and so there's yeah, people are talking about it.''
Representative from a design & engineering company

By promoting an enhanced CSR and D&I strategy, endorsed by Motability Operations and/or Motability the charity, OEMs will see the benefits in terms of greater brand recognition and positive associations with their brand. This in turn could help to promote inclusive design more broadly.

5.4. Build trust with a higher set of industry standards and regulations

This research highlighted that the electrification of vehicles and increased use of technology requires the conversion and adaptation sector to showcase a high technical and specialised skillset. Chief Executive Officer of the IMI, Steve Nash, stated that "the IMI would be deeply concerned if anyone believes the EV skills problem is not an immediate issue" and that " there is a need for continued professional development (CPD) in order to keep up to date with new technology".[122]

While upskilling of technicians is often talked about in the context of the maintenance and repair sector, an SMMT report from 2021 predicted that the specialist and low volume vehicle sector will need to upskill or reskill at least 43% of the workforce by 2030.[123] Given this high number, a lack of skills is evidently a major barrier for multiple sectors in the automotive industry. To advance the upskilling process, government funding is crucial to specifically supporting the conversion and adaptation industry, which in turn, will ensure that disabled people aren't any less safe in their vehicles than a non-disabled person. An official accreditation for adapters and converters could form nationwide standards and ensure the UK continues to be a lead development and manufacturing destination for WAVs and adapted vehicles within Europe.

While it is vital to ensure that the industry's workforce is maintaining a high standard as a whole, it is equally important for individual businesses to demonstrate quality management standards. This research highlights how a lack of legislation on post-registration adaptations and conversions leaves OEMs reluctant to share sensitive product information, particularly with adapters.

To reassure OEMs and improve levels of communication and collaboration, conversion and adaptation industry bodies should ensure their members have standardised – protocols, procedures and high-level quality management systems in place to meet industry standards such as ISO 9120[124] or the IATF 16 949.[125] This will build OEMs' confidence in industry practices. While both AVAM and WAVCA require members to obtain the ISO9001 Certification[126] they should continue to advocate and monitor the ongoing professional development of members and elevate standards where appropriate.

Overall, gaining official accreditation of high technical and specialised skills and business practices will improve trust and safety across the industry and is a starting point towards improving engagement with OEMs.

5.5. Greater engagement of UK bodies in EU working groups

As the adaptation and conversion industry is a small sector within larger OEM international markets, international legislation could be one of the most effective ways to influence OEMs. This should happen at the top political level to ensure OEMs acknowledge the adaptation and conversion sector in line with European regulations on inclusion.

''This is one of the bigger issues because everything has to happen on an international scale and UK doesn't really have the leverage by itself to change anything. […] It is a lack of involvement from the UK in other [European] bodies. And they will decide without us.''
Representative from a European organisation

Although the UK's conversion and adaptation market is one of the biggest in Europe, a representative from a European organisation stated that the UK is not sufficiently represented in key European bodies and committees. These bodies take actions and decisions on this industry, which means the UK is unable to influence any legislation. For example, the new Worldwide Harmonised Light Vehicle Test Procedure (WLTP) programme, does not recognise the specific accessibility needs of disabled people. It will be important for the UK's adaptation and conversion sector to joins forces with the wider industry, (e.g., the specialist automotive and repair and maintenance sector) at a national, as well as international, level to consider accessibility in new legislation.

''It really needs the might of politicians at the European level to set up post registration guidance involving the OEMs and national accreditation bodies to get together and recognise that drivers have different abilities.''
Representative from a European organisation

Ultimately, the majority of OEMs are based outside the UK and make decisions at a regional or global level.[127] While the engagement and influence of trade organisations like SMMT is strong on a national level within the automotive industry, it needs to be explored how UK bodies can have more impact on an international level.

European working groups, like the European Mobility group, attempt to highlight disabled consumers' needs and boost leverage by collaborating with European policymakers. It is important that the UK is represented in these working groups appropriately and in proportion to its significant market size to ensure disabled motorists are sufficiently considered when forming new legislation.

WAVCA previously influenced the EU and GB type approval schemes[128] and should expand its involvement in this area, together with AVAM. Also, representatives of the Motability Scheme, as the biggest provider of WAVs and adapted vehicles in the UK, could become an influential voice alongside UK Government officials. Together Motability and UK Government representatives could not only influence new EU regulations that will affect the UK market but also explore legal mechanisms, for example, to make information sharing a legal requirement for OEMs.

