

Powerful CB

Project Progress Report

December 2018



INVESTORS
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Glossary

Term	Description
ABB	Our technology partner for Method 1
AMAT	Applied Materials, our technology partner for Method 2
BAU	Business As Usual
CB	Circuit Breaker – Protection device that interrupts the flow of current in an electric circuit in the event of a fault
DG	Distributed Generation
DNO	Distribution Network Operator
ENA	The Energy Networks Association
EPN	Eastern Power Networks plc
ENWL	Electricity North West Limited
FCL	Fault Current Limiter – a FLMT that attenuates fault current by increasing its impedance (only) during a fault.
FLMT	Fault Level Mitigation Technology – a technical solution that reduces fault levels on the network
FLCB	Fault Limiting Circuit Breaker – a FLMT that blocks fault level contributions from a transformer / bus coupler / generator by disconnecting it before the first current peak of the fault
FNC	Frazer-Nash Consultancy
FSP	The Powerful CB Full Submission Proforma - http://bit.ly/Powerful CB-fsp
GB	Great Britain
HSE	The Health and Safety Executive
Imperial	Imperial Consultants (Imperial College London's consultancy company)
IPR	Intellectual Property Rights
LPN	London Power Networks plc
M1	Method 1 - Installation of a FLCB at a substation
M2	Method 2 - Installation of a FLCB at a customer's premises
NIC	Network Innovation Competition
RIIO-ED1	The current electricity distribution regulatory period, running from 2015 to 2023
SDRC	Successful Delivery Reward Criteria
SPN	South Eastern Power Networks plc
TRL	Technology Readiness Level
UKPN	UK Power Networks
WS1/2/3/4	Workstream 1/2/3/4

1 Executive summary

This report details the progress of UK Power Networks' Network Innovation Competition (NIC) project, Powerful CB, from June 2018 to December 2018.

1.1 Background

Powerful CB aims to demonstrate that fault-limiting circuit breakers (FLCBs) can enable us to connect more distributed generation (DG) to our 11kV distribution networks.

A FLCB is a solid-state circuit breaker that operates 20 times faster than existing ones. This high-speed operation can mitigate fault level contributions from DG, allowing us to connect more DG (particularly combined heat and power) to fault-level constrained networks in dense urban areas. This will help accelerate the decarbonisation of heat, which is a key element of the Government's Carbon Plan.

The project team had been working with two technology partners to develop two types of FLCB. ABB will develop a FLCB for use at a primary substation, known as Method 1 (M1). We believe Method 1 will be the world's first demonstration of a FLCB with a fast commutating switch. Applied Materials Inc. (AMAT) were to develop a FLCB for use at a customer's premises, known as Method 2 (M2).

The project team will continue to work with Frazer-Nash Consultancy (FNC) and Imperial Consultants (Imperial) to develop the safety cases for the M1 device.

The project started on 1 January 2017 and is on track to complete on 31 August 2021.

1.2 Key updates

In this reporting period, the Project Manager (PM) resigned from UK Power Networks for personal reasons. The recruitment process is now complete and the new PM will join the team in January 2019. An interim PM was appointed to the project who will continue to discharge these duties until January 2019. Other members of the team remain unchanged.

The project team continued to work collaboratively with the industry, including other DNOs and potential network customers. To raise awareness and generate higher interest, the team presented the project at a number of internal roadshows and external events. The project team also reviewed ENWL's project Respond closedown report to provide feedback and review the learnings; Project Respond aims to demonstrate that fault current can be managed at lower cost by deploying intelligent software together with innovative technical and commercial fault level mitigation techniques alongside existing assets.

Over the last six months, the project has made progress to prepare and facilitate M1 trials by working closely with internal stakeholders and ABB. However our M2 partner, AMAT, was unable to agree to the contractual terms and conditions and hence decided to withdraw from the project. The work on M2 has since been stalled and a formal change request to remove M2 from the project was submitted to Ofgem on 7 November 2018.

Key highlights regarding the progress of each method are provided below.

1.2.1 Method 1:

M1 network trials are planned to commence in Q2 2019. As such, over this reporting period, the project team has worked with ABB to ensure FLCB development and testing continues to progress as per plan. In parallel, the team also continued its engagement with key internal stakeholders including:

- Capital Programme & Procurement (CP&P) – responsible for site design, trial preparation works, installation and commissioning of the device;
- Outage Planning – responsible for agreeing the required outages for installation and commissioning whilst maintaining the integrity of the network under outage conditions; and
- Network Operations – responsible for on-going control and maintenance of the network, and other associated operations.

These internal liaison meetings were followed up by detailed workshops with nominated representatives of each internal stakeholder to progress work for trial facilitation. Some of the key achievements over this reporting period were:

- Approval and completion of conceptual design for trial site;
- Completion of the design for site civil works; and
- Initiation of the procurement process for material and services, including switchgears, monitoring equipment and cables, required to support trial site preparatory works.

1.2.2 Method 2:

Between June and July, the project made significant progress by recruiting a customer willing to make their site available for the M2 networks trial. This activity was concluded following a sustained period of customer liaison, assessment of the available locations against trial requirements and evaluation of practical feasibility of the sites being considered.

However, further work on M2 was stalled in late July, after AMAT decided to withdraw from the project. This decision was based on their hesitance to agree with the contractual terms of the NIC Collaboration Agreement. At the bid stage, the contractual conditions aligning with NIC Governance Document, were clearly communicated to all project partners. Any subsequent commitment from the partners were based upon their understanding of and agreement with these terms and conditions. Hence the project team had no reason to believe that AMAT or any partner would not sign on to the collaboration agreement.

Though the contractual delays were identified and highlighted as an issue in the last reporting period, AMAT had consistently indicated their willingness to remain an integral part of the project. To ensure that these delays would not have an impact on the project's critical path, the project team issued a final proposal to AMAT in July 2018. At this point, AMAT advised they were unable to commit to complete the contractual negotiations within the required timeframes and the parties agreed to terminate the partnership.

