COMPETITION: Electric vehicle charging for public spaces: real-world demonstrators

PROJECT TITLE

Scaling On-Street Charging Infrastructure (SOSCI) Project No: 34290

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'Stage 3 Report -– Guidance for Designers and Manufacturers'

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1. INTRODUCTION

This report is one of a series prepared under the SOSCI project.

This project for development of guidance standards for EV charging facilities is supported by funding from OZEV via Innovate UK, and forms part of the Scaling On-Street Charging Infrastructure (SOSCI) project led by Cybermoor Services Ltd.

This report, and all others, has been prepared by Access Consultancy Support.

1.1. Introduction to Stage 3

The overall aim of this report is to inform designers of current issues affecting user access to public charging facilities, and the considerations needed to address these as far as possible, as well as to inform further discussions on the accessibility of electric vehicles and public charging infrastructure.

A review of elements and features associated with EV charging commenced with the required space standards, which were produced from guidance obtained from BS 8300:2018 and with reference to Department for Transport research. The outcomes formed the basis for our Stage 1 Report.

Stage 2 considered best practice requirements for inclusive access to EV charging devices for current and future installations and investigated EV charging device accessibility for people with mobility impairments. Principally, this involved the proposed relationship between charging device and bollard protection in addition to accessible heights and zones for inclusive interaction with charging devices by persons standing and seated.

A one-day user trial was held involving participants with impairments who were interested in the potential of using an electric vehicle with public charging facilities. The outcomes of the user trial have been used to inform and update both Stage 2 and Stage 3.

Stage 3 discusses the issues that may require further consideration by designers and manufacturers in regard to current concerns for user accessibility, standardisation and consistency across all future charging devices to enable:

- ease of recognition of chargepoint status
- ease of connection
- the start and end of a charging session
- a simplified and accessible user experience

It is hoped that the information provided herein, along with the responding recommendations, will assist with informing and empowering designers and manufacturers to have greater awareness of the issues and the implications of their design and manufacturing decisions.

1.2. Executive Summary

The user trial had a significant impact on our original determinations. The trial was arranged to provide an opportunity to test the project's Stage 2 proposals on charging device reach height, interactive zone height and protection bollards arrangement relative to the charging device location for inclusive accessibility. In direct response to local consultation, a non-operational, mock-up charging device was also used to test current Stage 2 proposals for charging socket height and protection bollard arrangement.

The user trial identified significant challenges experienced by participants with impairments when attempting to charge an electric vehicle. The tasks involved in the trial were as follows:

- Managing and moving around with a charging cable
- Accessing chargepoint beyond protective bollards

- Viewing and reading printed information on chargepoint use
- Reading screen displays
- Inserting cable past socket flap and extracting cable

Many participants appeared to be unfamiliar with the smart-card reader logo on the charging devices, but once they were aware of it there was no issue with reaching to use this.

The outcomes of the user trial are expected to have potential importance in identifying the future needs for the design and use of EV charging devices as well as the ancillary facilities required to support ease of access and use for all potential users. The trial also confirmed the Stage 1 and 2 proposals for charging bay access aisle requirements to connect a cable between vehicle and chargepoint.

The outcomes also appear to indicate an urgent need for improvement in both the design and the technology of Electric Vehicles and EV charging equipment. The following report sections therefore provide a review of the user trial data and observations and recommendations that are considered to be relevant to the design and use of EV charging devices.

It was not possible to identify a single height display from the results for persons standing and seated. The disparity in the data between the results for wheelchair users and ambulant disabled persons suggests it is unlikely a single display screen height will best accommodate the needs of all users.

Recommendations include minimising the requirement for information to be visually displayed on screen to that of a simple meter to identify cost and charging status and / or estimated duration of battery charging. Guidance in BS8300:2018[1] advises that meters should be mounted between 1200 mm and 1400mm from the floor (or ground) so that the readings can be viewed by a person standing or sitting.

Section 3.2 of this report reflects on age and impairment related issues and Section 4 considers potential for simplification and standardisation: for ease of recognition of chargepoint operational status; interaction with chargepoint networks; user experience of the EV charging process; with the proposed involvement of manufacturers of EVs and EV charging equipment.

Government support is also advocated to encourage such development to be progressed in the UK, Europe and other countries supplying Europe and the UK, on the basis of inclusive / universal design, in recognition of: the urgent requirement to improve ease of use and accessibility of electric vehicles and EV charging facilities, for UK consumers and their own populations; and that many such countries have ageing populations who are likely to experience impairments that many disabled persons are already experiencing here in the UK.

Throughout the report there are a series of Recommendations (**R XX**), and Section 5 includes a complete of all recommendations.

2. PROJECT STAGE 3 DEVELOPMENT

Stage 3 discusses the issues that may require further consideration by designers and manufacturers to address current concerns for user accessibility, standardisation, and consistency across all future charging devices: to aid ease of recognition of chargepoint status; ease of connection and enabling the start and end of a charging session; for a simplified and accessible user experience.

The outcomes of the user trial have potential importance in identifying the future needs for the design and use of EV charging devices as well as the ancillary facilities required to support ease of access and use for all

[1] BS 8300-2:2018 Design of an accessible and inclusive built environment: Part 2 Buildings – Code of practice, 15.7.2: Location of outlets, switches, controls and meters

potential users. The following report section therefore provides a review of the user trial data and observations that are considered to be relevant to the design and use of EV charging devices.

2.1. User Trial Data Review

The following review aims to provide an overview of relevant User Trial results and outcomes, and discusses the data collected from the participants, with consideration of their comments in feedback during the trial tasks and observations of their activities during the event.

Recommendations listed in this report include some recommendations from the User Trial Report, as well as additional recommendations, that are considered to be relevant to the design and use of existing EV charging devices and considerations for their future improvement and development to support accessibility for all potential users.

Thirteen sets of data were collected from the participants who included: one person identifying as non-disabled, six sets include four manual wheelchair users and two powered wheelchair users, and the other six sets were for ambulant impaired persons including two using elbow crutches and one person with impaired sight who carried a white cane and reportedly has use of a guide dog, but he expected to assist in connecting a vehicle driven by his wife to a chargepoint if they had an electric vehicle.

The four user trial tasks involved cable connections at:

1. Electric vehicle with a power inlet socket centre-line height of 860mm
2. Alfen Eve Proline Single Socket unit (operational) - 940mm height socket
3. Alfen Proline Double-Socket unit (operational) - 1065mm height sockets.
4. Alfen Eve Proline Single Socket unit (mock-up) - 850mm height socket

All heights refer to socket centre-line height above the vehicle bay level, with level access available between charging devices and vehicle bays.

2.1.1. Bay and Cable Use

Individuals were asked to obtain the charging cable from the boot of a vehicle and then connect the cable between the vehicle and charging device. Participants were observed during the task and the space they each required to perform this task in the aisle adjacent to the vehicle. As expected, side aisle width of 1200mm was adequate for the majority of users, other than the two powered wheelchair users who required wider turning space when manoeuvring to connect and disconnect the cable at side of vehicle.

None of the participants required more than 1500mm aisle width during this task at side of the vehicle. However, based on the existing published research data in BS8300-2:2018[2], we continue to advise a preferred 1600mm-wide side aisle width, and a minimum width of 1500mm where existing space constraints impact on increased provision.

The overall results for all activities associated with this task was below 80% success, for the participants' experience of using a cable to connect between a vehicle and chargepoint, indicating that charging an electric vehicle with the current equipment available is likely to be problematic for most drivers with impairments. This outcome suggests there is an urgent need for improvement in both the design and the technology of Electric Vehicles and EV charging equipment. Such issues are considered further in chapters 5.0 and 6.0 of this report.

