WPD INNOVATION
Transforming the electricity network

Take Charge

6 Monthly Project Progress Report

October 2020 – March 2021

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Version Control

Issue	Date
D01	09/03/2021
D02	12/03/2021
V01	31/03/2021

Publication Control

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1. Executive Summary

Take Charge is a project funded through Ofgem's Network Innovation Allowance (NIA). The project was registered in April 2020 and is expected to be completed by December 2021.

The project will design, develop, construct and install a Compact Connection Solution (CCS) to provide a fast and cost effective solution to supply rapid Electric Vehicle (EV) charging facilities at Motorway Service Areas (MSAs). The design and build of the CCS will be led by Brush, a leading UK manufacturer of transformers and switchgear. Working closely alongside Brush we will focus on developing a solution with all the capabilities of a conventional substation but in a far more compact and low cost design. The CCS will be trialled at a site operated by Moto, the largest MSA operator in the UK. The CCS will be connected to existing 33 kV and 11 kV networks within the vicinity of the trial site and will provide supplies to existing and new EV charging infrastructure.

The demonstration of a new packaged substation on the live distribution network will provide the template for high capacity, low cost solutions to ensure rapid charging can be deployed efficiently to serve future numbers of EVs.

This report details project progress on Take Charge from October 2020 to March 2021.

1.1. Business Case

The development and roll-out of rapid EV charging is becoming increasingly important as EV manufacturers aim to minimise the time and disruption associated with customers charging their vehicles.

Motorway Service Areas (MSAs) have been identified as a specific location where rapid EV charging would need to be deployed on a large scale to allow simultaneous charging by multiple customers when undertaking long journeys. MSAs are currently supplied either directly via the local Low Voltage (LV) networks or via a distribution substation connected to the 11 kV network. However, the deployment of rapid EV charging at MSAs is likely to require a power supply capacity of up to 20 MVA to ensure that customers can simultaneously charge their vehicles at peak times.

Providing this level of capacity using traditional solutions would require the installation of a new 33/11 kV substation with associated transformers, compound, switchroom, switchgear and auxiliary equipment. The delivery of this solution would be expensive, time consuming and often far too complex for the needs of the customer.

The Government's Road to Zero strategy sets the ambition that by 2050 almost every car and van will be zero emission and has since moved its planned date for ending the sale of petrol and diesel vehicles from 2040 to 2035. It is therefore highly likely that large scale rollout of rapid EV chargers at all major MSAs will be required to meet future demand from EV customers. In GB there are three main MSA site owners. The following list indicates the number of MSA sites attributed to each owner:

- Moto – 44 sites
- Welcome Break – 26 sites
- Roadchef – 21 sites

There is a total of 91 sites where the solution could be installed. The post-trial method cost of the solution has been estimated as:

- £470k - (A).

The base case is the scenario that a traditional primary substation is constructed to supply the rapid charging demand for each MSA site.

The average cost of a 33/11kV primary substation is:

- £960k - (B)

Therefore, the solution offers a saving of:

- £490k per site - (B – A) = (C)

We anticipate that 68 MSA sites (75% x 91) will require the packaged substation solution. The total saving across the GB roll-out is therefore £33.3m (68 x C).

1.2. Project Progress

This progress report covers progress during the period October 2020 to March 2021. This is the second six monthly progress report since Take Charge was successfully registered on the Smarter Networks Portal in April 2020.

During this reporting period progress has centred around the design of the CCS and dissemination of the project findings to date.

This reporting period saw the CCS design and build contract finalised with Brush in December 2020. There were several areas that had to be reviewed before the contract was accepted by WPD/Brush and this resulted in a slight delay to commencing the design activities. However, the detailed design activities have now begun and further details on this are provided later in this report.

Engagement with project stakeholders with Ecotricity, Moto and Brush have continued this reporting period. Working in conjunction with Moto we have confirmed the site for the CCS and are progressing with finalising the layout.

In addition, we have been collaborating with our Primary System Design (PSD) and Engineering Design (ED) departments to refine the design and connection of the CCS at Sowton 132/33 kV Bulk Supply Point (BSP).

Finally, we have presented the findings of our work to date during the WPD Innovation Showcase event on 1 December 2020 and the Energy Networks Innovation Conference (ENIC) on 8 December 2020. The technical paper abstract submitted for CIRED 2021 was also accepted and the final paper has now been submitted.

1.3. Project Delivery Structure

The Take Charge Project Review Group meets on a bi-annual basis. The role of the Project Review Group is to:

- Perform reviews at agreed stage boundaries;
- Ensure the project is aligned with organisational strategy;
- Assist with resolving strategic level issues and risks; and
- Assess project progress and report on project to senior management and higher authorities.