Following the withdrawal of AMAT, the project team undertook a rigorous assessment of numerous options to determine the best way forward to ensure that customers received the best value from the project. The preference was to seek an alternative Fault Current Limiting (FCL) device supplier to continue M2 and retain the learnings,

and any associated benefits. However the results of the Request for Information (RFI) issued to find a replacement were not satisfactory, and no suitable supplier was found.

Subsequently, a change request was submitted to Ofgem to de-scope (remove) M2 from the project.

1.3 Outlook summary for the next period

Considering that a change request has been submitted to remove M2 from the project, the outlook for subsequent periods will only focus on M1.

Workstream 1 (Prototype and validation testing)

- Final witness testing will be conducted for the devices being built by ABB in March 2019.

Workstream 2 (Demonstration on the network)

- The detailed design for installation of trial device will be completed;
- Procurement of the required material & services, and any subsequent preparatory site works required for the trials will be completed; and
- The plan is to commence M1 device commissioning towards the end of the next reporting period.

Workstream 3 (Understanding customers' needs)

- Continue engagement with interested customers, logging their thoughts for BAU transition for M1 and capturing the feedback to assist projects similar to M2; and
- On-going collaboration with ENWL to ensure that the M1 solution is applicable in other DNO licence areas.

Workstream 4 (Knowledge dissemination)

- The project mailing list, consisting of external stakeholders, will be informed about the removal of M2 once a formal decision is received; and
- The project mailing list will be kept abreast of M1 progress.

1.4 Issues

Negotiating terms and conditions with the project partners (further details in section 2.3) has remained a key challenge for the project in this reporting period.

The key summary of progress to date:

- All activities related to the delivery of the retained SDRCs are on schedule;
- The interim PM is managing all appropriate tasks after a handover period;
- In this reporting period, the supplier has advised that the procurement of switchgear required to extend the busbar at M1 trial site will have long lead times. This risk (R31) had been identified at the FSP stage. Project team is currently exploring options with the supplier to mitigate this risk and minimise delivery timeframes;

- The terms of the M1 trial were negotiated with key representatives from the business to ensure trial activities do not compromise the integrity of the existing distribution network. Due to the difference in operating times of the FLCB as compared to a conventional circuit breaker, the stakeholder workshop identified a need to add an auto-close scheme to the existing bus coupler for a low probability scenario where a fault occurs on a specific feeder transformer. There is no existing auto-close scheme commissioned at Glaucus Street primary substation, therefore this additional requirement has expanded the scope of site works; however these are not expected to affect the project budget and timescales; and
- As expanded in Section 1.2.2, to avoid further delays to M2 and the wider project, AMAT was advised to sign the collaboration in this reporting period. At this point in July 2018, AMAT decided to withdraw from the project. Recognising the benefits and associated learnings of M2, the project team attempted to retain M2 by issuing RFI to the FCL supplier market to recruit a replacement but were unable to find a replacement supplier. Thereafter, in the best interests of customers, a change request was submitted to Ofgem for the removal of M2 from the project.

2 Project Manager’s report

Powerful CB aims to demonstrate that FLCBs can enable us to connect more DG to our 11kV distribution networks. The project started on 1 January 2017 and is due to complete on 31 August 2021.

This section describes the progress made in the reporting period from June 2018 to December 2018. Key issues, deliverables or events are drawn out and described in detail; referring where necessary to other sections of the report. This section also provides an outlook to the next reporting period, and describes any key issues or concerns that we consider will be a major challenge in the next reporting period.

2.1 Project team

The core project team continues to comprise of three dedicated roles:

Role	Status	Start date (*expected)
Project Manager	Recruitment complete	21 January 2019*
Workstream 1&2 Lead	Appointed	23 Mar 2018
Workstream 3&4 Lead	Appointed	3 July 2017

In this reporting period, the Project Manager (PM) resigned from UK Power Networks for personal reasons. The recruitment process is now complete and the new PM will join the team in January 2019. The process took longer than expected as two rounds of interviews had to be conducted to find the most suitable candidate for this role, who will continue to steer the project towards successful completion.

An official handover of activities and responsibilities to an interim PM was completed by the incumbent before their departure. The interim PM will continue to discharge these duties until January 2019.

Other members of the team remain unchanged. The graduate innovation engineer, who had been supporting WS1&2 prior to the appointment of the Lead, continues to provide support on the project where necessary.

The aforementioned steps have proven successful in minimising disruption and providing continued stability to the project. The delivery of activities as per plan and the follow-up actions on M2 after the withdrawal of AMAT demonstrates that the team remain focussed on delivering the best value for customers.

2.2 Consultants

We appointed the following consultants:

WS	Role/Scope	Appointee	Status	Start date
WS1	Deliver preliminary safety cases in May 2018	Frazer-Nash Consultancy (FNC)	Contract signed	16 March 2017

WS	Role/Scope	Appointee	Status	Start date
WS1	Provide expert advice on power electronics	Imperial Consultants	Contract signed	20 June 2017

2.2.1 Safety case consultant (FNC, WS1)

To ensure we deliver the safety case on time and on budget, we are contracting the safety case consultant in phases:

- Phase 1: Deliver preliminary safety case in May 2018;
- Phase 2: Update safety case in May 2019 with data and learning from factory testing; and
- Phase 3: Update safety case in June 2021 with data and learning from field trials.

FNC was appointed to deliver Phase 1 via a competitive fixed-price tender as outlined in the previous progress reports. Safety case Phase 1 milestones were delivered on time and as per agreed quality standard.

The work on the requirements and scope for Phases 2 and 3 will commence in the next reporting period, now that Phase 1 has been completed. Closer to the date for Phases 2 and 3, when their scope will be more certain, the project team will review the need to issue another competitive tender for these phases, or re-appoint FNC as the incumbent.

SDRCs 9.1.3 and 9.1.4, based on the production and delivery of an independent safety case, were successfully submitted on time and as per agreed direction. Following the submission of SDRC 9.1.4, the project team proactively contacted the relevant ENA panel for feedback and comments but did not receive any suggestions for improvement.