[2] BS 8300-2:2018 Design of an accessible and inclusive built environment: Part 2 Buildings – Code of practice, Annex G Space allowances for wheelchair manoeuvring and Tables G.2 and G8 - Dimensions associated with occupied space when stationary and turning 90-degrees.

2.1.2. Charging Cables

It was evident from the data that use of a cable and interaction with a vehicle and charging device is heavily reliant on an individual's ability and capacity. The results may also be influenced to some degree by the disposition of an individual and how they manage their impairment, particularly when faced with new or unfamiliar tasks, as in this trial event.

Figure 1: Participant with cable in Task 1 monitoring space at side of vehicle

Many participants had some problem with the cable, either to remove the dust cover from the plug end, moving with the cable, or when trying to re-coil the cable after use. Crutch users in particular had problems moving around with the cable.

In expectation of some of these issues, we initially advised in the earlier Stage 2 Report the provision of a cable rest to enable chargepoint users to lay the cable down at or adjacent to the chargepoint, to help with their management of the cable, whilst positioning themselves appropriately to interact with the chargepoint; as well as aiding them to maintain the cable clear from being an obstruction. However, following the user trial it became evident that provision of a cable rest should be incorporated within the charging device design or its mounting, within an appropriate height range to be accessible by persons standing and seated.

Where it is possible to do so, the weight of a cable should be as light as is absolutely necessary to satisfy its required electrical duty and safety regulations.

R1. Provision of a cable rest / holder on the chargepoint at a height between 750mm and 1000mm above the Centre Aisle surface

R2. Where it is possible to do so, the weight of a cable should be as light as is absolutely necessary to satisfy its required electrical duty and safety regulations, and consideration should also be given to other factors, including cable storage, care of cable, and the ease of removing and fitting dust caps.

2.1.3. Chargepoint Sockets Use

The process of lifting the socket-flap before inserting the plug, presented an issue for some individuals, including some ambulant disabled participants and some wheelchair users at one or more of the

chargepoints. The primary cause for this appears to be the inability to engage with the lower element of the flap in order to raise it and insert a plug.

We recommend further consideration should be given to increase the projection of the lower portion of the flap to provide a 'lip or tab' which may afford easier engagement with the flap for people with limited manual dexterity.

When all 13 sets of results are included for all participants (including one ambulant non-disabled participant), for scoring the task elements of lifting the charging socket cover flap, inserting the cable and removing the cable, there is a clear indication of an overall preference for the 940mm centreline height of socket for 'cover-flap and socket use'.

Generally, inserting the plug at a height of 940mm did not present with much of an issue for all but a few participants, however, for some the effort required to withdraw the plug from the unit was more problematic. Elbow-crutch users found the effort required to extract a plug from the charging device – with a sudden release – could be hazardous, risking their loss of balance and a potential fall, which would be a greater concern when conditions are slippery underfoot.

While we appreciate the necessity to ensure the plug is firmly engaged, further investigation and review of the issue should be considered to reduce the force required for both insertion and extraction of the cable plug.

An additional comment was received concerning the limited separation distance between the two sockets on the 1065mm height socket device, where a crutch user struggled to insert the cable plug with a two-handed grip when the adjacent sockets already had a plug in the outlet, which caused problematic access for this participant. A powered wheelchair user with impaired dexterity and reach was observed to also have this problem, and was unable to insert the plug even after they were assisted to lift the flap. After been given assistance to insert the plug, they were also unable to remove the plug, due to not being able to adequately grip the plug with the adjacent socket in use.

Figure 2: Participant with elbow crutches at 1065mm height socket device during task 3.

It is important to understand that the ease of insertion and removal of the plug from the socket is also affected by the socket's height above ground level. Also, the process of lifting the socket-flap before inserting the plug, presented an issue for some participants: this included some ambulant persons and wheelchair users with reach and manual dexterity limitations. The primary cause appeared to be an inability

to adequately engage with the lower element of the flap to raise it and insert the plug. This action was required to be achieved using only one hand by several ambulant and wheelchair user participants, due to their individual reach and / or dexterity limitations.

Results based on Impairment groups for the flap and socket use:

Socket Height above ground (mm)	Wheelchair Users Ave. Score	Percentage Score	Ambulant Disabled Ave. Score	Percentage Score
850	4.33	86.7%	3.75	75.0%
940	4.06	81.1%	4.33	86.7%
1065	3.56	71.1%	3.64	72.8%

However, when results for the non-disabled participant are discounted, and only the cumulative results considered for the two impairment groups of six wheelchair users and six ambulant participants with impairments, the difference in preference for ease of use for the three associated acts, appears to confirm a definitive split between the two groups; with the 850mm socket-height preferred by wheelchair users and the 940mm socket-height preferred by the ambulant impaired persons; as demonstrated in above table.

The results also indicate that chargepoints with a socket height above 940mm are less likely to provide an appropriate solution for persons with impairments affecting their mobility, strength, or dexterity; some of which are recognised impairment issues experienced by many people with ageing.

It has therefore been concluded that if an optimum chargepoint socket height exists, for all potential chargepoint users including those who are in wheelchairs or ambulant with impairments; it is likely that the height would be between 850mm and 940mm above the ground or floor level from where the chargepoint was accessed. On this basis, along with the previously documented review and consideration of published reach height data and advised standards in BS8300:2018, a standard socket height of 900mm above the charging bay level is proposed to provide inclusive access.

R3. Consider increasing the projection of the lower portion of the socket flap to provide a more pronounced ‘lip or tab’ which may afford easier engagement with the flap for people with limited manual dexterity.

R4. An optimum chargepoint socket height is proposed at 900mm above the surface from where the chargepoint is accessed, so as to be accessible by the majority of users.

R5. Further research and investigation is advised by charging socket designers to identify solutions to aid the ease of physical insertion and removal of the cable plug connection at chargepoints, which may also be an issue requiring consideration for electric vehicle development generally. Note: Although this report is based on charging devices with type 2 Mennekes socket connections, it should be recognised that similar issues may or may not be experienced with different charging socket types or devices.

R6. Appropriate separation distance is required between adjacent sockets on double-socket charging devices, so that there is adequate clearance for a two-handed grip around the cable plug when inserting and removing the cable connection. This may also benefit users with upper body prosthetics, as well as others with impaired dexterity and strength limitations, and potentially benefit many older persons.

2.1.4. Display Screens

Across the range of the results for all individuals who took part in the trial, almost all those with impairments experienced problems with legibility of the operational display screens; irrespective of their eye level. If we consider all six wheelchair users responses and all six ambulant disabled users' responses for the screens, we obtain the results in the table below.

Screen Information Cumulative Scores by Impairment Group:

Socket Height	Screen Top Height	Wheelchair Users Score out of 30	Ambulant Disabled Score out of 30
850	1030	28.5	13
940	1120	22	11
1065	1315	14	12

Perhaps not surprisingly the wheelchair users preferred the lowest screen height, although this was not operational and could therefore not be judged on ease of reading the display. However, if only the results for the two operational units are considered, it is clear that the lower height display was preferred by the wheelchair users; even though it had a smaller size display. Also by comparison with the overall scores for the three unit heights by the ambulant impaired participants, their scores were considerably lower overall than those for wheelchair users: this appears to indicate that the height of each of the devices with operational displays were too low for their ease of viewing as well as being difficult to read.

