WPD INNOVATION
Transforming the electricity network

EDGE-FCLi

6 Monthly Report

October 2021 – March 2022

WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales

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1. Executive Summary

The Embedded Distributed Generation Electronic Fault Current Limiting interrupter (EDGE-FCLi) project is funded through Ofgem's Network Innovation Allowance (NIA). EDGE-FCLi was registered in September 2018 and is due for completion by March 2022.

EDGE-FCLi aimed to develop a prototype solid-state fault current limiter into a commercial scale device. The device is manufactured by GridON, Israel and has been designed to connect in series with Distributed Generators (DG) on the 11kV network with a maximum 5MW rated output. The device can quickly disconnect the generation from the network upon detection of a fault condition. The FCLi has the capability to limit the fault current contribution from DG and therefore overcome fault level issues that can limit network capacity and prevent future DG connections without the need for network reinforcement or other methods to resolve fault level issues.

The project has been delivered collaboratively between Wester Power Distribution (WPD) and UK Power Networks (UKPN) to ensure that a device is developed that is safe to connect to the 11kV network and is also replicable so that it can be deployed throughout Great Britain (GB). Both WPD and UKPN sought to install and trial an FCLi device on their respective 11kV networks with significant coordination of the FCLi design, factory, and laboratory testing to share learnings and ensure that the devices are suitable for longer-term testing and trials in the field.

This report details project progress from October 2021 to March 2022.

1.1. Business Case

The growth of connected DG has caused an increase fault level across the 11kV network. This is particularly an issue in urban areas, where the fault level is more likely to exceed the capability of the switchgear to safely disconnect a network fault. The following section describes the business case for the FCLi device.

A typical 33/11kV urban primary substation can be assumed to contain 25 no. circuit breakers in total, with on average 20 no. 11kV feeders per substation. It has been assumed that there is eight Ring Main Units (RMUs) per 11kV feeder.

Within the GB distribution network, the majority of the existing 11kV switchgear is rated at 13.1kA (250MVA). The typical reinforcement approach includes upgrading the switchgear to 25kA (476MVA) units. In addition, RMUs close to the primary would also need to be upgraded.

The typical cost of replacing an 11kV circuit breaker and all peripheral equipment is £50k. Similarly, the typical cost of replacing an 11kV RMU is £20k. It is assumed that 25% of RMUs will need to be replaced if the fault level at the site increases above the existing limits. Therefore:

Base Case Cost= 11kV switchgear cost + 11kV RMU cost = (25 x £50k) + 0.25 x (20 x 8 x £20k) = £2,050k

The fault level headroom enabled by the 25kA switchgear is 226 MVA per site and this can accommodate approximately six no. 5MW synchronous generators. Due to other technical constraints, it is reasonable to assume that there will be a 33% reduction in allowed DG connections, hence allowing only four additional 5MW DGs.

The business-as-usual (BaU) cost of an 11kV, 5MW FCLi is expected to be £275k, hence:

Method Cost = 4 x £275k = £1,100k

There is therefore a saving of £950k per installation (Base Case Cost – Method Cost).

1.2. Project Progress

During the period from October 2021 to March 2022, the project team have been working on investigating and resolving the spurious trips that were experienced by the FCLi in the last reporting period. A root cause analysis was carried out into the Built-In-Test (BIT) trip issue experienced on the WPD EDGE-FCLi on 28 July 2021. The manufacturer, GridON, performed an extensive analysis that showed the trip was caused a metal filing located on the Micro Controller Unit (MCU) card in the device's low voltage cubicle. The filing caused a resistive coupling between two of the electronic signal pins on the printed circuit board, spuriously triggering the BIT function. The MCU returned to normal operation in GridON's laboratory after the metal filing was removed.

The root cause analysis took a significant amount of time as the MCU had to be removed and shipped to GridON's facilities in Israel. In addition, GridON performed multiple rigorous laboratory simulations to rule out any other issues that could have contributed to the trip seen on 28 July 2021. A detailed fault investigation report was provided by GridON on 28 October 2021 that summarised the laboratory findings and proposed some minor software modifications to optimise the EDGE-FCLi control system.

Preparations were then made to replace the MCU card and update the control system software so that the device could be reconnected to the grid. GridON attended site at the University of Warwick on 22 November 2021 to complete the remedial work as described in their site work plan. In addition to the updates, GridON performed routine maintenance on the device.

The project team have also been investigating changes to the telecontrol operation of the EDGE-FCLi to in parallel with the site based remedial works to the device. This activity was driven from conversations and feedback from our control engineers responsible for operating the device on our Network Management System (NMS) after the unit was initially connected to the 11kV network on 13 May 2021.

Throughout the reporting period we have continued to communicate regularly with UKPN to share progress information and to understand the respective impact of COVID-19 on each of our project programmes. Whilst COVID-19 has had a limited impact on the WPD installation, UKPN have experienced considerable delays as their trial customer is a Combined Heat and Power (CHP) generator that provides energy to a hospital complex.

