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FLEXDGRID

HEAT AND POWER FOR BIRMINGHAM

PROJECT PROGRESS REPORT

REPORTING PERIOD:

JUNE 2014 – NOVEMBER 2014

LCN Fund Low Carbon Networks

THE UNIVERSITY OF WARWICK

PARSONS BRINCKERHOFF

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Contents

Glossary

Term	Definition
AC	Alternating Current
AFD	Active Fault Decoupler
BaU	Business as Usual
BCC	Birmingham City Council
CBD	Central Business District
CHP	Combined Heat and Power
DC	Direct Current
DG	Distributed Generation
DNO	Distribution Network Operator
DPCR5	Distribution Price Control Review 5
ER G74	Engineering Recommendation G74
EU	European Union
FCL	Fault Current Limiter
FLM	Fault Level Monitor
FLMT	Fault Level Mitigation Technology
GT	Grid Transformer
HV	High Voltage - 6.6kV or 11kV
IEC	International Electrotechnical Commission
KPI	Key Performance Indicator
LCNI	Low Carbon Networks & Innovation
PEFCL	Power Electronic Fault Current Limiter
PSFCL	Pre-saturated Core Fault Current Limiter
PSS/E	Power System Simulator for Engineering
RAMs	Risk Assessment Method statement
RII0-ED1	DNO Price Control from 1 April 2015 to 31 March 2023
RSFCL	Resistive Superconducting Fault Current Limiter
SDRC	Successful Delivery Reward Criteria
SoW	Scope of Work
ST	Standard Technique
TCA	Testing and Certification Australia
UoW	University of Warwick
WPD	Western Power Distribution
X/R ratio	The X/R ratio is the ratio of the system reactance to the system resistance looking back towards the power source from any point in the network

1 Executive Summary

FlexDGrid is funded through Ofgem's Low Carbon Networks Second Tier funding mechanism. FlexDGrid was approved to commence in January 2013 and will be complete by 31st March 2017. FlexDGrid aims to develop and trial an Advanced Fault Level Management Solution to improve the utilisation of Distribution Network Operators' (DNO) 11kV (HV) electricity networks while facilitating the cost-effective and early integration of customers' generation and demand connections.

This report details progress of FlexDGrid, focusing on the last six months, June 2014 to November 2014.

1.1 Business Case

The business case for FlexDGrid remains unchanged. Birmingham City Council (BCC) continue to have a policy in place for the inclusion of combined heat and power (CHP) plants in new domestic and commercial construction sites.

1.2 Project Progress

FlexDGrid is now in the construction phase with significant works to include both fault level monitors (FLM) and fault level mitigation technologies (FLMT) being undertaken in this reporting period. Two FLMs are now installed, commissioned and operating and the first FLMT is installed with an energisation date of late February 2015.

Following on from the work carried out in previous reporting periods, the use of real-time modelled fault level data and data from the energised FLMs is now being used to understand the opportunity to utilise this data, to maximise the amount of distributed generation (DG) connected to the network, but also how to operate the network to provide greater security of supply to customers.

During this reporting period (June 2014 – November 2014) FlexDGrid has made significant progress in working towards the delivery of other project SDRCs, specifically SDRCs 7 - 11.

1.3 Project Delivery Structure

1.3.1 Project Review Group

The FlexDGrid Project Review Group met twice during this reporting period. The main focus of these meetings was the construction activities to integrate both the fault level monitors (FLM) and fault level mitigation technologies (FLMT).

1.3.2 Resourcing

There have been no significant resourcing changes during this reporting period.

Contracted construction staff continues to be employed on a site by site basis to support WPD with the delivery of the technology installation activities.

1.4 Procurement

As discussed in the previous Progress Report the procurement activity for the technologies (FLMs and FLMTs) is now complete, where all contracts are in place. An overview of these technologies and their expected installation dates is provided below in Table 1-1.

Table 1-1 - FlexDGrid Technology Contracts

Manufacturer	Technology	Applicable Substations	Anticipated Delivery Dates
S&C Electric	Fault Level Monitors	10 Sites	Phased throughout 2014 and 2015
GridON	Fault Current Limiter – Pre-saturated Core	Castle Bromwich	January 2015
Nexans	Fault Current Limiter - Resistive Superconducting	Chester Street Bournville	June 2015 August 2015
Alstom	Fault Current Limiter - Power Electronic	Kitts Green Sparkbrook	January 2016 April 2016

1.5 Installation

Two FLMs have now been installed and are currently operational, with three more sites currently under construction to be energised early next year. The two remaining FLMs, due to the installation process, are linked to the installation of the FLMT at each site, which means their installation is planned for the middle of 2015.