1.3.1. Project Resource

Table 1-1 provides an overview of the project resources for the project.

Table 1-1 Project resources

Project Partner	Name	Role
WPD	Yiango Mavrocostanti	Innovation Manager
	Paul Jewell	System Development Manager
	Stephen Hennell	Policy Engineer (Switchgear)
	Andy Reynolds	Policy Engineer (Transformers)
	Peter White	DSO Development Engineer
GHD	Neil Murdoch	Project Manager
	Daniel Hardman	Technical Lead

Project Partner	Name	Role
	David Thorn	Strategic Consultant
	Nicholas Edwards	Graduate Engineer
Brush	Andrew Watkins	Brush Lead
	Bill Carlyle	Senior Engineer
Moto	Paul Comer	Moto Lead
Ecotricity	Andrew Hibberd	Ecotricity Lead

1.4. Procurement

Table 1-2 provides a summary of the status of the procurement activities for the project.

Table 1-2 Procurement status

Provider	Services/Goods	Project Area	Status/Due Date
Brush	CCS Detailed Design	Design	In progress – due end of March 2021
Brush	CCS Build	Build	Scheduled to begin in March 2021
Brush	FAT	Testing	Scheduled to begin in July 2021
Brush	CCS Installation	Installation	Scheduled to begin in September 2021
Siemens	33kV switchgear	Installation	Procured and underway – due for delivery August 2021
GE	RTU	Installation	Scheduled to be procured in April 2021
Various	AC/DC auxiliary equipment	Installation	Scheduled to be procured in April 2021
TBD	33/11kV cabling	Installation	Scheduled to be procured in June 2021

1.5. Project risks

A proactive role has been taken to effectively manage risk in the delivery of the Take Charge project. Processes have been put in place to review the applicability of existing risks; identify and record new risks that have arisen; and update the impact, likelihood and proximity of risks that have developed.

A summary of the most significant risks is provided in Section 7.

1.6. Project learning and dissemination

The project learning is captured throughout the project lifecycle by monthly reporting and is available on the Take Charge project website.

In addition, during this reporting period the findings from the project have been captured through:

- WPD Innovation Showcase Event – 1 December 2020: Live presentation to a varied audience on the progress and findings to date on Take Charge
- ENIC 2020 – 8 December 2020: Live presentation to the industry on the progress and findings to date
- CIRED 2021: Abstract for technical paper entitled "*Site selection and assessment of required system capacity for rapid EV charging at motorway service areas*", accepted and full paper submitted in March 2021.

2. Project Manager's Report

2.1. Project background

The development and roll-out of rapid EV charging is becoming increasingly important as EV manufacturers aim to minimise the time and disruption associated with customers charging their vehicles.

The project will develop, construct and install a compact packaged 33/11 kV substation with a capacity expected to be in the range of 10-20 MVA. Construction will be undertaken at an MSA based on applicability and the expected number of Electric Vehicle (EV) customers. The new packaged substation will be connected to existing 33kV and 11kV networks within the vicinity of the trial site and will provide supplies to existing and new EV charging infrastructure.

2.2. Project progress in the last six months

Work during the last six months has focussed primarily on the design of the CCS and how it should be integrated with the 33 kV network following completion of the System Capacity Optimisation Work Package in the previous reporting period.

Table 2-1 provides an overview of the work packages that were detailed within the PEA and the progress that has been made to date.

Table 2-1 Take Charge work packages

Ref	Work Package Description	Status
1	Kick-Off and Data Gathering	Completed
2	System Capacity Optimisation	Completed
3	Design of the Solution	In Progress
4	Build of the Solution	Not started
5	Site Installation	Not started
6	Complete Trials	Not started
7	Closedown Report	Not started

The first key step of the design was to determine the exact location at Exeter MSA where the CCS should be installed. Various meetings took place between Moto, GHD and WPD and the location was finalised as detailed in Section 2.2.1.

The signature of the design and build contract with Brush took longer than expected with final sign-off completed in December 2020. The outline design of the CCS has now been completed and work is underway to finalise the detailed aspects of components such as the container, 11 kV switchgear, 33 kV switchgear, 33/11 kV transformer and auxiliary equipment. Further details of the design progress are detailed in Section 2.2.2.

The connection of the CCS to the 33 kV network has involved working closely with the PSD and ED departments. A cable route feasibility study has been commissioned and the connection point at Sowton 132/33 kV BSP is being finalised with details provided in Section 2.2.3.