The EDGE-FCLi project is due to close at the end of March 2022. This will therefore be the last 6 monthly progress report to be produced for the project. The final analysis of the project learning and trial data will be collated and summarised in the NIA closedown report that will the final project deliverable.

1.3. Project Delivery Structure

The EDGE-FCLi Project Review Group (PRG) meets on a bi-annual basis. The role of the PRG is to:

- Ensure the project is aligned with organisational strategy;
- Ensure the project makes good use of assets;
- Assist with resolving strategic level issues and risks;
- Approve or reject changes to the project with a high impact on timelines and budget;
- Assess project progress and report on project to senior management and higher authorities;
- Provide advice and guidance on business issues facing the project;
- Use influence and authority to assist the project in achieving its outcomes;
- Review and approve final project deliverables; and
- Perform reviews at agreed stage boundaries.

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
GHD	Daniel Hardman	Project Manager
UKPN	Jack McKellar	Innovation Lead
GridON	Yoram Valent	CEO
	Roy Iscovitsch	President & Co-Founder
	Uri Garbi	Project Manager
	Alex Oren	Senior Engineer
	Dvir Landwer	Senior Engineer

1.4. Procurement

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

Table 1-2 Procurement status

Provider	Services/Goods	Project Area	Status/Due Date
GridON	Detailed Design	Design	Complete
GridON	FCLi	Build	Complete
GridON	FAT	Testing	Complete
GridON	Short circuit testing	Testing	Complete
EMS	Sub.net monitoring system	Trial	Delivered
Envico	GRP housing	Installation	Delivered
Control Engineering Ltd	HMI wall box panel	Installation	Delivered
Nexans	Surge Arrestors	Installation	Delivered
Nexans	T-connectors	Installation	Delivered

1.5. Project risks

A proactive role has been taken to effectively manage risk in the delivery of the EDGE-FCLi 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 7.2.

1.6. Project learning and dissemination

The project learning is captured throughout the project lifecycle by engagement with project partners and stakeholders. Learning is regularly recorded and updated through our reporting processes and disseminated through various media. The project learning for the current reporting period is given in Section 5. Table 1-3 summarises the dissemination activities.

Table 1-3 Project dissemination

Event	Date	Attendance	Location
ENIC 2021	12 October 2021	D Hardman	Virtual
ENIC 2020	8 December 2020	D. Hardman	Virtual
Low Carbon Network Fund Conference	16 October 2018	N. Pogaku*	Telford, UK
Electricity Innovation Forum on New Technology and Commercial Evolution, ENA	28 September 2018	N. Pogaku*	London, UK

*Note – These are RINA employees that were responsible for project management prior to the re-baselining activities in late 2019. RINA no longer have an active involvement in WPD's programme delivery; however, they are providing support to UKPN.

2. Project Manager's Report

2.1. Project background

The project aims to design, build, test, install and trial a solid state FCLi on the 11kV distribution network. The FCLi is designed to connect in series with DG and quickly disconnect the generation upon the detection of a network fault. The FCLi is therefore able to reduce the fault current contribution from generation fitted with the device, thus allowing the cost-effective connection of DG to networks that are fault level constrained.

2.1.1. Project re-baseline

The EDGE FCLi project was re-baselined in December 2019 to allow for greater collaboration with UKPN to ensure that the device is replicable and deployable throughout GB. The collaboration will consist of working jointly on the design of the FCLi device, factory, and laboratory testing to ensure that it is suitable for longer-term testing and site trials. A further addition was the inclusion of a Long Duration Performance Test (LDPT) into the programme to understand how the device behaves over an extended period in a controlled environment. This gave further assurances that the FCLi was safe to connect to the 11kV network.

2.1.1. UKPN status

The UKPN EDGE-FCLi has been fully manufactured and tested; it is currently in storage awaiting deployment to their trial site. However, UKPN have been in detailed discussions with the generating customer due to changes in their operational environment because of COVID-19. The UKPN customer is a CHP generator that provides energy to a hospital complex and therefore COVID-19 has had a significant impact on the perception of risk associated with the first of a kind installation.

Originally, WPD's installation was conditional on a successful six-month trial of the EDGE-FCLi device at UKPN's trial site, however, this dependency could not be achieved due to the COVID-19 delays causing delays to the overall project schedule. Therefore, to maintain progress and project learning, we have continued with our EDGE-FCLi connection independently of UKPN. The project work packages have been modified accordingly and are shown in Table 2-1.

An updated NIA Project Registration and Project Eligibility Assessment (PEA) document was submitted to the ENA accordingly on 20 January 2022 to reflect the modified work packages and dependency on UKPN's programme.