On this basis, and that it has not been possible to identify a single optimum height display for persons standing and seated from the results, we advise minimising the requirement for information to be visually displayed on a screen to that of a simple meter; to identify cost and charging status and / or estimated duration of battery charging. Guidance in BS8300:2018[3] advises that meters should be mounted between 1200mm and 1400mm above floor or ground, so that readings can be viewed by persons standing or seated.

[3] BS 8300-2:2018 Design of an accessible and inclusive built environment: Part 2 Buildings – Code of practice, 15.7.2: Location of outlets, switches, controls and meters

Figure 3: Task 3 Chargepoint with 1065mm socket-height with visible screen reflections

In brief, the reported comments relating to use of charging devices overwhelmingly centred on poor background to text, icon contrast, and small font size for both screen sizes. Issue of glare and reflection also reportedly served to exacerbate legibility issues.

Most participants experienced problematic legibility caused by reflection and/or screen display contrast. Reflections were likely a result of angle of viewing as well as the ambient light level, which was generally high throughout the event, and to portions of a participant's own image being reflected. Although the results for screen height and size may not be conclusive, if we also take account of participants' comments, it becomes more evident that the height and size of screen was a lesser issue than screen legibility.

2.1.5. Consideration of Display Screen Information

The disparity in the data between the results for wheelchair users and ambulant disabled persons, as indicated in the table above, suggests that it is unlikely that a single display screen height will best accommodate the needs of all users.

Small display screens similar to those on the devices in this trial, when located at a height suitable for ambulant persons are unlikely to be suitable for wheelchair users and persons of short or very large stature.

Where screens are a requirement they should either be so large that they can be easily read from a distance by all potential users, and in all lighting conditions, by persons when standing and seated; or provided at two heights and located so as to allow close approach by ambulant persons and wheelchair users who require knee clearance to facilitate such an approach.

However, it may be possible to satisfy such disparate user needs by limiting the information and making the display as easy to read as possible.

After accessing a chargepoint location the information that a user may require from current public installations is likely to include:

a. How to use the charging device
b. The cost per kWh

c. How long it will take to charge their vehicle to say half or fully charged.

Where information screens are to remain in use, we suggest these utilise anti-glare properties to reduce or obviate reflection; with high-contrast LED text and iconography where it is appropriate to do so. Font size should be as large as practicable to enable reading from a reasonable distance, and text should have good colour contrast against its background.

Recommendations in regard to chargepoint displays for best practice and ease of use are provided below. Further consideration of chargepoint displays and the potential to minimise the information required to enable use of chargepoints is further discussed in Chapter 6.0 of this report.

Where screens are to remain in service the following should be considered:

R7. Minimising the fixed and dynamic variables in the display of information required can simplify the display to such as:

Fixed Display	Variable Information
Cost per kWh (£)	(Digital value)
Estimated full-charge time (Hrs and Mins)	(Digital values)
Cost of charge(£)	(Digital value)

R8. Minimising the amount of information in the display makes it easier and less time consuming for users to obtain the information they are likely to readily need.

R9. On this basis the display functions as a meter. Although the data indicates that one height does not necessarily satisfy all user needs, minimising the display information and providing high contrast easily legible displays, may be adequate for most users. Referring to BS8300:2018[4]: meters should be mounted between 1200 mm and 1400mm from the floor (or ground) so that the readings can be viewed by a person standing or sitting.

R10. Best practice guidance for sign design should be applied to the screen display design as well as any permanent printed information associated with the chargepoint and charging facility location; i.e. including:

- Minimum size of text for viewing display from short distance, should be as large as the screen display will allow and be equivalent to an x-height (lower case ‘x’ character height) of between 15mm and 25mm;
- Use any sans serif typeface (commonly used include Helvetica, Arial, Futura, Avant Garde);
- Where space permits, symbol should be at least 100mm in overall height;
- Letters, symbols and pictograms should contrast visually with the display background;
- Light coloured text and symbols or pictograms on a dark background are preferred.
- A difference in LRV (Light Reflectance Value) of 70 points between the letters, symbols or pictograms and the display background, can ensure good visual contrast.

R11. Anti-glare screen should be used to reduce or remove reflections: this applies to the display screen and any outer cover protecting the display.

R12. Provide high-contrast screens using good colour contrast for text and any symbol when viewed against the background.

R13. Where screens are a requirement at the chargepoint they should either be: -

[4] BS 8300-2:2018 Design of an accessible and inclusive built environment: Part 2 Buildings – Code of practice, 15.7.2: Location of outlets, switches, controls and meters

a. Large enough to be easily read from a distance by all potential users, and in all lighting conditions, by persons when standing and seated; or
b. Provided at two heights and located so as to allow close approach by ambulant persons and by wheelchair users who require knee clearance to facilitate such close approach.

R14. Where screens are a requirement:

a. Any such screen should utilise high contrast LEDs to be readable in all lighting conditions in external uncovered environments as well as internal or covered environments.
b. Where display screens are to be provided / required, improvements should give consideration to the display screen specification parameters including size of screen, quality of display, brightness and contrast between screen characters and background, text format and height, and use of non-reflective display and outer cover screens.

R15. Where display screens are necessitated on any chargepoint device, we advise further research is required to identify the optimum solution for the size and height of display screens to accommodate the viewing needs of wheelchair users and ambulant users, including persons of short or large stature.

R16. Where a display screen is recessed from the face of the device, it is important to ensure the viewing angle and therefore the visibility of the display is not diminished for persons standing or seated.

2.1.6. Printed Information on Charging Devices

Most participants had some difficulty reading the printed information on the two operational charging devices, with overall scoring of 67.7% for the 940mm socket-height device and 69.2% for the 1065mm socket-height device with larger print size, but its location on the side caused issues for viewing and recognition, as some participants had to be told to look on the side.

The single socket unit with printed information located on the front face was preferred, however, several negative comments were received, including one which said there was “too much going on”. In general, individuals preferred the printed information to be located on the front of the unit, which obviates any confusion with its location and assists with accessibility. The font size was also problematic for some individuals to read and requires further consideration with regard to increasing font size and reducing the amount of text used.

Several individuals were required to withdraw from the double socket unit and manoeuvre around to the side in order to access the information. One comment was received which outlined that although the printed information had a reasonable font size, the instructions were quite verbose.

Printed information on front of single socket device used in Task 1 and Task 2

Larger print on side of the larger double socket device

Figure 4: Printed Information on Device

Figure 5: Task 3 participant reviewing printed information at 1065mm height socket device

2.1.7. Complementary and Audible Information

Consideration should be given to the use of charging facilities by persons who have limited reading skills, or for whom English may not be a first language: this may need to be in the form of printed information in other language(s) appropriate to the local demographics, or possibly via recorded audio information or a dedicated telephone contact.

Also for persons with impaired hearing, a number of different wireless devices are available for transmitting information to be received by a hearing-aid wearer. Because these systems reduce the number of audible announcements produced, noise nuisance is reduced. Invasive audible announcements can be stressful for hearing aid users who rely on additional visual support such as lip reading to understand a message.

R17. The necessity to provide lengthy instructions on use of charging devices for those unfamiliar with the procedure should be avoided whenever possible.

R18. Best practice guidance for sign design (as referred to in recommendations at 2.4.1, R10 above) should be applied to any permanent printed information associated with the chargepoint and charging facility location.

R19. Consider simplifying the charging process to enable a reduced requirement for printed instruction on chargepoint use.