2.2.2 Power electronics consultant (Imperial Consultants, WS1)

The project has contracted Professor Tim Green from Imperial Consultants (Imperial College London's contracting entity) on a time and materials basis to provide ad hoc expert advice on power electronics. His first engagement was participating in the safety case hazard assessment process. He has not been engaged further in this reporting period but will remain available when required.

2.3 Collaboration agreements

One project partner (ABB) has signed on to a collaboration agreement, while the other (AMAT) could not agree with the contractual terms. As such, we have agreed to exclude AMAT from the project and subsequently submitted a change request to de-scope (remove) M2.

WS	Role/Scope	Project Partner	Status	Commentary
WS1/2	Develop & Trial Method 1 FLCB device	ABB	Contract signed	Use schedule contingency to mitigate two-month late start on ABB tasks.
WS1/2	Develop & Trial Method 2 FLCB device	Applied Materials (AMAT)	Withdrawn	Remove Method 2 from the project. Change request submitted on 7 November 2018

2.3.1 Method 1 – ABB

In this reporting period, ABB have successfully delivered a number of activities relating to M1:

- Completed endurance testing including heat endurance tests;
- Developed the design for prototype integration in the cabinet, and also considered cabling requirements; and
- Initiated the process to procure all materials required to build the three phase trial device.

ABB's key deliverables are as follows:

Ref	ABB Deliverable	Evidence	Original Date	Revised Date	Status
1	Sub parts delivered for one prototype unit	Copies of the relevant invoices and delivery notes	12/06/2017	12/08/2017	Complete
2	First complete prototype assembled	Evidence that the single phase prototype is ready, e.g. completed punch list and results from basic functional tests	08/12/2017	08/02/2018	Complete
3	Validation testing at ABB's corporate research facility	Validation testing report approved by UK Power Networks	06/04/2018	20/06/2018	Complete
4	Validation testing at high power lab	Validation tests witnessed by UK Power Networks Representative; and Validation testing report approved by UK Power Networks	18/12/2018	29/03/2019	On Schedule as per revised date
5	Energisation at UK Power Networks	Commissioning report approved by UK Power Networks	04/06/2019	31/07/2019	On schedule as per revised date

Deliverable 4 "Validation testing at high power lab" provides the key inputs to SDRC 9.1.1 and was originally planned for December 2018. ABB now plan to complete this deliverable on 29 March 2019 due to the limited availability of their high power laboratory and the preparatory works required. This is in addition to the original two month delay at the beginning of the project as explained in the previous progress reports. This gives the project team two months to complete the SDRC. The team will work with ABB closely in the run up to this deadline to ensure there are no impacts on the SDRC submission.

Deliverable 5 "Energisation at UK Power Networks" provides the key inputs to SDRC 9.2.1 is now due on 31 July 2020. As highlighted in Section 1.4 (and Risk R37), a long lead time have been quoted for the delivery of the switchgear required to prepare the site for trials. Although it does not have any material impact on the SDRC, the project team is

proactively working with the supplier to minimise any deviation from the project plan and commence the trials as early as possible.

2.3.2 Method 2 – AMAT

The development and delivery partner originally selected for M2 is a California based company, Applied Materials, Inc. (AMAT) which manufactures fault current limiters.

A non-disclosure agreement was entered into by AMAT during the NIC bid development stage in 2016. UK Power Networks also issued AMAT with its standard form NIC Collaboration Agreement for review during the bid development stage (see Appendix B).

The intellectual property provisions in the NIC Collaboration Agreement were negotiated extensively by UK Power Networks and AMAT between July 2016 and July 2018. The main provisions that were the subject of negotiation were:

- The warranty that use of AMAT's Relevant Background IPR (as that term is defined in NIC Governance Document) would not infringe upon any third party rights (as required under chapter 9.22 of the NIC Governance); and
- The (reciprocal) indemnity for loss suffered by a party as a result of the infringement of third party intellectual property.

It became apparent that the requirements of the NIC Governance Document were in conflict with AMAT-US's (United States) standard contracting position. AMAT's lawyers indicated a number of times that the proposed intellectual property provisions were not market standard in the United States. Progress in the negotiations was impacted by AMAT's slow response times and the need for them to escalate individual matters to management level (or general counsel) approvals offshore. Despite this, we were continually assured by the Managing Director and his team that AMAT were willing to commit to fulfilling the NIC requirements.

The UK Power Networks project team additionally escalated matters that were in dispute to its senior management and general counsel level to ensure every effort was made to come to an agreement. Whilst progress was made by the parties in relation to the intellectual property provisions, final clauses were not formally agreed. After UK Power Networks' final version of the contract rested with AMAT for over nine weeks without a response, and when no satisfactory response was received despite following up several times, the project team issued a final proposal to AMAT in order to reach an agreement in July 2018. At this point, AMAT advised they were unable to commit to complete the contractual negotiations within the required timeframes and the parties agreed to terminate the partnership.

Following the withdrawal of AMAT, UK Power Networks undertook a rigorous assessment of numerous options to determine the best way forward. The underlying principle of this evaluation was to ensure that customers received the best value from our delivered outputs, as per the FSP, whilst complying with the NIC Governance Document. The preference was to retain the learnings and resume M2 by seeking an alternative supplier. The project team engaged with the FCL supplier market by issuing a Request for Information (RFI) to over 50 suppliers but were unable to find a suitable replacement who would have been able to deliver within budget and on time. Subsequently, a change request was submitted to Ofgem to remove M2 from the project.

The project team is confident that Method 1 of the project remains completely unaffected; and is on track to deliver the benefits as stated in the FSP (£400m for GB electricity consumers by 2050), as such the project maintains a good return on investment for customers.

2.4 Workstream Achievements & Outlook

Considering that a change request has been submitted to remove M2 from the project, the outlook for subsequent periods will only focus on M1.