Table 2-1 Adjusted work packages following UKPN COVID-19 delays

Work Package No.	Work Package Description	Status
1	Device specifications	Completed
2	Preliminary FCLi design and review	Completed
3	Detailed FCLi design and review	Completed
4	FCLi device manufacture	Completed
5	Performance testing (FAT & Short Circuit Testing)	Completed
6*	LDPT (conditional on successful completion of WP 1-5)	Completed
7*	Trial of the WPD FCLi on the 11kV network where 6 is successful	In progress
Asterisk (*) indicates the updated/new work packages		

In the last reporting period UKPN were due to create a separate NIA project to carry out the remainder of their EDGE-FCLi programme. However, UKPN have encountered significant difficulty coming to agreement with the customer at the proposed trial site as mentioned above, and this has been further compounded by reliability concerns related to UKPN

trialling the trialling the FCLi at a hospital, due to the spurious trips experienced in the field trial that have caused some outages of the EDGE-FCLi at the WPD trial site.

After continuing discussions with WPD, we understand UKPN have been evaluating the merits of different options for continuing with a separate NIA project, including selecting a different trial site for EDGE-FCLi. However, at the time of this process is still underway and a separate NIA project has not yet been developed.

2.2. Project progress in the last six months

The following sections summarise the progress that has been made on the EDGE-FCLi project in the last six-month period.

2.2.1. BIT trip 1

The initial BIT failure occurred on 19 May 2021. This failure was attributed to noise in the transducer measurement system under field trial conditions. To resolve this issue the software was modified to raise the phase current threshold at which the BIT function is triggered to avoid the impact of noise on the triggering logic. After a period of software implementation and verification by the manufacturer, the software was successfully uploaded to the device and the EDGE-FCLi and the issue resolved. The EDGE-FCLi was reconnected to the grid on 19 July 2021.

2.2.2. Root cause analysis on BIT trip 2

The EDGE-FCLi experienced a second BIT trip event on 28 July 2021. The EDGE-FCLi control system logs various parameters in its internal memory and these log files were issued to the manufacturer to undergo a more detailed investigation into the cause of the error. While this investigation was ongoing the EDGE-FCLi was left disconnected from the 11kV network and the site was restored to its normal configuration.

GridON carried out an analysis of the detailed log files and reported that in the lead up to the error, the EDGE-FCLi successfully passed several BIT initiations; however, the timing duration of a BIT triggered on phase 2 of the device was much smaller than the nominal duration programmed into the software. This then caused the trip as described above.

The project team deemed it extremely important to investigate these issues to avoid further spurious trips. As a result, GridON carried out extensive testing and simulations in their laboratory to try and replicate the fault. However, none of the investigations yielded any root cause. The last step was to remove the MCU printed circuit board in the EDGE-FCLi and send it back to the GridON factory for detailed inspection. Following receipt of the unit in Israel, GridON carried out an extensive inspection of the printed circuit board and found two metal filings lodged on the MCU. These are shown in Figure 2-1 and Figure 2-2 respectively. The first filing was found to have no impact on the control system operation. However, the second filing shown in Figure 2-2 broached two signal pins on the printed circuit board and analysis showed that this caused a resistive coupling between the two pins, spuriously triggering the BIT function and causing the issue at the site. The MCU returned to normal operation in GridON's laboratory after the metal filing was removed from the MCU.

Figure 2-1 Image showing metal filing no. 1

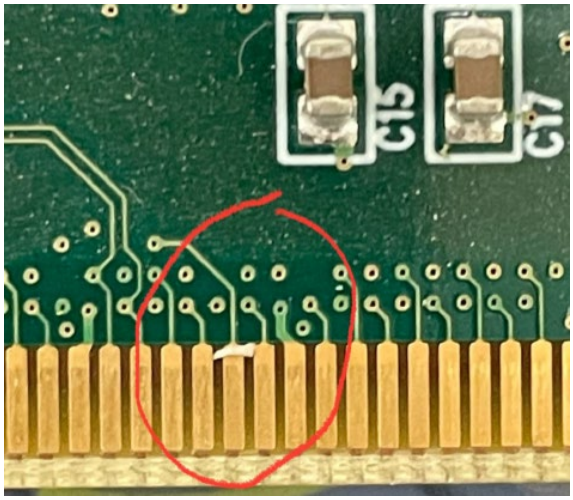

Figure 2-2 Image showing metal filing no. 2

2.2.3. Remedial work and maintenance

After the root cause analysis into the BIT trip was complete, the project team began coordinating with GridON to formulate a plan to get the EDGE-FCLi reconnected to the grid. The MCU card that was sent back to the factory for testing was replaced with a new unit. A polymer protective cover was fitted over the new MCU card to guard against further particulate matter from coming into contact with the sensitive electronics.

GridON also proposed two minor updates to the control system software to improve the operation and diagnostic capabilities of the device. The first software change relaxed some of the pre-qualification timing settings for certain trip conditions. This had the effect of making the device slightly less sensitive to reduce the future likelihood of spurious trip events. Secondly, GridON made some modifications into the way the device logged its internal diagnostic information. The project team confirmed that all changes were suitably tested in GridON's factory prior to the updates being made at the trial site.