R20. Consideration should be given to alternative means of providing information on chargepoint use for persons who have limited reading skills, or for who English may not be a first language; possibly including electronic information in easy-read format, and / or audible recordings.

R21. Consider provision of recorded information, to be available to persons with impaired hearing who can receive speech via hearing aids equipped with a T-coil.

2.1.8. Communication with Chargepoint Network

The MER chargepoint network currently supports user access and control of the chargepoint function either by means of a smartphone app or smartcard use with the charging device sensor, identified by a '  ' Wi-Fi symbol as pictured in the images for the double and single socket charging devices.

The user trial did not include participant experience of the MER App for smart devices, as this was not possible within the time constraints for the one-day trial event; and there was no certainty that all participants would either have possession of, or be familiar with the use of, smartphones or such device applications.

The results of the trial indicate that none of the participants had any issues reaching to use the smart card reader function, once they were told the location was the symbol on the black panel under the display screen.

The results therefore appear to support the proposed zone for the location of such smart sensing provision between the heights of 750mm and 1200mm, which compares with the UK standard accessibility guidance for reach height to light switches and other permanently wired switches in buildings.

Alternatives for user communication with the chargepoint network require consideration to facilitate access and control of the charging function by persons without the necessary smart card or smart phone technology. This issue is considered later in this report in Chapter 5.0.

R22. Access to the chargepoint network should be simplified to enable access without the need for internet or Wi-Fi access, such that a PAYG service is available to anyone with a recognised Debit or Credit Card.

R23. An optimum chargepoint Card Reader sensor height is proposed directly above the charging socket and clear of any socket flap when open, so as to be accessible by all potential users. However where this is not possible, the location of the sensor should be within a height of 750mm to 1200mm above the surface from where it is accessed, i.e. the vehicle bay level, to be accessible to all potential users.

R24. Card reader sensing location should be readily recognisable by use of a standard icon that is preferably internationally recognised.

3. APPLICATION OF OUTCOMES FROM USER TRIAL REVIEW

The outcomes in regard to inclusive design for user interaction height with chargepoints on future installation of EV charging equipment, and the design of charging equipment of the type considered in this project, are summarised below and discussed further within this report to develop improved guidance for EV chargepoint designers and manufacturers.

3.1. Chargepoint Reach and Viewing Heights

Following the review of the results from the user trial event data, including the event observation, the following diagram demonstrates the proposed revisions to accessible and inclusive reach heights at EV chargepoints for persons standing and seated.

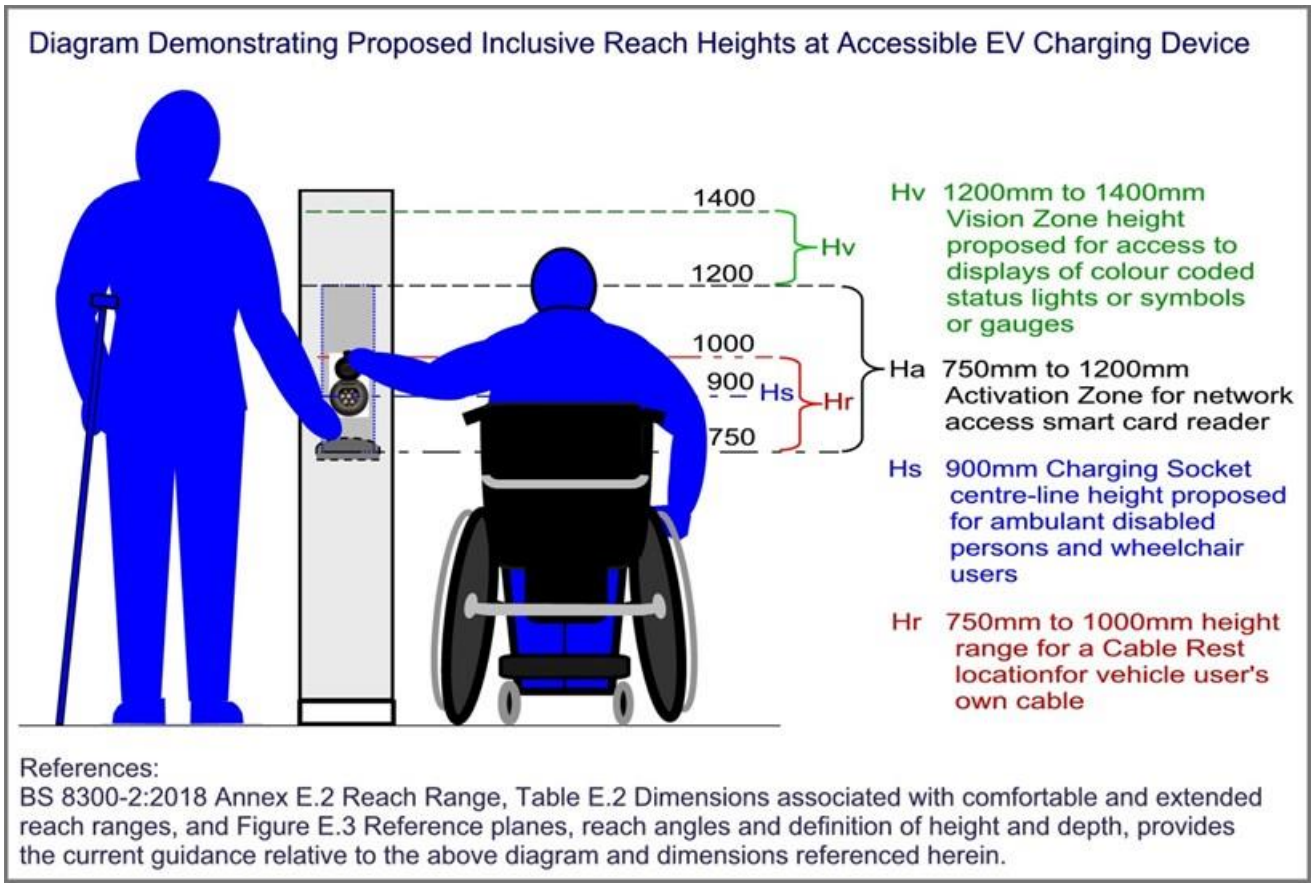

Figure 6: Above diagram illustrates the proposed inclusive reach heights and zones

As previously mentioned, many participants had some problem with the cable, either to remove the dust cover from the plug end, moving with the cable, or when trying to re-coil the cable after use. Crutch users in particular had problems moving around with the cable. In response to the issues we initially advised in the earlier Stage 2 Report the provision of a cable rest to enable chargepoint users to lay the cable down at or adjacent to the chargepoint, to help with their management of the cable, whilst positioning themselves appropriately to interact with the chargepoint, as well as aiding them to maintain the cable clear from being an obstruction. However, following the user trial it was clear that provision of a cable rest should be incorporated within the charging device design or its mounting.

The following listed chargepoint features assumes use of two single-socket charging devices or one double-socket charging device, with the interactive features of the chargepoint located as demonstrated in the above diagram:

1. Charging Unit(s) mounted on same level as vehicle bays' surface with their location centred on the longitudinal centreline of the Centre Access Aisle shared by two adjacent charging bays, and as close as possible to the head of the aisle.
2. Charging device sockets centreline height to be located at preferred height of 900mm above the Centre Aisle surface (Hs in above diagram).
3. Any display of visual information for chargepoint status should be located between 1200mm and 1400mm above the Centre Aisle surface
(Hv in above diagram).
4. Smart card activation sensor and / or QR Code where provided, should be located between 750mm and 1200mm above the Centre Aisle surface
(Ha in above diagram).
5. Provision of a cable rest / holder on the chargepoint at a height between 750mm and 1000mm above the Centre Aisle surface
(Hr in above diagram).