2.4.1 Workstream 1 – Prototype and validation testing

The ultimate objectives of Workstream 1 (WS1) are:

- Deliver one working M1 (ABB) prototype to the M1 trial site; and
- ~~Deliver one working M2 (AMAT) prototype to the M2 trial site~~
- Develop preliminary safety cases for ~~both~~ M1 FLCBs.

Key achievements

In this reporting period, ABB successfully completed validation testing of M1 single phase prototype at their corporate research facility in June 2018 (ABB Deliverable 3, refer to Section 2.3.1). The testing successfully proved that the single phase prototype aligned with the desired characteristics of a fault current limiting device to be deployed for Powerful CB i.e. time taken to interrupt the fault current would remain within three milliseconds. Figures 1 and 2 compare the expected profile against the results generated during validation testing.

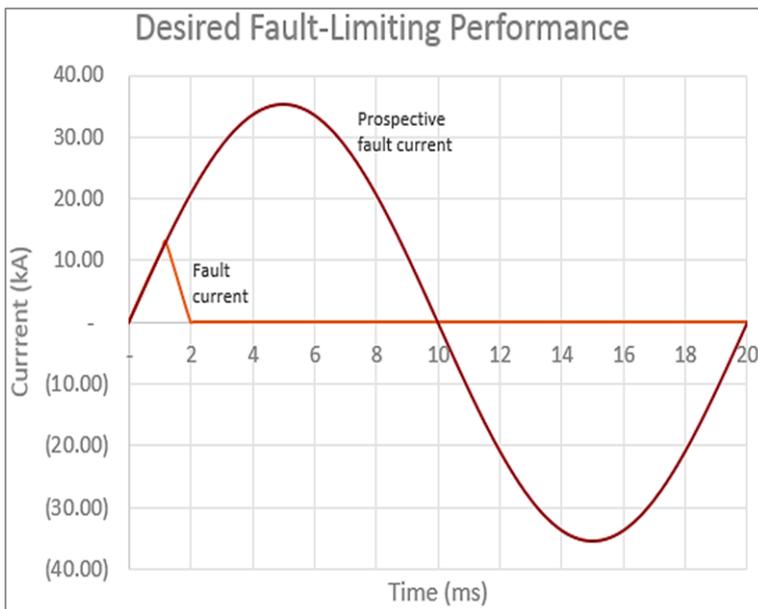


Figure 1: Desired Fault-Limiting Performance

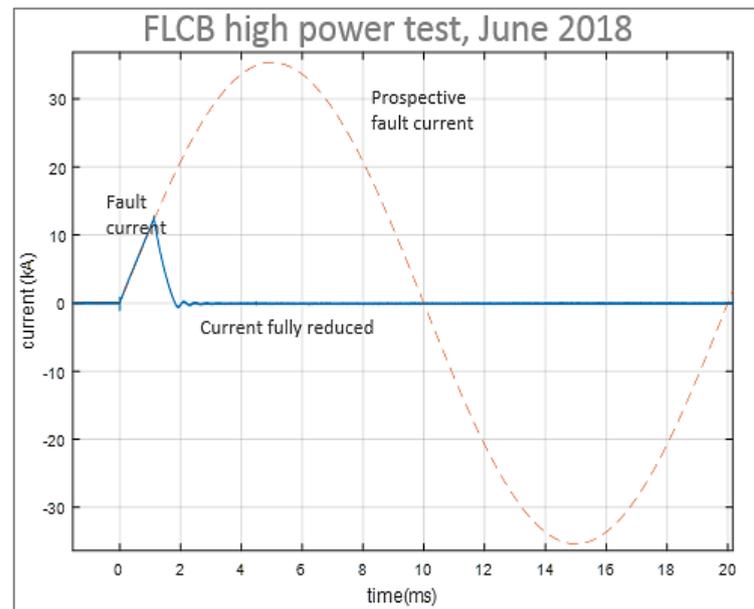


Figure 2: ABB FLCB Validation test result, June 2018

Following the delivery of the validation testing report, ABB also successfully completed FLCB panel integration and preliminary temperature rise testing of the single phase prototype. The previous progress report discussed a two month delay against each of these deliverables, due to the time taken for ABB to sign the collaboration agreement. The project timeframes remain unaffected by this shift in plan as the delays have been absorbed by the schedule contingency.

Outlook

ABB will continue to focus on building their first full scale three phase FLCB prototype and panel integration, at their sites in Vasteras, Sweden and Rattingen, Germany. In parallel they will also provide necessary design documentation required for the completion of detailed electrical design to prepare the trial site for installation and commissioning.

Final witness testing of the devices being built for M1 will be conducted in March 2019 (ABB Deliverable 4, refer to Section 2.3.1). This involves UK Power Networks representatives to witness the testing and approve the report for the ABB deliverable to be considered complete.

2.4.2 Workstream 2 – Demonstration on the network

The ultimate objectives of Workstream 2 (WS2) are:

- Install and commission the FLCBs at the trial sites;
- Collect adequate data to prove that the FLCBs is safe and effective; and
- Update the preliminary safety case to consider data and learning from the field trials.

Key Achievements

M1 trial site selection and preliminary design was completed in this period. Considering the Glaucus Street 11kV substation has been selected as the preferred trial site as per the M1 selection criteria. Appropriate internal stakeholders, including Capital Programme & Procurement, Outage Planning and Network Operations have been engaged to ensure the trial site is ready for device installation by summer 2019.

The electrical running arrangement of the trial site was agreed following a series of workshops with the representatives of aforementioned stakeholders. It was decided that the M1 device will be installed in parallel with the existing bus coupler of the selected substation. The target remains to test and prove the device in normal conditions while minimising risk to the network.

In this reporting period, the project team also worked with these stakeholders to complete the detailed civil design for the trial and commenced the electrical design and procurement activities for the trial site preparation. To reflect the accurate status, the project plan was also updated according to expected civil and electrical enabling works timelines.

Outlook

The detailed design of M1 installation will be completed at the beginning of the next reporting period. It was expected for this work to be complete in this reporting period; however, the activity was deferred to the next reporting period following the delays in signing off the conceptual design.