2.2.1. CCS location

To identify a suitable location at Exeter MSA for the new substation, a desktop study was carried out to assess each location against a set of criteria that would determine the technical suitability and evaluate each location against the objectives of minimising costs, time and disruption associated with the trial.

The main criteria used for the scoring each of the locations is shown in Table 2-2.

Table 2-2 Criteria required to determine the location

Criteria	Goal
Cost	Minimise or Optimise
Land and Accessibility	Clear access with very limited impact on local environment, community and/or infrastructure.
Disruption	Avoid or Minimise
Health, Safety and Environment	Avoid or Minimise Risk
Strategic Planning	Maximise Future Opportunities

In conjunction with Moto and using aerial imagery of the site, four locations were considered for the CCS at the Exeter MSA. These were as follows:

A. Adjacent to the entrance of the MSA

B. Adjacent to the staff car park

C. Adjacent to the coach bays

D. Open space between the fuel station and main services building

Figure 2-1 provides an overview of the site locations considered.

Figure 2-1 Substation locations

From the assessment, location A (adjacent to the entrance of the MSA) was recommended as the most suitable location for the CCS. This location provides a generous amount of space for construction with minor disruption caused to the existing infrastructure and environment. The additional space can provide a layby for WPD operatives with

space still available for any future expansion. It is anticipated that the 33 kV cables from Sowton 132/33 kV BSP will be connected from the west side of the MSA. Disruption to facilities and cost is drastically reduced, as cable trenching across the main car park is avoided for the 33 kV cables. An overview of the site location and proposed EV charging is shown in Figure 2-2.

Figure 2-2 Detailed view of location A

2.2.2. CCS design

As discussed previously, the main focus of last six month period was the design of the CCS. The design activities are mainly being led by Brush who are responsible for the design and build of the transformer, 11 kV switchgear and container for the switchgear and ancillary equipment. WPD will free issue various equipment to Brush to integrate within the container including the 33 kV switchgear, battery chargers and Remote Terminal Unit (RTU).

The first stage of the design process involved finalising the arrangement and connection of equipment within the CCS. Through discussions with Policy, PSD and ED the arrangement of the equipment was agreed and finalised as shown in Figure 2-3.

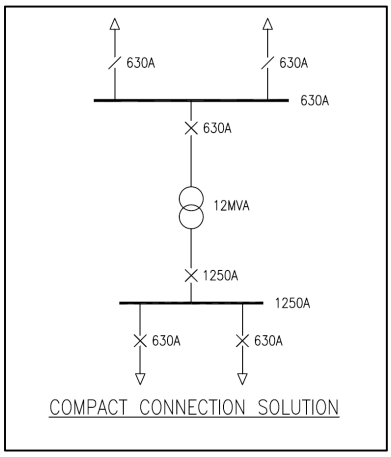

Figure 2-3 CCS configuration

Following confirmation of the arrangement and detail types of equipment, the first main item to be finalised was the 11 kV switchgear. Brush's versatile Quantum 11 kV switchgear will be used for the CCS due to its compact form and functionality. The detailed schematics and drawings for the switchgear were produced in January 2021, reviewed by the design team and approved in February 2021. Figure 2-4 shows the general arrangement of the switchgear to be used in the CCS.