5.6. Use the ZEV mandate to incentivise the production of WAV base vehicles

To enable the transition to eWAVs, the continued supply of WAV base vehicles must be incentivised. One potential mechanism that could be utilised to guarantee supply is to offer more certificates for WAV base vehicles. This possibility was recognised by the Department for Transport (DfT) in the 'incentivisation longlist' produced as part of the ZEV Mandate consultation.[129] Through this project, Motability the charity and Energy Saving Trust had encouraging conversations with DfT regarding the design of the ZEV Mandate.

The number of additional ZEV mandate certificates should be decided in consultation with OEMs and converters. Additional WAV certificates could be divided between them to encourage greater collaboration. This would also allow converters to sell certificates as an additional revenue stream.

The DVLA registration process should be reviewed to see if a dedicated WAV marker could be added to the vehicle description to enable this ZEV mandate feature. This would make it simpler to implement multiple certificates and easier to track the development of the WAV market.

5.7. Strengthen the Plug-in Car Grant to support customers with higher upfront costs for EVs

In June 2022, the government announced that the Plug-in Car Grant (PiCG) would be closed owing to its diminishing impact.[130] The Government stated that they would instead focus on growing sub-sectors that had been slower to adopt EVs such as "vans, trucks, motorcycles and wheelchair accessible vehicles". Subsequently, £300 million in grant funding was made available for the sale of electric vans, taxis and motorcycles. It is important that WAVs and adapted vehicles are supported in a similar way.

A PiCG for WAVs has been retained, offering funds for 35% of the price of an eWAV conversion up to a max of £2,500 while the base vehicle must cost below £35,000. A total of 1,000 grants have been made available per year. However, take up is low.

Awareness of the PiCG scheme among disabled consumers is low, with over half of this research's survey respondents (51%) saying they were unaware of the PiCG scheme. Of those who were aware of the PiCG, 19% said the eligible cars were unsuitable for them and highlighted that it does not make the high upfront costs more affordable.

"I wasn't aware of it and possibly it didn't exist when I bought my car; plus, £2,500 is nothing compared to the total cost of a new vehicle so I wouldn't be able to afford it anyway."
User survey respondent

Based on conversations with the adaptation and conversion industry, in addition to insights into WAV users' perspectives through the user survey and case studies, it can be concluded that the scheme is too restrictive to drive the widespread adoption of eWAVs and support the industry. In order to boost take up and eWAV development, the following is recommended:

- Advertising the PiCG scheme more widely to drive engagement. Raising the cost cap for base vehicles to reflect typical EV base vehicle costs.
- Making the level of grant funding more generous to reflect the additional cost of adapting EVs .
- Making more grants available per year to reflect the number of WAVs being produced annually and the need to transition to electric mobility.
- Making suitable second-hand vehicles eligible under the scheme.
- Compelling OEMs of eligible base vehicles to list them as PiCG eligible. Currently no Ford, Fiat or Volkswagen vehicles are listed despite these OEMs producing some of the most popular base vehicles.

6. Conclusion

The proportion of EVs is growing in the UK and disabled drivers and passengers cannot be left behind in this important transition. It is therefore essential that research is conducted into the accessibility issues of EVs and requirements of disabled vehicle users.

This research has sought to identify and understand the range of EV accessibility issues disabled consumers face to help facilitate an equitable transition to EVs. Specifically, barriers to accessible EV design have been explored by identifying the needs of people with disabilities. It has also explored whether EVs are being built or modified to be 'accessible' for disabled consumers with a spotlight on WAV users as one subgroup of disabled motorists.

The research in this report was conducted using a combination of technical and policy desk research, user and industry surveys, interviews with industry experts and case studies with disabled consumers. This broad and deep research approach has delivered detailed and robust findings and recommendations and made a significant contribution to this under-researched subject of EV accessibility design for disabled consumers.

6.1. Research findings

The key global trend of increasingly complex electronically controlled vehicles highlights a lack of lack of engagement and consideration for their disables users' unique requirements to ensure a user-friendly experience. Further challenges exist for the conversion and adaptation industry, including the uncertainty about whether new technologies will affect the compatibility of their products.

The specific accessibility issues in EV design were found to be the placement of the battery and the charging socket. The inability to drill holes at the EV battery location is particularly challenging for the conversion of smaller vehicles to eWAVs, as the majority of them require cutting into rear parts of the vehicle to lower the floor.