The procurement activities for the relevant equipment including cables, fault recorded and switchgear required for M1 installation and trial will be completed. Though the procurement exercise has been commenced, the completion of this activity has also been deferred to the next reporting period for the aforementioned reason.

According to the updated project plan, all preparatory site works for M1 trials will be completed and M1 device commissioning will commence towards the end of the next reporting period.

2.4.3 Workstream 3 – Understanding customers' needs

The ultimate objectives of this Workstream 3 (WS3) are:

- Understand our customers' needs; and
- Ensure that we design the solutions to meet our customers' needs.
- ~~Recruit a trial participant for the Method 2 demonstration~~

Achievements

The project team created an essential and desirable criteria matrix and weighted each interested M2 trial participant in Q1 2018. This was followed up by visiting three sites to understand the space, how the trial could impact on critical business activity and their willingness to be involved with media/outreach. The team was able to discount one site due to a space constraint, even with the modular device there was not enough space whether that be in width or height. The other two sites were owned by the same company so the customer was given an option to select the most appropriate site to suit their needs. At the end, A 4.2 MW CHP was selected as the preferred trial site for M2

The preferred trial customer was kept abreast of any changes to M2. The team contacted the customer in September to inform them about the withdrawal of AMAT and asked if there were willing to be considered should we find an alternative device. The customer is still interested and would like to be kept informed. However when no replacement supplier was found, the customer was advised about the outcome and our way forward i.e. a change request to remove M2 from the project and advised that M1 could offer them an alternative solution. The customer, though disappointed, is keen to be remain informed about the project.

Outlook

The team intends to keep the project mailing list informed about how M1 is progressing and also share the details of other FLCB projects in the distribution network domain.

2.4.4 Workstream 4 – Knowledge Dissemination

The objective of Workstream 4 (WS4) is to disseminate knowledge to our key stakeholders.

Achievements

In this period, the project team has successfully engaged with our Distribution Planning Engineers, for their input and feedback. This group is another key internal stakeholder group as they would be the business as usual solution owners should this innovative solution be successfully developed and demonstrated. It is important that the project team take on board their inputs to ensure a smooth BAU transition at the end of the project.

Externally, the project team presented the learnings and achievements were presented at technical forums and innovation conferences, including the Low Carbon Network Innovation Conference (LCNI).

The team also reviewed project closedown report from ENWL project Respond and provided feedback. The project identified similarities and drew upon learnings to avoid similar issues.



Figure 3: Presenting Powerful CB to Distribution Planning Engineers



Figure 4: Project learnings and achievements, were shared and discussed at the LCNI

Outlook

Workstream 4 aspires to share the project learning and inform all stakeholders as the project progresses through different stages. The project team also aims to disseminate knowledge with external parties at innovation event and conferences.

The project also plans to host a webinar for the customer working group during the next reporting period to provide updates on the project progress of M1.

3 Business case update

This section notes any developments or events that might affect the benefits to be gained from the Project. As previously stated, a change request has been submitted to request the removal of M2 from the project. However this does not have any material impact on the quantity or the quality of project benefits outlined in the FSP.

The Powerful CB project FSP stated that the project aims to deliver benefits between £370m and £403m; depending on the solution method deployed. It did not imply that the total value of benefits being delivered would equate to

£773m; and M1 and M2 are solutions to the same problem in different network configurations, and would not be deployed in a situation where they would be used in conjunction.

M1 would be deployed at a substation, eliminating the need for M2 at a customer's premises. Equally, if M2 was deployed at a customer's premises, it may eliminate the need to deploy M1 at our substation.

- 100% Deployment of M1 could result in £403m of benefits
- 100% Deployment of M2 could result in £370m of benefits

In the change request, sufficient details have been provided to demonstrate that the underlying issue being addressed by the project is still relevant, and M1 remains an innovative and cost effective solution. M1 is unaffected by the proposed change and is progressing well. We believe that it is in the best interest of GB customers to continue M1, which expects to deliver benefits of over £400m by 2050.

In summary, even though M2 will no longer be pursued via Powerful CB, M1 remains on track to deliver the benefits outlined in the FSP. As such, this is not perceived to be a significant change to the project's business case.

4 Progress against plan

This section summarises the project's progress in the previous period June 2018 to December 2018. It describes issues we faced and how we managed them, key achievements, notable events, key planned activities for the next reporting period December 2018 to June 2019, and any issues we expect in the next reporting period.

4.1 Overview

All SDRCs are on schedule, the project has consumed a small portion of the schedule contingency to mitigate challenges with resourcing, and negotiating collaboration agreements.

4.2 Issues affecting progress

The main challenges affecting progress in this period were:

- Finding the right person for Project Manager role after the incumbent resigned from the company (see section 2.1 for details)
- Attempting to find a replacement supplier for M2 following AMAT's withdrawal from the project. The project team considered the impact on overall value and benefits of the project before submitting a formal change request to remove M2 (see section 2.3 for details)
- The terms of M1 trial were negotiated with key representatives from the business to ensure trial activities do not compromise the integrity of the existing distribution network. Some additional requirements identified have extended the scope of work for the trial; however these are not expected to affect the project timescales. (refer to section 1.4 for details)

- The supplier has advised that the procurement of switchgear required to extend the busbar at M1 trial site will have long lead times. This risk (R31) had been identified at the FSP stage. Project team is currently exploring options with the supplier to mitigate this risk and minimise delivery timeframes.

5 Progress against budget

This section is provided as a confidential appendix.

6 Bank Account

This section is provided as a confidential appendix.

7 SDRCs

This section provides a brief narrative against each of the SDRCs set out in the Project Direction. The narrative describes progress towards the SDRCs and any challenges we may face in the next reporting period. We have struck-through the SDRCs that we have requested to be removed as part of the change request.