GridON attended a site visit at the University of Warwick on 22 November 2021 to install and configure the remedial works as described in site work plan provided to WPD for approval prior to the site visit. In addition to the updates described above, GridON performed routine maintenance on the device as per their operation and maintenance manual. This included a full visual inspection of the internal phase compartments, low voltage cubicle and HV cable termination cubicle. The filters locating in the air intake ducts on the external GRP housing were also replaced by the GridON team.

Figure 2-3 and Figure 2-4 show the EDGE-FCLi undergoing the remedial site works on 22 November 2021.

Figure 2-3 Image showing EDGE-FCLi during remedial work site visit

Figure 2-4 Image showing IGBT modules during visual inspection

2.2.4. Telecontrol modifications

In this reporting period the project team received feedback from the control engineers responsible for operating the EDGE-FCLi remotely from the WPD Network Management System (NMS). The feedback involved improvements to the telecontrol of the EDGE-FCLi to make it simpler and easier to control. In parallel with the site-based improvements, the project team have been carrying out a minor redesign to the telecontrol interface the control engineers see at on their NMS control screens.

To improve the telecontrol functionality, a set of simplified operational flow charts were produced based on the existing EDGE-FCLi's operational modes. These flow charts were then shared and refined based on the feedback received from control. The EDGE-FCLi has two main operational modes that can be executed from the control centre. The first is "RECOVERY" mode, which closes the IGBT switches in the device, making it ready to be energised at 11kV. The second original telecontrol was the "IDLE" mode, which opens the IGBT switches in the device and puts the device into a 'sleep' state. We have now redefined these modes as "ON" and "OFF" respectively, to make it clearer and simpler for the control engineers to interpret the function of the modes.

Figure 2-5 and Figure 2-6 below show examples of the simplified control flowcharts that were used to guide the redefinition of the operational modes.

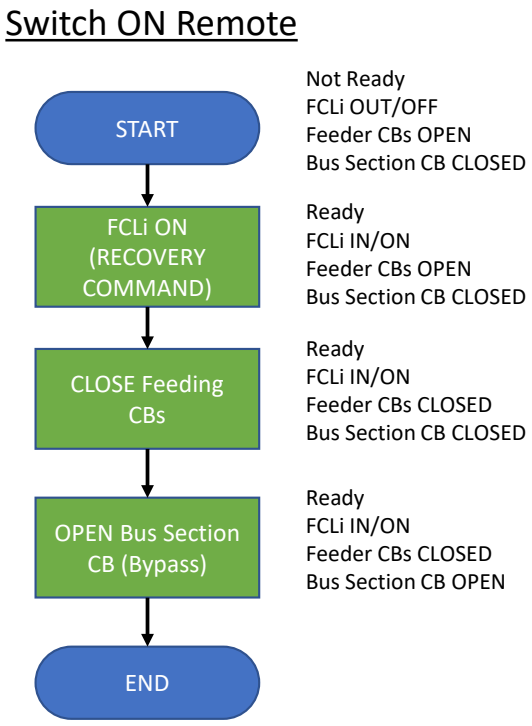

Figure 2-5 EDGE-FCLi remote switch on flowchart

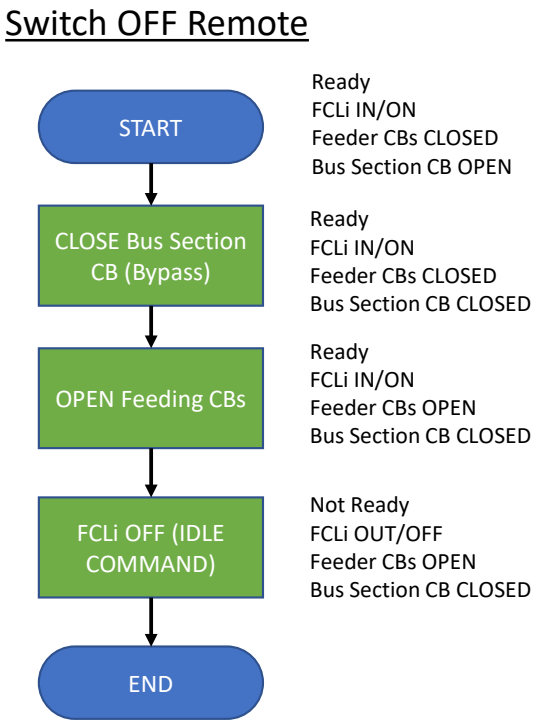

Figure 2-6 EDGE-FCLi remote switch off flowchart

2.2.5. Energisation and reconnection

The project team are currently finalising and carrying out the required telecontrol modifications. After this is complete, they will be tested at the site to make sure the telecontrols correlate with the right operational modes on the device. Once the testing is complete the EDGE-FCLi will be reconnected at 11kV for the remainder of the trial period.