3.2. Implications of Age and Impairments

The following information was recorded anonymously for fourteen individuals who attended the user trial event, of which thirteen took part in the full event, resulting in thirteen full sets of trial data.

Participants identifying as:			Age Group			Age Group	
Male	12		Under 18	0		45-54	4
Female	2		18-24	0		55-64	2
Disabled	12		25-34	1		65-74	4
Not disabled	2		35-44	1		75+	2

The large majority of participants, eleven persons (84.6%) were over the age of 45-years and identified themselves as disabled. There was only one of the 13 participant who identified themselves as a non-disabled person (i.e. not a person having a long-standing illness, disability or infirmity which has a substantial effect on their day-to-day life, where longstanding means it has lasted, or is likely to last, for over a year).

Assuming the age range of the event attendees to be fairly representative of the UK age groups most likely to either already have an EV, or are considering having an electric vehicle as their primary means of personal transport, then it is also important to consider the implications of age and impairment on the results and implications for future EVs and Chargepoint development.

3.2.1. Impairment Groups and Implications for Chargepoint Use

Though not attending as a group, the User Trial Report compares the results for the six ambulant persons with impairments with the results for the six wheelchair users; which would seem a logical approach given that a principal aim was to consider chargepoint users reach requirements that could potentially satisfy persons of different stature, i.e. when standing or seated.

Common issues experienced, to varying degrees by individual participants within both impairment groups, included impairments that affect an individual's strength or stamina, mobility, dexterity and reduced eyesight perception; all of which are also recognised as common issues experienced with ageing.

It is well recognised that an individual's cognition potential can also reduce with age by varying degrees, making it more difficult to understand and take on new knowledge and skills. Therefore, ageing is likely to be an inevitable factor that may influence an individual's ability and experience of new or less familiar tasks; such as the tasks experienced by participants during the event.

3.2.2. Viewing Screens and Printed Information

Several participants including ambulant persons and wheelchair users were observed to wear spectacles or stated they had spectacles for reading. One person said they could not read chargepoint screen displays because they did not have their reading glasses. Another participant commented they found it difficult to read the display wearing their bifocal lenses. So it is clear that several participants would be reliant on having the appropriate spectacle lenses in order to use chargepoints with visual displays and printed text of the type experienced during the trial event. The majority of participants had some issues with regard to the viewing height or location of displays and /or printed information.

3.2.3. Chargepoint User Support for Interaction

Further issues observed during the trial event included the difficulty experienced by ambulant persons with impaired mobility trying to maintain their standing position and stability whilst attempting to interact with the charging device, including inserting and removing the cable connection. Those who were possibly most at risk of falling during such procedures were the two crutch users, one of whom was observed to physically lean against the chargepoints, either to steady themself or to briefly rest before moving on; which was possibly a further issue for them in regard to their use of the lower height chargepoints being more problematic to view and to use, and their lower scoring for the two lower height charging devices.

In a similar fashion some wheelchair users were observed to utilise either an adjacent bollard or the chargepoint as a leaning post, to steady themselves when reaching to interact with the two operational chargepoints.

Consideration should therefore be given to the needs of individuals who, when standing or seated, need to be able to steady themselves while interacting with the charging device.

3.2.4. Cable Management

Many participants also had some problem with the cable, either to remove the dust cover from the plug end, moving with the cable, or when trying to
re-coil the cable after use. Crutch users in particular had problems moving around with the cable.

Participants with mobility and / or dexterity issues also had issues with coiling the cable after use, to be able to store it back into the vehicle. One person attending commented that it would be helpful if the cable was permanently connected to the vehicle, to be pulled out to connect for charging and mechanically recoiled after use, similar to many vacuum cleaners in current use: an issue that had previously been voiced during other consultations on EV charging provision.

In response to the above issues, we initially advised in the earlier Stage 2 Report the provision of a cable rest to enable chargepoint users to lay the cable down at or adjacent to the chargepoint, to help with their management of the cable, whilst positioning themselves appropriately to interact with the chargepoint, as well as aiding them to maintain the cable clear from being an obstruction. However, following the user trial

it is clear that provision of a cable rest should be incorporated within the charging device design or its mounting.

3.2.5. Design and Manufacturing Implications

If we apply the above assumption of the participant group as a whole being fairly representative of those persons in the UK, who would most likely have an EV or be considering getting one, then issues of ageing and impairment should be recognised as having considerable importance for EV designers and charging infrastructure providers. With a population tendency to live longer, there is an increasing likelihood of a significant proportion of drivers having some form of impairment that may affect their day-to-day life, and their use of private and public transport; with implications for the accessibility of electric vehicle use and charging infrastructure.

However, given the current limitations such consumers have to availability of adequately accessible EVs, suitably designed to satisfy their needs and expectations, and EV charging infrastructure that supports their ease of use, there appears to be some very realistic negative implications for the UK's proposed timeline for transition from combustion engines vehicles.

Government support is advised to encourage all manufacturers involved in the supply of electric vehicles in the UK, Europe and other countries supplying Europe and the UK, to recognise the urgent requirement to improve the ease of use and accessibility of electric vehicles and EV charging facilities for the UK's consumers and their own populations.

In many countries there exists the potential for living longer and experiencing impairments through ageing that many disabled persons are already experiencing, and as such there needs to be a more inclusive approach to design, instead of the current vehicle market models that appear to be based on perceptions of the desires of the driver, family, activity, or their status, for marketing purposes. This issue of inclusive design is relevant to vehicles and charging infrastructure accessibility as discussed further in this report.

R25. EV charging equipment designers and manufacturers should give consideration to enabling the chargepoint to be used as a hand-hold and rest-post / leaning-post for persons to steady themselves when interacting with the chargepoint, including while inserting and extracting a cable connection.

R25. EV charging equipment designers and manufacturers should give consideration to provision of a cable rest at the chargepoint either as part of the charging device or its mounting post to improve cable management, minimise obstruction to charging device by any trailing cable, and to enable chargepoint users to safely lay the cable down whilst they interact with the chargepoint. The cable rest location height is advised to be between 750mm and 1000mm to be accessible to all potential users.

R26. Electric vehicle and EV charging infrastructure designers and manufacturers should give high priority to improving current and future design and technology of their products and services, on the basis of inclusive design, which inherently requires considerations for the needs of all potential user with inclusion of:

a. An ageing population who have an expectation and need to remain mobile whilst experiencing the impacts of age related impairments;
b. People with impairments who are disabled by inadequate environmental design, provision, and services;
c. People with children and infants who may require increased and flexible provision in regards to how equipment and facilities can be used, as well as the potential need of increased space for their access; and
d. Suitability of vehicles for ease of adaptation to accommodate the needs of persons with impairments affecting their upper and / or lower body and limbs, who can have the ability to

control a vehicle providing the vehicle can accept the required modifications to the physical infrastructure and the electronic infrastructure that controls the vehicle; which also requires the designers and manufacturers consideration of what interfaces can be provided, possibly as standard, to facilitate such adaptation and thereby minimise the need for modifications or conversion.

R27. UK Government support is advised to encourage all manufacturers involved in the supply of electric vehicle and EV charging infrastructure in the UK, Europe and other countries supplying Europe and the UK, to recognise the urgent requirement to improve the ease of use and accessibility of electric vehicles and EV charging facilities for UK consumers and their own populations; recognising that many such countries have ageing populations who are likely to experience impairments that many disabled persons are already experiencing here in the UK.