SDRC	Evidence	Progress/Status
9.1 Work with industry to advance new FLMTs based on FLCB technology		
9.1.1 Prototype and lab test a substation-based solution (Method 1)	<p>Publish Learning Report – Development of a FLCB for substations, which will include: recommendations for specifying a substation-based FLCB; results and learning from type tests (including a short circuit test) conducted at an accredited high power laboratory; and requirements for integrating FLCBs into existing networks and ensuring safety.</p> <p>(31 May 2019)</p>	<ul style="list-style-type: none"> • On schedule, despite delays in negotiating collaboration agreement and FLCB specifications. • We finalised the collaboration agreement with ABB on 02/06/2017 • We finalised the FLCB specification on 08/05/2017

SDRC	Evidence	Progress/Status
<p>9.1.2 Prototype and lab test a customer-based solution (Method 2)</p>	<p>Publish Learning Report – Development of a FLCB for customers, which will include: recommendations for specifying a customer-based FLCB; results and learning from type tests (including a short circuit test) conducted at an accredited high power laboratory; and requirements for integrating FLCBs into existing networks and ensuring safety.</p> <p>(31 August 2019)</p>	<ul style="list-style-type: none"> ● On schedule ● We are currently negotiating the collaboration agreement with AMAT. We expect to finalise and sign it before AMAT need to start work on Method 2 development.
<p>9.1.3 Independent review of safety case</p>	<p>Issue preliminary safety case to relevant ENA panel(s) for independent review which will include: Definition and justification of acceptable levels of risk; analysis of failure modes and effects; details of proposed mitigations; and claims, arguments, and evidence to demonstrate that the proposed mitigations reduce the overall level of risk to an acceptably low level.</p> <p>(31 May 2018)</p>	<ul style="list-style-type: none"> ● Complete
<p>9.1.4 Safety case for FLCB installation without back-up</p>	<p>Publish preliminary safety case which will include the technological and operational safety case to the time when the trial equipment could be deployed as BAU without the FLCBs being installed in series with a back-up circuit breaker.</p> <p>(31 May 2018)</p>	<ul style="list-style-type: none"> ● Complete
<p>9.2 Trial the technical suitability of these two technologies including effectiveness and safety considerations for relieving fault level constraints for 11kV networks</p>		
<p>9.2.1 Install and commission solution at an 11kV substation (Method 1)</p>	<p>Publish Interim Learning Report – Demonstration of a FLCB for substations, which will include results and learning from installation, commissioning, and operation to date of a FLCB at a substation.</p> <p>(31 July 2020)</p>	<ul style="list-style-type: none"> ● On schedule

SDRC	Evidence	Progress/Status
<p>9.2.2 Install and commission solution at a customer's premises (Method 2)</p>	<p>Publish Interim Learning Report – Demonstration of a FLCB for customers, which will include results and learning from installation, commissioning, and operation to date of a FLCB at a customer's premises. (31 July 2020)</p>	<p>● On schedule</p>
<p>9.2.3 Demonstration of solution at an 11kV substation (Method 1)</p>	<p>Publish Final Learning Report – Demonstration of a FLCB for substations, which will include results and learning from operating and maintaining a substation containing a FLCB, and technical performance of the FLCB and overall solution under real network conditions. (30 June 2021)</p>	<p>● On schedule</p>
<p>9.2.4 Demonstration of solution at a customer's premises (Method 2)</p>	<p>Publish Final Learning Report – Demonstration of a FLCB for customers, which will include results and learning from operating and maintaining a FLCB at a customer's premises, and technical performance of the FLCB and overall solution under real network conditions. (30 June 2021)</p>	<p>● On schedule</p>
<p>9.3 Assess the suitability of the solutions against customers' needs</p>		
<p>9.3.1 Review the customer needs for these two FLCBs technologies on behalf of DNOs and DG stakeholders</p>	<p>Publish Learning report – Understanding customers' requirements, which will describe our findings from customer dialogue sessions, i.e. understanding their requirements and concerns about FLCBs, and customer feedback. (31 October 2017)</p>	<p>● Complete</p>

SDRC	Evidence	Progress/Status
9.3.2 Assess the (commercial) business case based on the technical and customer findings, focusing on investment decision criteria and trade-offs, such as cost, time to connect, space and impact on security of supply	<p>Publish Learning report – Suitability of FLCBs, which will inform generation customers of the solutions, answer frequently-asked questions, and provide enough information for customers to assess whether the solution meets their requirements (e.g. cost, time to connect, space required, operational impacts, etc.).</p> <p>(31 March 2020)</p>	<ul style="list-style-type: none"> • On schedule
9.4 Share the learning throughout the project with the wider utility industry		
9.4.1 Share overall learning from the project with customers, regulators, other DNOs, other manufacturers, and academia via a stakeholder event	<p>Publish key materials from the stakeholder event (e.g. slides), and provide Ofgem with a list of invitees and attendees.</p> <p>(30 September 2021)</p>	<ul style="list-style-type: none"> • On schedule

8 Data access details

To view the full Innovation Data Sharing Policy, please visit UK Power Networks' website here:
<http://innovation.ukpowernetworks.co.uk/innovation/en/contact-us/InnovationDataSharingPolicy.pdf>

UK Power Networks recognise that Innovation projects may produce network and consumption data, and that this data may be useful to others. This data may be shared with interested parties, whenever it is practicable and legal to do so, and it is in the interest of GB electricity customers. In accordance with the Innovation Data Sharing Policy published in 2017/18, UK Power Networks aim to make available all non-personal, non-confidential/non-sensitive data on request, so that interested parties can benefit from this data.

9 Learning outcomes

This section briefly describes the main learning outcomes from the reporting period, and how we have disseminated them.

No SDRC reports were issued in this reporting period.

10 Intellectual Property Rights (IPR)

This section lists any relevant IPR that has been generated or registered during the reporting period along with details of who owns the IPR and any royalties which have resulted, and any relevant IPR that is forecast to be registered in the next reporting period.

10.1 IPR generated last period

IPR Description	Owner	Type
None at the moment of writing this report	-	-

10.2 IPR forecast next period

IPR Description	Owner	Type
None at the moment of writing this report	-	-

11 Risk management

This section lists the risks highlighted in the Full Submission pro forma, plus any other risks that have arisen in the reporting period. We have described how we are managing the risks we have highlighted and how we are learning from the management of these risks.