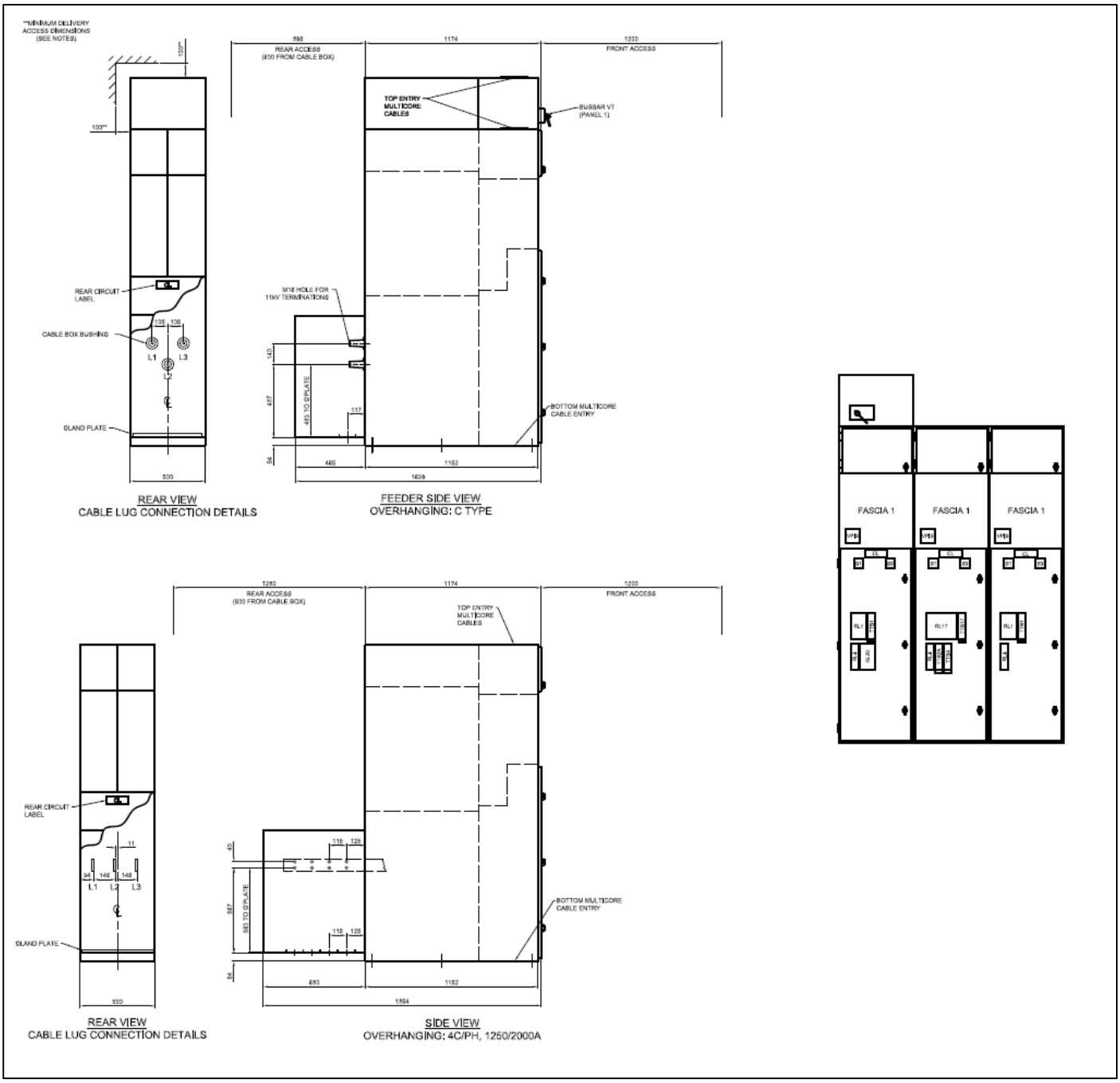

Figure 2-4 11 kV switchgear general arrangement

Brush have also progressed with the design of the 33/11 kV transformer during this reporting period. The 33/11 kV transformer will differ from standard transformers for two main reasons:

1. Hermetically sealed – the transformer will not be equipped with a standard conservator and cooling will be non-forced with standard radiators attached directly to the main tank
2. Vacuum tap-changer – the transformer will be equipped with the latest vacuum tap changer technology

These features, along with self-dehydrating breathers on the main tank and tap changer, will significantly reduce the overall maintenance requirements of the transformer.

The first revision of the detailed design for the transformer have been submitted by Brush and reviewed by the project team and work is underway to update the design ready for approval.

Figure 2-5 provides an overview of the 33/11 kV transformer.