R28. UK Government support is also advised to encourage all Governments within European countries and other countries supplying the UK and Europe's electric vehicle and EV charging infrastructure markets, to take similar action to support and encourage their manufacturers supplying these markets, to recognise the urgent requirement to improve the ease of use and accessibility of electric vehicles and EV charging facilities for UK consumers and their own populations: such actions should make economic sense when considering that many countries like the UK have ageing populations who are likely to experience impairments that many disabled persons are already experiencing here in the UK and in their countries also.

4. CONSIDERATIONS FOR FUTURE DEVELOPMENT

Looking ahead to how the use of EV chargepoint facilities can be made more easily accessible to all users, the following notes consider how the user experience could be simplified by the chargepoint provider and network operator, from start to finish; i.e. from accessing the charging facility location to ending the charging of the vehicle.

4.1. Visual Recognition of Charging Device Operational Status

The operational status of any chargepoint should be evident on arrival before alighting from a vehicle. EV users should not need to be reliant on smart device Apps. Neither should they be reliant on navigation systems to inform them that there is an operational chargepoint available at a given location; even though such information can be very helpful.

On entering a location with EV charging, the driver should be able to recognise which chargepoints are available and operational on approach to the charging bay(s).

This will best be achieved for the consumer through a standardised system for all public chargepoints, such as by the use of illuminated high-contrast LED lighting located prominently on the charging device. For example: green illumination where the charging device is operational; blue when the charging device is in use (charging); and red indicating that the charging device is non-operational; as well as possibly flashing blue intermittently when charging is finished, as follows: -

Green = the charging device is **operational**;

Blue = the charging device is **in use** (charging);

Red = the charging device is **non-operational**;

B l u e flashing intermittently = **charging finished**.

No illumination = Out-of-use

This facility would obviate the requirement for persons with impaired mobility including such as a wheelchair user to alight from their vehicle, take the time and effort to transfer to their mobility aid only to discover a charging device is not operational. We appreciate this would require users to be familiar with the process, as well as the potential need to standardise the colours used by charging device manufacturers / suppliers. However, a standardised status display in this way is simple to understand and should be simple to engineer and implement on future chargepoint designs, or as a potential retrofit to some existing chargepoints such as those with backlit or edge-lit display screens.

Public information on such a standardised chargepoint status lighting system can also be provided by various means, including: public information broadcast and advertising; permanent notices at chargepoint locations; on-screen information in vehicles; and also via vehicle EV charging Apps and mobile phone Apps; vehicle handbooks; and at vehicle distributors in their physical showrooms, on websites, and virtual showrooms.

R29. Charging device operational status should be evident on arrival that is before alighting from a vehicle. This could be achieved through use of high-contrast LED lights located prominently on the charging device, for example:

Green = the charging device is **operational**;

Blue = the charging device is **in use** (charging);

Red = the charging device is **non-operational**;

B l u e flashing intermittently = **charging finished**.

4.2. User Communication with Chargepoint Network

The MER chargepoint network currently supports user access and control of the chargepoint function either by means of a smartphone app or smartcard use with the charging device sensor, identified by a symbol '((•))' as on the chargepoints pictured below. However, alternatives for user communication with the chargepoint network require consideration to facilitate access and control of the charging function by persons without the necessary smart card or smart phone technology. This issue is considered further below.

The user trial did not include participant experience of the MER App for smart devices, as this was not possible within the time constraints for the one-day trial event; and there was no certainty that all participants would either have possession of, or be familiar with the use of, smartphones or such device applications.

Figure 7: Close-up view of charging devices showing card reader symbol below screen

The MER chargepoints currently offer a 'Pay As You Go' (PAYG) service, and 24-hour helpline with an 020 telephone number provided for assistance. However, unless the person wishing to use the chargepoint either has an account with this network or access to the smartphone App they will be unable to use the chargepoint and the technical support line cannot provide any assistance. The printed information on the chargepoints currently indicates that a QR Code option for accessing the use of the charging device is coming soon. Above this it also states 'download the app to use the QR code' which appears to suggest that a PAYG user would still need to have the Network's App downloaded on a Smartphone and registered with the network before they can also make use of the QR Code access.

Such requirements for chargepoint access are likely to be a barrier to people who are not computer literate, unable to use the internet to setup an account, or do not have a smartphone to download an App; which is likely to include many older people as well as some with language or literacy issues. It is also likely to be off-putting to some people who do not wish to install another App or setup an account for a network they may seldom if ever use again; such as persons who are travelling through or are temporary visitors.

Currently, anyone travelling away from their local area or region in the UK is likely to find they need to access several different EV chargepoint networks. Some networks will accept a PAYG user phoning the network with a Debit Card or Credit Card to access their chargepoint, and some at supermarkets may even be free to use. However, the further one travels there is increased likelihood of needing several mobile apps

and accounts to be able to complete a journey. This needs to be recognised as one of the issues that are currently dissuading drivers from changing to an electric vehicle.

As confirmed during the trial event, several participants did not have the ability to easily read the printed information on how to access the chargepoint network and use the charging devices, due to not having the right spectacles with them. Some were naturally concerned that there was so much that needed to be read before they knew what was required.

Access to chargepoint networks and individual chargepoints requires simplification, as does the availability of alternatives for user communication with the chargepoint network, to facilitate access and control of the charging function by persons without the necessary smart card or smart phone technology.

4.3. Proposed Simplification of Chargepoint Use

As discussed in the User Trial Report, the disparity in the data between the display screen results for wheelchair users and ambulant disabled persons, as indicated in the table above at 2.4, suggests that it is unlikely that a single display screen height will best accommodate the needs of all users.

However, it may be possible to satisfy such disparate user needs by limiting the information and making the display as easy to read as possible.

After accessing a chargepoint location the information that a user may require from current public installations is likely to include:

A) How to use the charging device
B) The cost per kWh
C) How long it will take to charge their vehicle to say half or fully charged.

As discussed at 2.4.1, minimising fixed and dynamic variables in the display of information can simplify the display to perform as a meter display, to such as:

Fixed Display	Variable Information
Cost per kWh (£)	(Digital value)
Estimated full-charge time (Hrs and Mins)	(Digital values)
Cost of charge(£)	(Digital value)

Minimising the amount of information in the display also makes it easier and less time consuming for users to obtain the information they are likely to readily need.

However, display screens as we know, as with many mobile phones also, are not easy to read in the external environment and therefore should not be an essential to the EV charging process. Neither should there be a reliance on smart phone Apps, as previously discussed above; as some users may not possess or be familiar with either smart phones or the use of Apps.

Provision of a telephone contact number can be an alternative and potentially very helpful means of access to a charging network and information on use, providing the network operates such a support service. However even this option can fail where there is no mobile network reception for the user's phone service, or when their phone battery is depleted; or when a pay-as-you-go (PAYG) service requires the user to be registered beforehand as in the case of some network providers like MER.

As confirmed during the trial event, several participants did not have the ability to easily read the printed information on how to access the chargepoint network and use the charging devices, due to not having the right spectacles with them. Some were also naturally concerned that there was so much that needed to be

read before they knew what was required. Access to chargepoint networks and the use of chargepoints requires simplification.

4.3.1. Plug-in and Charge Function

Considering the possible simplification of the charging process for the existing devices, would involve the consumer simply inserting the plug into whichever socket is their preferred option; usually this will be at the vehicle, before they move to connect to the charging device. After inserting the plug into the charging device, any screen should commence with:

- Charge rate £kWh
- Touch card to reader to start charge (icon here)
- Charging - To end charging and remove cable- touch card to reader (card reader icon)

However, alternatives for user communication with the chargepoint network require consideration to facilitate access and control of the charging function by persons without the necessary smart card or smart phone technology.