Ref	WS	Description	Bid Mitigation	Current Status	RAG
R1	WS1	ABB's costs increase because of exchange rate movements due to Brexit developments	ABB has agreed to hold their quoted price in GBP until the project commences. Once the project has commenced, we will agree the ABB contract price in GBP, or agree the price in EUR and take steps to hedge the exchange rate risk.	Since the contract has been agreed and signed in GBP, this risk is mitigated.	G

Ref	WS	Description	Bid Mitigation	Current Status	RAG
R2	WS3	Unable to find a suitable site / willing customer for customer trial	We will engage with customers to understand their motivations for participating in the trial, so that we can design the trial and recruitment campaign to provide the right incentives and target the right customers. We will also consider relevant customer research and learning from ENWL's FCL Service trial.	We identified three potential trial sites for Method 2, discounting one due to space we still had two sites interested in trialling the solution prior to AMAT withdrawing from the project.	G
R3	-	Not used	-	-	
R4	WS1	Delay and/or cost overrun - prototype development	ABB and AMAT have agreed to take all risk of cost overruns within their control. UK Power Networks will use our existing change control procedures to minimise the risk of changes that cause additional costs for ABB and AMAT.	We have negotiated the collaboration agreements with ABB to minimise the risk of cost overruns and should have both of these signed in the next reporting period.	G
R5	WS1	Delay and/or cost overrun - safety case (due to unforeseeable requirements)	We have allowed specific contingency for the safety case, based on Frazer-Nash's experience of required effort in the event of unforeseen requirements.	FNC delivered the preliminary safety case within the given timescales. SDRC 9.1.4 is now complete.	G

Ref	WS	Description	Bid Mitigation	Current Status	RAG
R6	WS1	Prototype as delivered is not fit for purpose	UK Power Networks, ABB, AMAT, FNC to collaborate to develop the FLCB specifications; Safety consultant to develop safety case in parallel; engage with other HSE, ENA, and other DNOs.	We ensured that ABB, AMAT, FNC, and UKPN technical experts collaborated on the FLCB specification and safety case. The preliminary safety case is now delivered. During detailed design for the trial we have gained better understanding of what fit for purpose means.	G
R7	WS1	Solution does not deliver the necessary reliability and/or redundancy to be able to prove the safety case	Safety case feasibility study completed before full submission. Safety case to be developed in close collaboration with FLCB designers and engineering standards.	All key stakeholders, including ABB, AMAT, and UKPN technical experts, attended the safety case workshops. Outcomes are shaping the design requirements for the trials.	G
R8	WS1	Solution is not suitable for general population of GB sites due to operational or physical space constraints	We will engage with other DNOs to understand any operational or physical space constraints that are unique to their networks.	N/A this period.	G
R9	WS2	Trial site does not experience enough HV network faults to prove that the solution is safe and reliable	We will use history of HV network faults as a criterion when selecting trial sites. We will use the safety case to determine how much data is required to prove that the FLCB is safe.	The selected site has historically experienced a large volume of faults annually.	G

Ref	WS	Description	Bid Mitigation	Current Status	RAG
R10	WS2	Trial fails to capture the data necessary to prove that the solution is safe and reliable	We will ensure that our data capture solution has adequate reliability and redundancy so that we don't miss any opportunities to capture data from real network faults.	We have consulted with ABB about proper placement of fault recorders and sampling requirements. Additionally we will use numerical relays for the protection of the extended busbar which have fault recording capabilities.	G
R11	WS2	Solution fails to operate correctly during field trial (i.e. faults to limit fault current)	We will not allow fault levels to exceed equipment ratings until the FLCB has been proven safe and reliable. This minimises the risk of an unsafe situation if the FLCB fails to operate correctly.	In addition we are going to use a probation period at the start of the trial in order to identify any potential issues early on. During that period the device will put under extreme stress.	G
R12	WS2	Customer trial has adverse impacts on customer	We will identify the potential impacts on the customer and work with them to ensure the risks are well managed.	Method 2 (customer site trials) will no longer be pursued as part of this project. Change request submitted to remove Method 2 from the project.	Closed
R13	WS4	ABB decides not to offer a commercial product	ABB have confirmed that if they are unable to offer their foreground IPR to Licensees in the form of a commercial FLCB product, they are willing, in principle, to licence any relevant foreground/background IPR to a third party for the purpose of developing a commercial FLCB product.	N/A this period.	G

Ref	WS	Description	Bid Mitigation	Current Status	RAG
R14	WS4	Solution is not accepted by other DNOs	We will engage with other DNOs at key stages of the design and specification processes to ensure that their requirements and concerns are addressed.	N/A this period.	G
R15	WS1	Project partners unable to deliver on commitments on time because of lack of resources and/or other commitments	We will agree heads of terms and scopes for collaboration agreements with all project partners in advance of project kick-off.	AMAT has decided not to sign the collaboration agreement. They have withdrawn from the project. We have submitted a change request to remove Method 2 from the project. Currently, ABB has committed to deliver all milestones as per plan.	G
R16	PM	UK Power Networks not able to deliver on commitments because project delivery team is under-resourced	We will secure resources for the core project delivery team in advance of project kick-off, and ensure adequate succession planning to manage the risk of staff movements.	Incumbent Project Manager resigned from the company. A replacement has been found and are expected to start in January 2019. An interim PM has been appointed to mitigate this risk.	A
R17	PM	UK Power Networks not able to deliver on commitments because other teams supporting the project are under-resourced	We have engaged the relevant business units within UK Power Networks to confirm their support of the project, and will confirm resourcing commitments during project mobilisation.	We are working with the relevant business units actively in site selection and trial operation activities.	G