2.2.6. COVID-19 impact

Whilst having a significant impact on WPD's EDGE-FCLi project delivery during the device testing phase over the summer in 2020, the COVID-19 pandemic has had minimal impact during this reporting period. However, we have continued to monitor and assess the COVID-19 risks on an ongoing basis. Table 2-2 presents a summary of the overall COVID-19 impact to the project and a summary of the actions being taken in response to the event.

Table 2-2 Summary of COVID-19 impact

Work Package No.	Work Package Description	Affected?	Comment
5	FAT & Short Circuit Testing	Yes	This work package is now complete. In the re-baselined programme, the FAT & Short Circuit Testing was due for 17-18 March 2020 and 23-24 April 2020, respectively. They were then postponed to 1 June 2020 and 29-30 June 2020 respectively
6	Long Duration Performance Test (LDPT)	Yes	This work package is now complete. Whilst there were some minor restrictions, the impact on this phase of work was minimal
7	Trial of the WPD FCLi on the 11kV network where 6 is successful	No	The trial is currently underway, and the situation is being monitored carefully, however, there are no indications at this time that there will be delays due to COVID-19

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	GridON EDGE-FCLi Unit	1,250.0	1,250.0	1,249.7	-0.3	-0.02
2	Contractor Costs	367.6	360.5	360.5	0.0	0.00
3	WPD Project Management	122.1	67.1	67.1	0.0	0.00
4	Equipment and Labour	258.9	246.5	246.5	0.0	0.00
5	Schneider Switchgear	105.2	105.2	105.2	0.0	0.00
6	Long Term Performance Test	108.0	108.0	0.0	-108.0	-100
-	**Totals**	**2,211.8**	**2,137.4**	**2,029.1**	**-108.3**	**-5.07**

Comments around variance

The LDPT budget item (no. 6) was originally set up to account for the costs of testing the FCLi at a third-party external laboratory. As explained in previous six-monthly reports, an alternative method of performing the test at the University of Warwick (UoW) substation was explored and found to be the optimal solution. The cost for the alternative LDPT solution was significantly lower than the original solution and was able to be absorbed into the budget for the site commissioning activities, hence the reason for zero spend on the associated line item in Table 3-1.

4. Progress towards success criteria

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

Table 4-1 Progress towards success criteria

Criterion No.	Success Criterion	Progress
1	The FCLi limits and reduces the fault current contribution of the generator to zero before the first current peak	The FCLi underwent Short Circuit Testing on 29-30 June 2020. The device successfully detected and interrupted all short circuit conditions before the first current peak of the prospective short circuit current. Refer to further detail on the findings from the testing in the April 2020 – September 2020 six monthly progress report. The device is currently under trial; however, no network faults have been encountered
2	The FCLi introduces minimal disturbance to the network and the generator during normal operation	The EDGE-FCLi has experienced two trip events during the live trial that have caused the device to disconnect itself from the network and this has hindered the amount of trial data that we have been able to collect. A detailed description of the trip events was provided in the last 6 monthly report (April 2021 – September 2021). The learning we've gained from the root cause investigations into the second BIT trip, and our plan of action to remedy these issues is given in Section 2.2. It is important to note, in both trip instances, that the generating customer at UoW was able to be reconnected immediately following the trip event by using the bypass circuit breaker across the EDGE-FCLi, minimising the distruption of the generator. This success criterion can only be assessed fully following the completion of the field trial in March 2022
3	The FCLi remains in normal conduction mode for transient non-fault related events and for faults outside the 11kV network on to which it is connected.	The FCLi underwent Short Circuit Testing on 29-30 June 2020. The device successfully detected and interrupted all prospective fault currents greater than the fault detection settings. The device did not trigger for currents below the settings value and remained in its conduction mode. Refer to further detail on the findings from the testing in April 2020 – September 2020 six monthly progress report. The device is currently under trial; however, no transients have been encountered
4	Any device failures are minor and do not render the plant unavailable for more than a few hours	As described in Item 2, The EDGE-FCLi has experienced two trip events during the live trial that have caused the device to disconnect itself from the network. This has led to significant outages for the EDGE-FCLi but has not led to any long duration outages for the generating plant. This is because the bypass circuit breaker that was installed as a mitigation for prolonged outages of the FCLi was

		immediately closed in both instances, reconnecting the generator to the 11kV network.

5. Learning outcomes

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

5.1. Telecontrol

An important aspect of the learning from the trial is related to the telecontrol configuration used on the EDGE-FCLi. The control engineers responsible for operating the device remotely have communicated feedback to the project team on improvements that could be made to this interface. This is described in detail in Section 2.2.3.