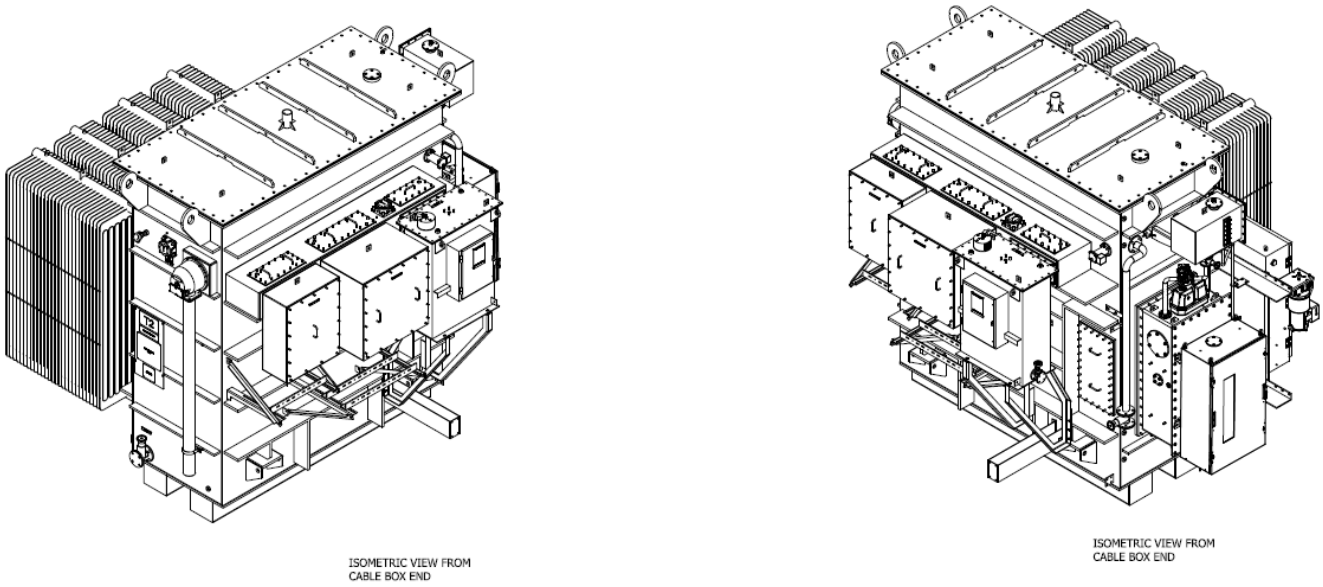

Figure 2-5 33/11 kV transformer iso-metric view

Work has also been progressing on the design of the other equipment associated with the CCS including:

- 33 kV switchgear – order placed with the manufacturer and design underway
- DC batteries and chargers – outline specification produced and ready for order
- RTU – outline specification produced for GE iBox (compact RTU). Specification to be finalised following approval of transformer schematics
- Transformer protection panel – outline drawings produced for a combined protection and Automatic Voltage Control (AVC) panel. Design to be finalised following approval of transformer schematics

The design for the equipment of the CCS is progressing well and the next main stage of the design will be to combine these different components together and finalise the container that will house most of them.

2.2.3. CCS connection

The CCS will be connected to Sowton 132/33 kV BSP via a 33 kV cable approximately 1.5km along. The connection of the 33 kV cable at Sowton will initially involve connecting into the existing outdoor open-busbar infrastructure. This will facilitate a “temporary” connection as there is a separate scheme underway to replace the 33 kV switchgear at Sowton. Figure 2-6 shows an example of how the 33 kV connection will be provided at Sowton.

In addition, a cable route feasibility study has been instigated to evaluate the proposed 33 kV cable route from Sowton to Exeter MSA (indicative route shown in Figure 2-7). This study will help determine any “pinch points” along the route and inform the details required for the cable installation tender.

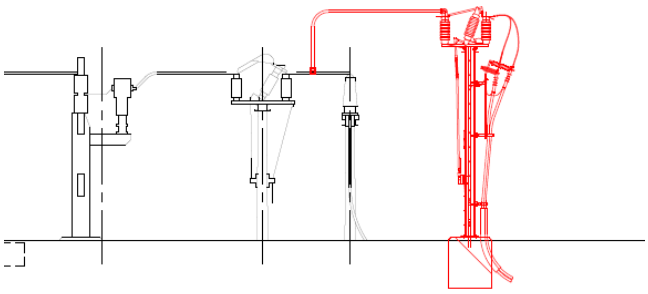

Figure 2-6 Proposed CCS connection in red

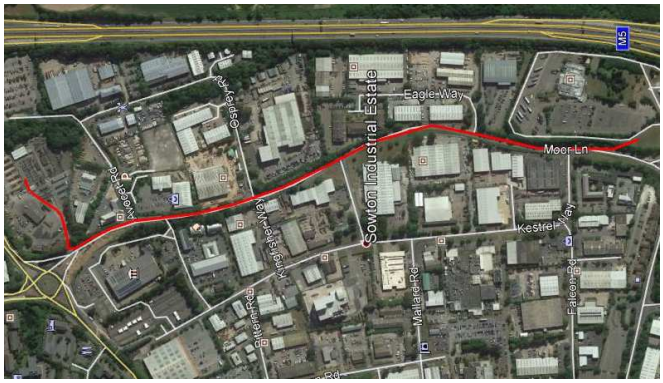

Figure 2-7 Proposed 33 kV cable route in red

2.2.4. Future activities

Following completion of the detailed design, the CCS will move into the build stage. The key item for the build stage will be the 33/11 kV transformer as this will be a fully bespoke design for the CCS. Completion of the detailed CCS design will also allow us to finalise the site design for Exeter MSA and submit a planning application for the substation.