Considering how to make the use of EV chargepoint facilities more easily accessible to all users, should include how the user experience can be simplified by the chargepoint provider and network operator.

This should include considering how chargepoint providers can enable a plug-in and charge function without any other required actions by the service user other than to connect a cable from their vehicle to the chargepoint, or in the case of chargepoints with tethered cables, vice versa connecting the cable to the vehicle. Obviously this initially requires compatibility between the charging device output and the vehicle charging capacity and the appropriate connections between the two for power transfer.

The alternative of a 'plug-and-charge' function solves the first issue 'A' above, on 'how to charge the vehicle', but does not necessarily answer the questions on cost or time to re-charge.

Permanent printed information on standard cost per kWh may be helpful; however the varying cost of energy may make this unfeasible. Provision of examples of re-charging times based on say: the kW capacity of vehicle batteries; or possibly some popular makes of EVs; and possibly the estimated cost to fully charge could provide a useful guide to some users. However this presumes the user is knowledgeable of the vehicles power rating, or is able to draw a reasonable comparison to their own vehicle; neither of which may be an appropriate assumption.

It is therefore important that vehicle manufacturers also consider how this very necessary task of re-charging their production vehicles is made as straight-forward as possible for their owners.

Many EVs currently in the UK market, in Europe and further abroad, are already brimming with technology than can provide their owners with information on the vehicle's status. Such information can include the current available battery capacity and range; as well as other optional information than can be selected to display.

Some such vehicles also have permanent safety features that can control and even override the driver's operation of certain vehicle functions, including braking to avoid a potential collision and applying steering corrections and / or physical or audible prompts to increase driver awareness to avoid accidental lane departure; as well as providing visual feedback on the driver's awareness.

Many EVs also provide navigation features and search functions to locate public facilities including EV charging, and potentially the current status of public charging facilities and individual charging sockets; although as yet, not where to find an accessible charging facility or an assisted EV charging service: such accessible and assisted charging provision are improvements that are currently required given the 26,000

(approx.) current EV charging facilities installed in the UK that are not accessible to disabled drivers; and most of which are likely to remain so unless there is further public and /or private investment to address these inadequacies and inequalities of provision.

Considering current technology in use on vehicles, with on-going developments by the motor vehicle industry, including development of semi-autonomous and fully-autonomous features and facilities, and related vehicle monitoring systems; it should be eminently possible for motor vehicle manufacturers to enable their production model vehicles to manage the re-charging scenario at public chargepoints. Such provision would enable on-board information to be made directly available to the driver, so they are made aware of the essential information needed in relation to the charging function.

Such information would likely need to include: cost per kWh; time to full or half-charge capacity; charge received (kW); and cost of charge: similar to re-fuelling vehicles with liquid fuels, but with all the details displayed on the dashboard screen to be easily viewed and understood, instead of a display on the fuel delivery device. However this may require charging networks to operate with open-source technology, if they don't already, to enable the vehicle systems to communicate with the chargepoint network.

4.4. Potential for Bollard-Free Chargepoints

Considering the currently availability of vehicle-route safety and hazard avoidance features on many existing production model EVs, it seems reasonable to suppose that such systems in time could even result in the reduction in any need for physical protection of charging devices in the immediate vicinity of vehicle charging bays, i.e. enabling provision of bollard-free and plinth-free charging bay environments and access for all.

4.5. Future Electric Vehicles and Charging Infrastructure Development

Government support is required to encourage as far as possible, and legislate where necessary, to achieve improvements in design standards to include:

- Standardisation and uniformity of the provision of visual recognition of EV chargepoint operational status for vehicle drivers on approach to charging facilities and at the chargepoint, to be visible by the driver before exiting the vehicle.
- There should also be a requirement for the chargepoint network operator to provide clear indication of the cost per kilowatt-hour (£.p/kW), which should be visible on approach to the EV charging location and at the individual chargepoints, similar to how liquid fuel costs are displayed at filling stations.

Although it will be preferable from the customers perspective to have all chargepoints offering the same cost rate, particularly for any chargepoints on the same operator network, this should initially be the domain of the operator to decide on the charge cost-rate, appropriate to the location and the local power supply distribution network operators (DNO) charges.

R30. Current engagement between chargepoint designers, network operators and UK Government including Department of Transport representatives should give consideration to improving the consumer experience of using EV charging Infrastructure, and preferably enact a programme for the 'standardisation of chargepoint status designation' utilising such as high contrast LEDs based on a uniform standard, for example as advised above at Recommendation R30: -

Green = the charging device is **operational**;

Blue = the charging device is **in use** (charging);

Red = the charging device is **non-operational**;

B l u e flashing intermittently = **charging finished**.

R31. Current engagement between chargepoint designers, network operators and UK Government including Department of Transport representatives should give consideration to improving the consumer experience of EV charging Infrastructure, to include a requirement for the chargepoint network operator to provide clear indication of the cost per kilowatt-hour (£.p/kW), which should also be visible on approach to the EV charging location and at the individual chargepoints, similar to how liquid fuel costs are displayed at filling stations.

Government support is also advised to encourage electric vehicle manufacturers in the UK, Europe and other countries supplying Europe and the UK, to recognise the urgent requirement to improve the ease of use and accessibility of electric vehicles and EV charging facilities for UK and their own populations. In most countries there exists the potential for living longer and experiencing impairments through ageing that many disabled persons are already experiencing, and as such there needs to be a more inclusive approach to design, instead of the current vehicle market models that appear to be based on perceptions of the desires of the driver, family, activity, or their status, for marketing purposes. This issue of inclusive design is relevant to vehicles and charging infrastructure accessibility as discussed in this report.

R32. Engagement with Motor Vehicle Manufacturers is also advised to include considerations to enable all future EV production vehicles to utilise on-board re-charging control systems to communicate with chargepoints on completion of charging cable connection to:

a. Confirm charging supply compatibility before initiating charging;
b. Provide confirmation via vehicle dashboard display of unit cost £/kWh for re-charging for drivers information, with estimated time and cost to re-charge, and request driver's acceptant to commence / continue with re-charging;
c. Initiate re-charging, providing periodic updates to driver's information screen.
d. On completion of charging, provide automatic notification to driver either in-car or via a driver's own paired Wi-Fi device / Vehicle App.
e. Provide automated reminders, such as by text message as well as App based notification at appropriate intervals to encourage driver to return to vehicle to vacate the charging bay on completion of charging.

5. APPENDIX: RECOMMENDATIONS SUMMARY

R1. Provision of a cable rest / holder on the chargepoint at a height between 750mm and 1000mm above the Centre Aisle surface
(Hr in above diagram).

R2. Where it is possible to do so, the weight of a cable should be as light as is absolutely necessary to satisfy its required electrical duty and safety regulations, and consideration should also be given to other factors, including cable storage, care of cable, and the ease of removing and fitting dust caps.

R3. Consider increasing the projection of the lower portion of the socket flap to provide a more pronounced 'lip or tab' which may afford easier engagement with the flap for people with limited manual dexterity.

R4. An optimum chargepoint socket height is proposed at 900mm above the surface from where the chargepoint is accessed, so as to be accessible by the majority of users.