The control engineers' main concern was that the "IDLE" and "RECOVERY" mode labelling on the control screens was significantly different to traditional network equipment, which could cause some misunderstanding when trying to operate the device remotely. After a period of review, the "IDLE" and "RECOVERY" commands could realistically map to new labels "OFF" and "ON" respectively on the control screens. This is a much simpler description of the operational modes from a control perspective and aligns with the existing terminology for network equipment.

The learning point for future reference would be to engage with the control engineers in the detailed design phase of the project that deals with formalising the operational regime of the device that is being connected. In that way, there is greater visibility of the telecontrol aspects earlier in the project delivery and reducing the likelihood of changes to the telecontrol configuration after device energisation.

5.2. BIT trip 2 root cause investigation

The detailed events leading up to the second BIT trip event that occurred on 28 July 2021 can be found in the last 6 monthly report (April 2021 – September 2021). As discussed in Section 2.2.1, the manufacturer of the EDGE-FCLi carried out extensive testing and simulations in their laboratory to try and replicate the BIT fault. However, none of the investigations yielded any root cause. The last step was to send the MCU printed circuit board in the EDGE-FCLi back to the GridON factory for detailed inspection. Following receipt of the unit in Israel, GridON carried out an extensive inspection of the printed circuit board and found two metal filings lodged on the MCU electronics were the source of the BIT fault. These are shown in Figure 2-1 and Figure 2-2 respectively. The first filing was found to have no impact on the control system operation. However, the second filing shown in Figure 2-2 was broached two signal pins on the printed circuit board and analysis showed that this caused a resistive coupling between the two pins, spuriously triggering the BIT function and causing the issue at the site.

This is a highly unusual and unlikely event to occur to a piece of operational hardware and it is not known conclusively where the metal debris originally came from. It is probable, however, that the debris was generated from the drilling of the gland plate at the bottom of the LV cubicle to allow the multicore and LV cables to be terminated into the device. The MCU electronics have now been retrofitted with a plastic cover to avoid further debris coming into contact with the electronics. In future it may be advisable to drill the cable gland plates away from the LV cubicle to reduce the likelihood of stray metal debris finding its way on the sensitive electronics.

5.3. Generator circuit breaker tripping

If the EDGE-FCLi detects a network fault, experiences a device malfunction, or loses its auxiliary LV supply, the unit disconnects itself from the network by tripping its feeding circuit breakers (CB22, CB24) and also CB26 that supplies the CHP generators at UoW. Figure 5-1 shows the final single line diagram of the UoW site and indicates in red the new 11kV circuit breakers added to the existing switchboard to integrate the EDGE-FCLi.

When the project team was carrying out the remedial works discussed in Section 2.2.2, it was observed that the automatic tripping of CB26 was an unnecessary action, especially when cycling the LV auxiliary supply to the EDGE-FCLi during testing and commissioning activities. There is a risk that the CHP generators can be accidentally disconnected unnecessarily leading to a customer outage. After a review of the protection scheme, the tripping of CB26 does not serve any identifiable technical purpose and therefore the decision was made to remove the associated trip links from the circuit breaker trip circuit.