We will also work with Brush to start the preparation of draft versions of the manual and testing documentation for the CCS during the next reporting period. These documents will be crucial to ensure that the CCS is ready for connection to the live network and will inform our own policy documentation.

2.2.5. COVID-19 Impact

The COVID-19 pandemic has not had a significant impact on the Take Charge project at the current stage. However, the situation is being monitored and the possible future risks with the design, build and installation stages have been identified and rated.

Table 2-3 presents a summary of the possible impact to the project and the mitigation action plans in order to reduce these risks.

Table 2-3 Summary of COVID-19 impact

Risk	Risk Rating	Mitigation Action Plan	Progress
The Covid-19 pandemic causes delays to site visits	Moderate	Regular engagement with Moto and local site teams. Continually monitor government, WPD and Moto guidelines. Conduct as much investigation using desktop techniques.	Situation still being monitored.
The Covid-19 pandemic causes delays to the installation of the equipment on the 33 kV & 11 kV network (i.e. difficult to plan outages)	Moderate	Early engagement to understand the restrictions on site staff and continual monitoring of the situation	No updates on progress – installation not until mid-2021. Keep monitoring
Covid-19 delays the testing of new Brush equipment	Moderate	Early engagement with Brush to understand if there are social distancing working arrangements that can be implemented.	No updates on progress – testing not until mid-2021. Keep monitoring

3. Progress against budget

Table 3-1 summarises the details of the progress that has been made with respect to the project budget.

Table 3-1 Project finances

Budget Item No.	Budget Item	Budget (£k)	Expected Spend to Date (£k)	Actual Spend to date (£k)	Variance to Expected (£k)	Variance to Expected (%)
1	Project Management and Design	355.0	200.0	99.0	-101.0	-50.5%
2	Internal Project Review and Controls	75.0	25.0	0.0	-25.0	-100%
3	Free-issue equipment and installation	350.0	180.0	0.0	-180.0	-100%
4	CCS	600.0	125.0	117.5	-7.5	-6%
-	Totals	1,380.0	530.0	216.5	-313.5	-59.2%

Comments around variance

The delay in signing the design and build contract has had an impact on the spend incurred on the project. In summary, it was anticipated that the build phase would be underway and all free-issue equipment would have been fully designed and purchased. The delay to the contract signature is also likely to have an impact on the overall programme as it is unlikely that works will be able to be carried out at Exeter MSA during the peak summer holiday season. At this stage it is not expected that the budget will need to be altered, however, there may be a need to extend the timescales to account for the delay. This will continue to be monitored as the project moves into the build stage. There is also a possibility that delays could be incurred due to the impact of COVID-19 as presented in section 2.2.5.

4. Progress towards success criteria

Table 4-1 presents the progress towards the success criteria documented in the Take Charge Project Registration and PEA document.

Table 4-1 Progress towards success criteria

Criterion No.	Success Criterion	Progress
1	Analysis of information and data to inform the design of the new solution	Completed – all data gathered from internal sources, Moto, Ecotricity and Brush.
2	Selection of a suitable trial site for the installation	Completed – Exeter MSA selected as the trial site for the installation. Site Selection report details the methodology and other shortlisted sites.
3	Development of a design for the new package solution	In progress – Contract signed and detailed design underway.
4	Installation and integration of the new package solution at the trial site	Not started – installation and integration of the CCS will begin after Item 3
5	Monitor and analyse information and data during the trial phase	Not started – monitoring and analysis of data will begin after Item 4
6	Dissemination of key results, findings and learning to internal and external stakeholders	In progress – Two presentations held and a full paper for CIRED prepared and submitted for 2021 conference.

5. Learning outcomes

The following sections list some of the key learning outcomes that resulted from activities during this reporting period:

5.1. Site location

Whilst determining the optimum location of the CCS at Exeter MSA, several learning outcomes were noted:

- Detailed discussions with WPD's property department were held to review the requirements for the substation at Exeter MSA. It was been confirmed that any new substations over 29m³ would require full planning permission, therefore, this would need to be accommodated for the CCS at Exeter. The planning process for the substation would normally require around 12 weeks, however, due to COVID-19 this timescale was extended by a further two weeks.
- The proposed location of the CCS at Exeter MSA was determined by evaluating several factors including cost, accessibility, disruption and HSE. These were all typical factors that would normally be accounted for when carrying out such an evaluation. However, whilst discussing the locations with Moto it became clear that the visual impact of the CCS would also be important. As such, the project is considering ways in which to engage with customers at Moto rather than simply "hide" the CCS.