R5. Further research and investigation is advised by charging socket designers to identify solutions to aid the ease of physical insertion and removal of the cable plug connection at chargepoints, which may also be an issue requiring consideration for electric vehicle development generally. Note: Although this report is based on charging devices with type 2 Mennekes socket connections, it should be recognised that similar issues may or may not be experienced with different charging socket types or devices.

R6. Appropriate separation distance is required between adjacent sockets on double-socket charging devices, so that there is adequate clearance for a two-handed grip around the cable plug when inserting and removing the cable connection. This may also benefit users with upper body prosthetics, as well as others with impaired dexterity and strength limitations, and potentially benefit many older persons.

R7. Minimising the fixed and dynamic variables in the display of information required can simplify the display to such as:

Fixed Display	Variable Information
Cost per kWh (£)	(Digital value)
Estimated full-charge time (Hrs and Mins)	(Digital values)
Cost of charge(£)	(Digital value)

R8. Minimising the amount of information in the display makes it easier and less time consuming for users to obtain the information they are likely to readily need.

R9. On this basis the display functions as a meter. Although the data indicates that one height does not necessarily satisfy all user needs, minimising the display information and providing high contrast easily legible displays, may be adequate for most users. Referring to BS8300:2018[5]: meters should be mounted between 1200 mm and 1400mm from the floor (or ground) so that the readings can be viewed by a person standing or sitting.

R10. Best practice guidance for sign design should be applied to the screen display design as well as any permanent printed information associated with the chargepoint and charging facility location; i.e. including:

[5] BS 8300-2:2018 Design of an accessible and inclusive built environment: Part 2 Buildings – Code of practice, 15.7.2: Location of outlets, switches, controls and meters

- Minimum size of text for viewing display from short distance, should be as large as the screen display will allow and be equivalent to an x-height (lower case 'x' character height) of between 15mm and 25mm;
- Use any sans serif typeface (commonly used include Helvetica, Arial, Futura, Avant Garde);
- Where space permits, symbol should be at least 100mm in overall height;
- Letters, symbols and pictograms should contrast visually with the display background;
- Light coloured text and symbols or pictograms on a dark background are preferred.
- A difference in LRV (Light Reflectance Value) of 70 points between the letters, symbols or pictograms and the display background, can ensure good visual contrast.

R11. Anti-glare screen should be used to reduce or remove reflections: this applies to the display screen and any outer cover protecting the display.

R12. Provide high-contrast screens using good colour contrast for text and any symbol when viewed against the background.

R13. Where screens are a requirement at the chargepoint they should either be: -

a. Large enough to be easily read from a distance by all potential users, and in all lighting conditions, by persons when standing and seated; or
b. Provided at two heights and located so as to allow close approach by ambulant persons and by wheelchair users who require knee clearance to facilitate such close approach.

R14. Where screens are a requirement:

a. Any such screen should utilise high contrast LEDs to be readable in all lighting conditions in external uncovered environments as well as internal or covered environments.
b. Where display screens are to be provided / required, improvements should give consideration to the display screen specification parameters including size of screen, quality of display, brightness and contrast between screen characters and background, text format and height, and use of non-reflective display and outer cover screens.

R15. Where display screens are necessitated on any chargepoint device, we advise further research is required to identify the optimum solution for the size and height of display screens to accommodate the viewing needs of wheelchair users and ambulant users, including persons of short or large stature.

R16. Where a display screen is recessed from the face of the device, it is important to ensure the viewing angle and therefore the visibility of the display is not diminished for persons standing or seated.

R17. The necessity to provide lengthy instructions on use of charging devices for those unfamiliar with the procedure should be avoided whenever possible.

R18. Best practice guidance for sign design (as referred to in recommendations at 2.4.1 R10 above) should be applied to any permanent printed information associated with the chargepoint and charging facility location.

R19. Consider simplifying the charging process to enable a reduced requirement for printed instruction on chargepoint use.

R20. Consideration should be given to alternative means of providing information on chargepoint use for persons who have limited reading skills, or for who English may not be a first language; possibly including electronic information in easy-read format, and / or audible recordings.

R21. Consider provision of recorded information, to be available to persons with impaired hearing who can receive speech via hearing aids equipped with a T-coil.

R22. Access to the chargepoint network should be simplified to enable access without the need for internet or Wi-Fi access, such that a PAYG (Pay As You Go) service is available to anyone with a recognised Debit or Credit Card.

R23. An optimum chargepoint Card Reader sensor height is proposed directly above the charging socket and clear of any socket flap when open, so as to be accessible by all potential users. However where

this is not possible, the location of the sensor should be within a height of 750mm to 1200mm above the surface from where it is accessed, i.e. the vehicle bay level, to be accessible to all potential users.

R24. Card reader sensing location should be readily recognisable by use of a standard icon that is preferably internationally recognised.

R25. EV charging equipment designers and manufacturers should give consideration to enabling the chargepoint to be used as a hand-hold and rest-post / leaning-post for persons to steady themselves when interacting with the chargepoint, including while inserting and extracting a cable connection.

R26. EV charging equipment designers and manufacturers should give consideration to provision of a cable rest at the chargepoint either as part of the charging device or its mounting post to improve cable management, minimise obstruction to charging device by any trailing cable, and to enable chargepoint users to safely lay the cable down whilst they interact with the chargepoint. The cable rest location height is advised to be between 750mm and 1000mm to be accessible to all potential users.

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b. People with impairments who are disabled by inadequate environmental design, provision, and services.
c. People with children and infants who may require increased and flexible provision in regards to how equipment and facilities can be used, as well as the potential need of increased space for their access.
d. Suitability of vehicles for ease of adaptation to accommodate the needs of persons with impairments affecting their upper and / or lower body and limbs, who can have the ability to control a vehicle providing the vehicle can accept the required modifications to the physical infrastructure and the electronic infrastructure that controls the vehicle; which also requires the designers and manufacturers consideration of what interfaces can be provided, possibly as standard , to facilitate such adaptation and minimise the need for modifications or conversion.

R28. UK Government support is advised to encourage all manufacturers involved in the supply of electric vehicle and EV charging infrastructure in the UK, Europe and other countries supplying Europe and the UK, to recognise the urgent requirement to improve the ease of use and accessibility of electric vehicles and EV charging facilities for UK consumers and their own populations; recognising that many such countries have ageing populations who are likely to experience impairments that many disabled persons are already experiencing here in the UK

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R30. Charging device operational status should be evident on arrival that is before alighting from a vehicle. This could be achieved through use of high-contrast LED lights located prominently on the charging device, for example:

Green = the charging device is **operational**;

Blue = the charging device is **in use** (charging);

Red = the charging device is **non-operational**;

Blue flashing intermittently = **charging finished**.

R31. Current engagement between chargepoint designers, network operators and UK Government including Department of Transport representatives should give consideration to improving the consumer experience of using EV charging Infrastructure, and preferably enact a programme for the 'standardisation of chargepoint status designation' utilising such as high contrast LEDs based on a uniform standard, for example as advised above at Recommendation R30: -

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a. Confirm charging supply compatibility before initiating charging;
b. Provide confirmation via vehicle dashboard display of unit cost £/kWh for re-charging for drivers information, with estimated time and cost to re-charge, and request driver's acceptant to commence / continue with re-charging;
c. Initiate re-charging, providing periodic updates to driver's information screen.
d. On completion of charging, provide automatic notification to driver either in-car or via a driver's own paired Wi-Fi device / Vehicle App.
e. Provide automated reminders, such as by text message as well as App based notification at appropriate intervals to encourage driver to return to vehicle to vacate the charging bay on completion of charging.