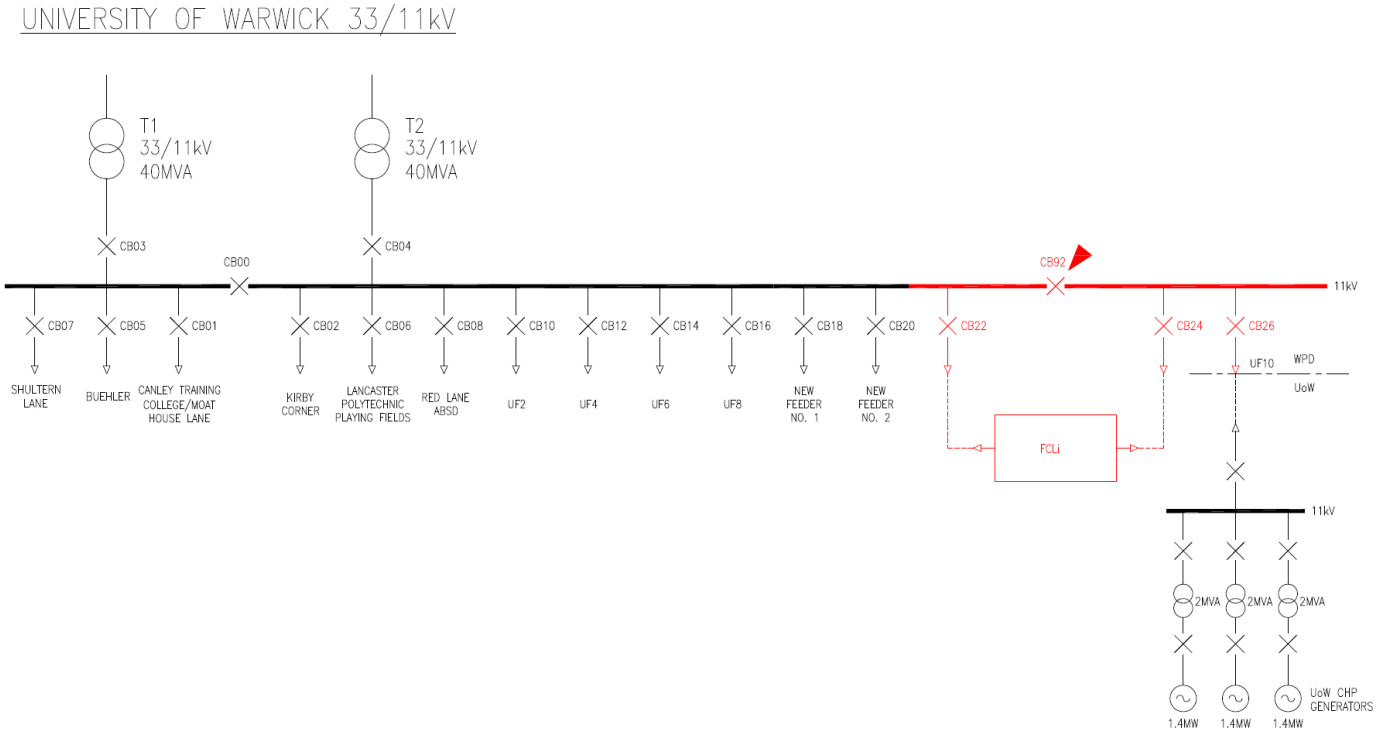

Figure 5-1 Final single line diagram of 33/11kV UoW substation

6. Intellectual property rights

A complete list of all background IPR from all project partners has been compiled. The IP register is reviewed on a quarterly basis.

GridON entered this project with two relevant background IPR patent applications:

1. Patent application “DC Power Supply Arrangement” - filed on 24 January 2017
2. Patent application “AC Switching Arrangement” - filed on 21 March 2017

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

The EDGE-FCLi risk register is a live document and is updated regularly. There are currently seven live project related risks, which has increased from six in the last six-monthly report. This is due to the issues experienced with the spurious BIT trips and telecontrol system as discussed in Section 2. The risk register includes mitigation action plans for each identified risk and appropriate steps then taken to ensure risks do not become issues wherever possible.

Table 7-1 details the top 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
The telecontrol modifications cannot be implemented as required	Major	Coordinate effectively with the internal WPD teams to finalise a simplified telecontrol approach	Meetings with the required staff members have been scheduled and discussions towards simplified and feasible telecontrol approach are underway
The FCLi persistently trips on BIT	Major	If tripping is persistent the FCLi software may need to be modified to mitigate the impact	The manufacturer has carried out a detailed investigation into the spurious BIT tripping and has found that the root cause was a foreign object lodged on

Risk	Risk Rating	Mitigation Action Plan	Progress
			the control electronics. This reduces the likelihood that there are major software issues with the BIT
No faults occur during the trial period	Moderate	Ensure that the EDGE-FCLi is connected to the 11kV network for as much time as possible considering the technical constraints on the BIT function	The manufacturer has carried out a detailed investigation into the spurious BIT tripping and has found that the root cause was a foreign object lodged on the control electronics. This reduces the likelihood that there are major software issues with the BIT. The device is due to be reconnected when the telecontrol mods are agreed and implemented
Software modifications cause knock-on effects on other EDGE-FCLi systems	Moderate	Ensure that any software changes are tested by GridON thoroughly in the lab. Also, try to limit the number of changes in the software to a minimum	There have been some software modifications following BIT trip 1 and 2 events. These have been kept to a minimum and have been thoroughly tested in GridON' laboratory facilities prior to being uploaded on the device during the remedial work that took place on 22 Nov 2022
Customer requests a change to their current supply arrangement	Moderate	There are no immediate plans to change the configuration, however, close communication with WPD internal teams and the customer will help with early identification	Communication with the appropriate parties is ongoing