5.2. Design

The design phase has seen several key points captured through discussions and dialogue between internal WPD policy engineers and Brush. The learning points listed below are valuable to ensure the CCS is fit for purpose:

- The 11 kV switchgear was originally planned to be equipped with metering facilities directly on the outgoing circuit breakers. However, following engagement with EV charging providers it was clear that they would prefer to be metered at HV RMUs further downstream. This requirement was reflected in the design and will reduce the price of the CCS.
- The proposed switchgear for the 33 kV side of the CCS is Siemens 36 kV switchgear, type 8DJH36. Following discussions with Siemens, it was established that the whole installation can be provided as a single unit, helping to avoid additional installation works.
- Traditionally, the Neutral Earthing Resistor (NER) for 33/11 kV substations would be installed on a separate plinth adjacent to the primary transformer. During discussions with Brush and WPD Policy the option of installing the NER on the transformer tank was considered. This option is now being progressed and will help reduce the overall civil requirements for the CCS.

6. Intellectual property rights

There is no current IPR to date. However this situation is being monitored and will be updated throughout the design stage as required.

7. Risk management

7.1. General

Our risk management objectives are to:

- Ensure that risk management is clearly and consistently integrated into the project management activities and evidenced through the project documentation;
- Comply with WPDs risk management processes and any governance requirements as specified by Ofgem; and
- Anticipate and respond to changing project requirements.

These objectives will be achieved by:

- Defining the roles, responsibilities and reporting lines within the project delivery;
- Team for risk management;
- Including risk management issues when writing reports and considering decisions;
- Maintaining a risk register;
- Communicating risks and ensuring suitable training and supervision is provided;
- Preparing mitigation action plans;
- Preparing contingency action plans; and
- Monitoring and updating of risks and the risk controls.

7.2. Current risks

Table 7-1 details the top five current risks by category. For each of these risks, a mitigation action plan has been identified and the progress of these are tracked and reported.

Table 7-1 Top five current project risks (by rating)

Risk	Risk Rating	Mitigation Action Plan	Progress
Protection for the rapid charging connection solution does not meet WPD policy requirements	Major	Review protection requirements with WPD policy engineer and build these into the functional specification	Protection reviewed by PSD. Need to coordinate with ED now
Unable to agree land rights or lease for the new substation at Exeter MSA	Major	Engage with Moto and Ecotricity to determine the optimum way of obtaining permission to site the CCS	Discussions held with WPD property department. Follow-up meeting to be arranged
High visitor numbers at MSA trial site during works	Major	Coordinate closely with Moto. Aim to start enabling works before the school summer holidays. Alternatively, delay install until Sept 2021.	Work underway to finalise install programme and understand potential conflicts
Point of Connection (PoC) cannot be provided at chosen substation	Major	Ensure there is enough space in the substation to install the equipment and coordinate with PSD and ED departments	Design currently progressing with connection at Sowton BSP.

Risk	Risk Rating	Mitigation Action Plan	Progress
Package substation enclosure design does not comply with HSE regulations	Major	Work with Brush to ensure that the design and layout of the enclosure complies with HSE requirements and WPD requirements	Discussed with Brush and WPD – Further details provided by Bradgate (manufacturer)

Figure 7-1 provides a graphical summary of the project risk register to give an ongoing understanding of the project risks.