Ref	WS	Description	Bid Mitigation	Current Status	RAG
R18	PM	Partner withdraws from project for financial, commercial, or technical reasons	If one technology partner withdraws from the project, we will consider using the same technology at both substation and customer sites, or if this would not provide value for customers' money, we would de-scope the project to only trial one technology at one site. If FNC withdraw from the project, we will seek an alternative partner who can provide the necessary safety case expertise.	AMAT has decided not to sign the collaboration agreement. They have withdrawn from the project. Following this change, we engaged with the market to find an alternative partner for Method 2. However when no suitable replacement could be found, we decided to request a change from Ofgem to remove Method 2 from the project. ABB remains committed.	Impacted
R19	WS2	Customer (trial participant) withdraws from the project because the trial is impacting their business activities	To minimise probability, We will only consider customers where the risk of adverse impact on their business activities is minimal or can be managed.	Method 2 (customer site trials) will no longer be pursued as part of this project. Change request submitted to remove Method 2 from the project.	Closed
R20	PM	Breach of data protection regulations	We will ensure that all customer's details are handled and stored in accordance with our data protection procedures.	N/A this period.	G
R21	WS2	Solution has adverse impacts on protection grading, causing unacceptable fault clearance times	We will complete a protection coordination study to ensure that the solution does not have any adverse effects on protection coordination.	We have identified some issues on protection grading during the trial detailed design. We are going to manage them through adding auto switching capabilities to specific switchgear in the trial site. We will retain this knowledge for when we produce the engineering design standard.	G

Ref	WS	Description	Bid Mitigation	Current Status	RAG
R22	WS2	Solution fails, causing unplanned outages	We will install additional circuit breakers that enable the FLCB to be remotely bypassed and isolated to minimise the risk of unplanned outages in the event that it fails.	N/A this period.	G
R23	WS2	Solution is not suitable for general population of UK Power Networks sites due to operational or physical space constraints	We have already completed a preliminary feasibility study on a sample of LPN sites, and will complete a feasibility study on a sample of LPN, EPN, and SPN sites as part of the project.	N/A this period.	G
R24	WS3, WS4	BAU method cost is higher than expected	If we discover any issues that could increase the BAU method cost to the point where the project business case is no longer viable, we will assess whether the project should be halted or de-scoped.	N/A this period.	G
R25	WS1	Equipment fails to pass high power type tests	ABB and AMAT have both allowed adequate contingency to build another prototype, in the event that the device intended for the field trials fails catastrophically during type testing and cannot be salvaged.	N/A this period.	G

Ref	WS	Description	Bid Mitigation	Current Status	RAG
R26	WS2	Unable to find a suitable site for substation trial	If we are unable to find a suitable site in LPN (e.g. there are sites that would be suitable for a BAU deployment but not suitable for a trial for business/commercial/safety reasons), we will also consider sites in SPN or EPN that have similar operational and/or physical constraints as typical LPN sites.	We have found a suitable site for the substation trial. This risk can be considered closed.	Closed
R27	WS4	Learning from the project is not disseminated effectively to the DNO community	We will benchmark our knowledge dissemination strategy against other projects and other DNOs to ensure its effectiveness.	During our change requested we have requested to maintain part of the funding of WS3&4 to disseminate the knowledge gained.	G
R28	WS4	Solution is not approved by UK Power Networks	We will involve key UK Power Networks stakeholders to champion the design and specification of the solution to ensure that it is accepted.	Key UK Power Networks stakeholders (i.e. technical experts) are forming an internal working group to discuss issues that may arise in the BAU adoption of FLCB technology.	G
R29	WS3	Solution is not accepted by customers	We will engage with customers to understand their requirements and motivations, and ensure the solution is designed to meet their needs.	We have listened to customer requirements and published our findings in SDRC 9.3.1 – Understanding customers' requirements.	Closed
R30	WS2	Delay and/or cost overrun - civil works	We will leverage the expertise of our in-house capital delivery teams to ensure that all site works are well managed.	N/A this period.	G

Ref	WS	Description	Bid Mitigation	Current Status	RAG
R31	WS2	Delay and/or cost overrun - electrical installation works	We will leverage the expertise of our in-house capital delivery teams to ensure that all site works are well managed.	The supplier has advised us of potential long lead time for retrofitted circuit breakers required to extend the busbars at the trial site. We are currently exploring options with the supplier to mitigate this risk and minimise the timeframes.	A
R32	WS1	Project kick-off delayed by negotiations with project partners	We have agreed heads of terms and scopes for collaboration agreements with all project partners before full submission.	AMAT have decided not to sign the collaboration agreement. They have withdrawn from the project. However we undertook activities to ensure that the critical path remains unaffected.	Closed
R33	WS1, WS2	Project delivery team lacks necessary technical expertise	We have engaged technical experts within the business to serve as the project design authority. We will also engage an expert on power electronics to provide assurance on ABB and AMAT's designs and specifications.	We are working closely with any relevant business units where necessary.	G
R34	WS2	Delay and/or cost overrun – commissioning	We will leverage the expertise of our in-house capital delivery teams to ensure that all site works are well managed.	N/A this period.	G
R35	WS3	Delay and/or cost overrun – customer engagement/recruitment	We will leverage the expertise of our in-house capital delivery teams to ensure that all site works are well managed.	N/A this period.	G

Ref	WS	Description	Bid Mitigation	Current Status	RAG
R36	WS2	ABB–provided (conventional) circuit breakers do not comply with UK Power Network’s requirements	We have allowed adequate contingency for UK Power Networks to supply approved circuit breakers, which would be connected to the FLCB by joggle panels ¹ .	N/A this period.	G

12 Accuracy assurance statement

The project implemented a project governance structure as outlined in our innovation policies and procedures that effectively and efficiently manages the project and all its products. All information produced and held by the project is reviewed and updated when required to ensure quality and accuracy. This report has gone through an internal project review and a further review within UK Power Networks to ensure the accuracy of information.

We hereby confirm that this report represents a true, complete and accurate statement on the progress of the Powerful CB project in its fourth six-month reporting period and an accurate view of our understanding of the activities for the next reporting period.

Signed

Date

Suleman Alli

Director of Safety, Strategy and Support Services

UK Power Networks