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

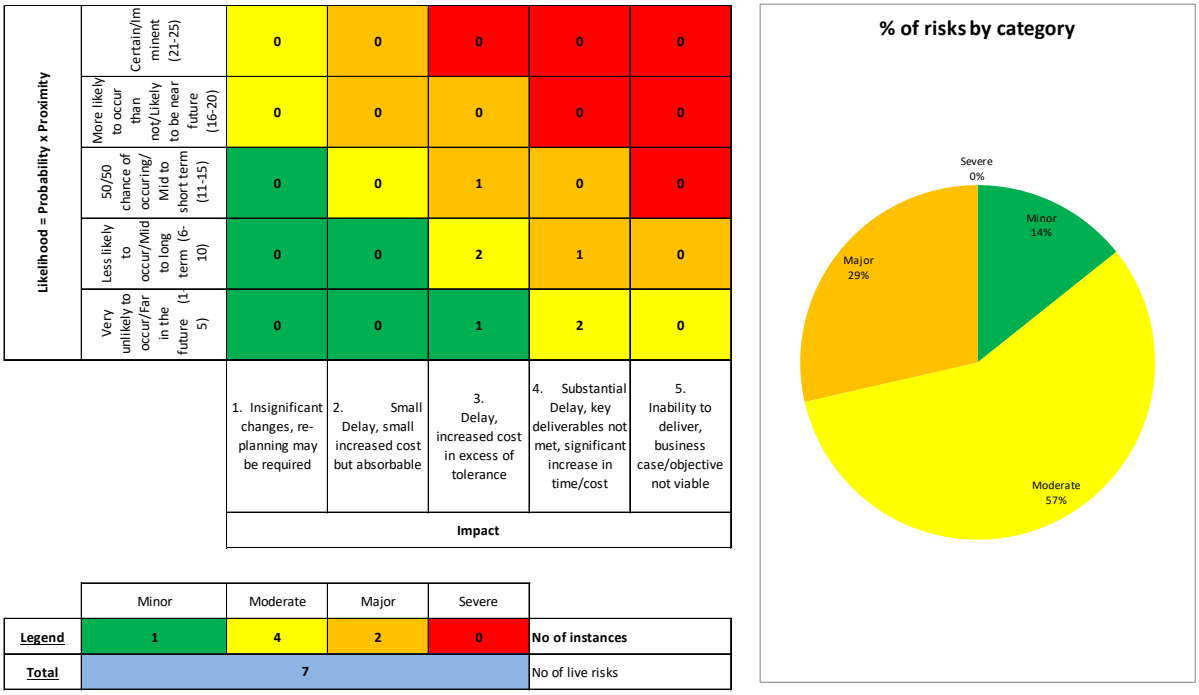

Figure 7-1 Graphical view of project risks

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	Risk Rating	Mitigation Action Plan	Progress
The FCLi persistently trips on BIT	Major	If tripping is persistent the FCLi software may need to be modified to mitigate the impact	The manufacturer has carried out a detailed investigation into the spurious BIT tripping and has found that the root cause was a foreign object lodged on the control electronics.
Root cause of BIT issues not found	Major	Manufacturer to carry out a detailed investigation and simulation of similar conditions in the lab	The manufacturer has carried out a detailed investigation into the spurious BIT tripping and has found that the root cause was a foreign object lodged on the control electronics. This risk is now closed
No faults occur during the trial period	Moderate	Ensure that the EDGE-FCLi is connected to the 11kV network for as much time as possible	The project team is currently working to finalise and implement the telecontrol modifications to allow the

Risk	Risk Rating	Mitigation Action Plan	Progress
		considering the technical constraints on the BIT function	EDGE-FCLi to be reconnected as soon as possible
Customer requests a change to their current supply arrangement	Moderate	There are no immediate plans to change the configuration, however, close communication with WPD internal teams and the customer will help with early identification	Communication with the appropriate parties is ongoing
FCLi fails to trip for a network fault	Moderate	EDGE-FCLi has undergone short circuit testing, however, there have been subsequent software modifications to mitigate issues with the BIT function. Manufacturer to review and ensure that no 'knock-on' effects are apparent	The manufacturer has carried out a detailed investigation into the spurious BIT tripping and has found that the root cause was a foreign object lodged on the control electronics. This reduces the likelihood of any additional spurious trips

8. Consistency with project registration document

A copy of the latest Project Registration and PEA document can be found here.

At this point in time the project is consistent with the project budget and programme. The COVID-19 pandemic is also not causing delays to the overall WPD programme.

9. Accuracy assurance statement

This report has been prepared by the EDGE-FCLi Project Manager (Daniel Hardman), reviewed, and approved by the Innovation 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
BaU	Business as Usual
BIT	Built In Test
CEO	Chief Executive Officer
CHP	Combined Heat and Power
COVID	Coronavirus disease 2019
DC	Direct Current
DG	Distributed Generation
EDGE-FCLi	Embedded Distributed Generation Electronic Fault Current Limiting interrupter
ENA	Energy Networks Association
ENIC	Energy Networks Innovation Conference
FAT	Factory Acceptance Testing
GB	Great Britain
GHD	Gutteridge, Haskins & Davey Limited
GRP	Glass Reinforced Plastic
HMI	Human Machine Interface
HV	High Voltage
IGBT	Insulated Gate Bipolar Transistor
IP	Intellectual Property
IPR	Intellectual Property Rights
LDPT	Long Duration Performance Test
LV	Low Voltage
MCU	Micro Controller Unit
MVA	Mega Volt-Amperes
NIA	Network Innovation Allowance
NMS	Network Management System
PEA	Project Eligibility Assessment
PRG	Project Review Group
PSD	Primary Systems Design
RMU	Ring Main Unit
SCADA	Supervisory Control and Data Acquisition
UKPN	UK Power Networks
WP	Work Package
WPD	Western Power Distribution

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