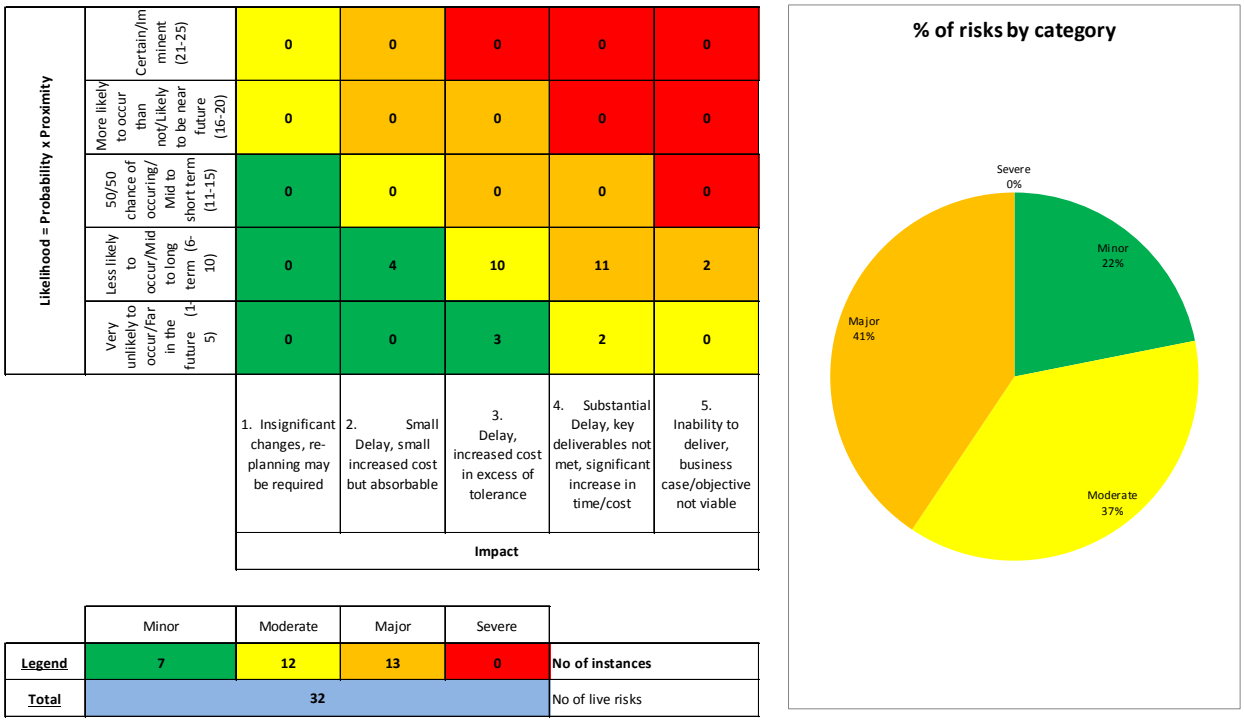

Figure 7-1 Graphical view of project risks

7.3. Update for risks previously identified

Descriptions of the most significant risks, identified in the previous six monthly progress report are provided in Table 7-2 with updates on their current risk status.

Table 7-2 Top five risks from previous reporting period

Risk	Previous Risk Rating	Risk Rating	Mitigation Action Plan	Progress
Protection for the rapid charging connection solution does not meet WPD policy requirements	Major	Major	See above	See above
Unable to agree land rights or lease for the new substation at Exeter MSA	Major	Major	See above	See above
Trial site location has to	Major	Moderate	Confirm suitability of	Site selection methodology

Risk	Previous Risk Rating	Risk Rating	Mitigation Action Plan	Progress
be changed during the project			selected trial site with Moto. Also have back up sites prepared and discussed in case the site has to be changed	has been prepared and all sites have been shortlisted.
33kV connection for the CCS is delayed	Major	Major	Monitor the progress on the 33kV connection and identify if there any major issues with the proposed works	33kV connection design is underway and no major issues identified to date
CCS enclosure design does not comply with HSE regulations	Major	Major	See above	See above

8. Consistency with project registration document

The project is being carried out according to the Project Registration and PEA document, and no inconsistencies or required changes have been identified relating to completed or future work on the project.

9. Accuracy assurance statement

This report has been prepared by the Take Charge Project Manager (Neil Murdoch), reviewed and approved by the Innovation Team Manager (Yiango Mavrocostanti).

All efforts have been made to ensure that the information contained within this report is accurate. WPD confirms that this report has been produced, reviewed and approved following our quality assurance process for external documents and reports.

Glossary

Acronym	Definition
AC	Alternating Current
BSP	Bulk Supply Point
CCS	Compact Connection Solution
COVID	Coronavirus Disease 2019
CIRED	International Conference on Electricity Distribution
DC	Direct Current
DNO	Distribution Network Operator
EMU	Electronic Mapping Utilisation
ENA	Energy Networks Association
EV	Electric Vehicle
FAT	Factory Acceptance Testing
GB	Great Britain
GHD	Gutteridge Haskins and Davey Ltd
HSE	Health and Safety Executive
IPR	Intellectual Property Rights
kV	Kilovolts
LV	Low Voltage
HV	High Voltage
MSA	Motorway Service Areas
MVA	Mega Volt-Amperes
NER	Neutral Earthing Resistor
NIA	Network Innovation Allowance
PoC	Point of Connection
PEA	Project Eligibility Assessment
RAID	Risks, Assumptions, Issues and Dependencies
RMU	Ring Main Unit
RTU	Remote Terminal Unit
VT	Voltage Transformer
WPD	Western Power Distribution

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