The findings of this research provide a better understanding of the perspectives and relationships between different stakeholders. For the adaptation and conversion industry, a limited choice of suitable base vehicles, limited access to information from OEMs and legislation that doesn't consider the industry's unique needs can have a major impact on its capacity to produce accessible vehicles.

This report proposes several solutions to influence global OEMs to consider accessible and inclusive vehicle design. The main recommendation for Motability the charity and Motability Operations is to actively promote greater engagement with WAV converters, adapters and OEMS, helping to foster meaningful business relationships. Other recommendations for the whole industry are to collaboratively develop accessible design guidelines and strive for a higher set of industry standards, fostering trust and introducing a solution-orientated approach.

This report makes the following recommendations for the UK Government regarding the WAV adaptation and conversion markets during the UK's transition to EVs:

1. To incentivise the production of WAV base vehicles with help of the ZEV mandate.
2. To strengthen the Plug-In Car Grant to support customers' uptake of eWAVs.

6.2. Limitations

The chosen methodologies and scope of this report bring some limitations to the research.

Due to the original nature of this research, some sections were built largely on the data collected through in-depth interviews because existing literature on barriers to accessible vehicle design is sparse. The findings in Chapters 3 and 4, in particular, were significantly influenced by these interviews. While the findings in Chapter 3 on accessible EVs can be partly supported with additional sources, Chapter 4 relies mainly on the collected interview data. The reliance on interview data, together with a lack of reliable literature and research on this topic, results in several limitations that will have an impact on the validity of the findings.

Firstly, the intention of the interviews was to establish each industry's perspective through the lens of their representatives. However, these perspectives will inevitably be limited given the views of only a single or small number of industry representatives were recorded. This will also be dependent on the seniority of the representative and their knowledge of their industry and the subject matter of this report.

Secondly, the amount of qualitative data that could be collected was restricted by the time limit imposed on the interviews, which were set for up to 60 minutes. Due to the number of research questions addressed in this work, the interviews were highly structured and focused on these areas to make efficient use of time. Consequently, conversations might have missed additional insights and contributing findings.

The validity of the research findings is further limited by the relatively small sample size of interview participants and the possible biases of interviewees given their specific industry and relationships with other industries as highlighted by this report.

A further limitation is the sample size and method of the user survey, which solely gathered responses from WAV users. Therefore, finding do not reflect the perspective of the wider population and are not representative of all disabled people.

6.3. Next steps/future work

This report provides original insight into the barriers to accessible EV design. A range of topics have been explored in this research which serve as a foundation for future work to address any gaps and expand on the findings.

The following recommendations suggest further research that can be carried out to complement and strengthen the results of this report.

1. Extensive user research on accessibility barriers within vehicle design.

While this report engaged with disabled WAV users to identify barriers to the uptake of eWAVs, it is crucial to engage with a wider range of disabled consumers to capture their full perspectives. Extensive user engagement is vital to identify specific vehicle design barriers, rather than viewing the conversion and adaptation industries' barriers in isolation. This is key in ensuring that any potential design guidelines are truly accessible.

2. Exploration of commonalities with the wider automotive specialist industry.

As touched on in this report, the wider automotive specialist industry, such as the maintenance and repair sector, has some mutual interest with the adaptation and conversion industry. It is beneficial to identify how their common goals align and to explore areas where collaboration is possible to unify their voices. This would add leverage to any proposed changes or demands.

3. Exploration of OEMs' perspectives and decision-making.

Further research can focus on capturing OEMs' perspectives on accessible design, delving deeper into vehicle development and decision-making progresses. By aiming to understand the full picture of national and global factors that influence OEMs, such research can add the necessary depth to gain a better understanding of their way of operating and identify areas for action, e.g., concerning D&I policies.

4. Engagement with UK Government.

The role that UK Government should adopt to support accessible EV design needs to be explored further by identifying opportunities where their support is needed the most and would be realistically achievable. This could also include the exploration of internal government and European bodies and committees that are working on relevant legislation.

5. Exploration of OEMs motivators in relation to positive D&I, CSR, and ESG practices.

Further research into the motivations behind the incorporation of positive D&I, CSR, ESG practices by OEMs could provide valuable insight into the underlying drivers shaping the industry. A deeper understanding of the motivations behind these efforts could be used to inform Motability the charity and other stakeholders as they seek to engage with the industry. Such research could provide valuable guidance for stakeholders as they work to promote the growth and development of a more responsible and sustainable automotive industry.

Footnotes

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