The first FLMT is now installed on site with a planned energisation date of February 2015. Work on the remaining four sites for FLMT installations is ongoing. The timeline for these installations is throughout 2015 and early 2016.

1.6 Project Risks

A proactive role in ensuring effective risk management for FlexDGrid is taken. This ensures that processes have been put in place to review whether risks still exist, whether new risks have arisen, whether the likelihood and impact of risks have changed, reporting of significant changes that will affect risk priorities and deliver assurance of the effectiveness of control.

Contained within Section 8.1 of this report are the current top risks associated with successfully delivering FlexDGrid as captured in our Risk Register along with an update on the risks captured in our last six monthly project report. Section 0 provides an update on the most prominent risks identified at the project bid phase.

1.7 Project learning and dissemination

Project lessons learned and what worked well are captured throughout the project lifecycle. These are captured through a series of on-going reviews with stakeholders and project team members, and will be shared in lessons learned workshops at the end of the project. These are reported in Section 0 of this report.

A key aim of FlexDGrid is to ensure that significant elements of the work carried out for network modelling, monitoring, design and installation are captured and shared within WPD and the wider DNO community. During this period the main focus has been to capture learning in the form of WPD policy documents.

We have also shared our FlexDGrid newsletter, which contains up to date information on the progress of project activities and links to further resources, with over 450 project stakeholders.

The LCNI Conference which took place from the 20th to 22nd October was also used as an opportunity to externally disseminate FlexDGrid's learning to date and plan moving forwards.

In addition to this we have shared our learning (where applicable), through discussions and networking at a number of knowledge sharing events hosted by other organisations.

2 Project Manager's Report

2.1 Project Background

The FlexDGrid Low Carbon Networks Fund project aims to develop and trial an Advanced Fault Level Management Solution to improve the utilisation of Distribution Network Operators' (DNO) 11kV (HV) electricity networks while facilitating the cost-effective and early integration of customers' generation and demand connections. The FlexDGrid project was awarded funding through Ofgem's Low Carbon Networks Second Tier funding mechanism and commenced on the 7th January 2013.

The Carbon Plan aims to deliver carbon emission cuts of 34% on 1990 levels by 2020. This national target is devolved, in part, through local government carbon emission reduction targets as set out in their strategy planning documents. The Carbon Plan sets out ways to generate 30% of the UK's electricity from renewable sources by 2020 in order to meet the legally binding European Union (EU) target to source 15% of the UK's energy renewable sources by 2020. The UK Government has identified distributed generation (DG) as a major low carbon energy enabler and an important part of the future electricity generation mix.

Fault level is a measure of electrical stress when faults occur within networks. It is a growing issue in the connection of Distributed Generation (DG), especially in urban networks, as the majority of DG increases the system fault level. Conventional solutions to manage Fault Level often entail significant capital costs and long lead times.

In order to address the Fault Level Management Problem, three methods will be trialled and evaluated within the Central Business District (CBD) of Birmingham. The findings from these three methods will be extrapolated in order to understand the wider applicability to GB urban networks.

These Methods are:

Method Alpha (α)	-	Enhanced Fault Level Assessment;
Method Beta (β)	-	Real-time Management; and
Method Gamma (γ)	-	Fault Level Mitigation Technologies.

These three methods aim to defer or avoid significant capital investment and create a wider choice of connection options for customers who can accept a flexible connection to the network. These benefits will be provided to customers through advanced and modified generation connection agreements. Each method on its own will help customers to connect DG more flexibly. The three methods used together will aim to create greater customer choice and opportunities for connection.

2.2 Project Progress

This is the fourth reporting period, where the first two focussed on the design, development and procurement activities, with the previous moving from concept design to final design and construction. Within this reporting period the construction activities have continued along with technologies being built, tested, installed and operated. Additional work including the approval and publication of WPD engineering specifications and standard techniques relating to FLMs and FLMTs has been completed.

2.3 Project Reporting Progress

Table 2-1: Project Reporting Dates

Due Date	Type	Description	Status
12.09.2014	KPI	First FLMT Passed Testing	Complete
31.10.2014	KPI	First FLM Commissioned	Complete
31.10.2014	KPI	FLM Policies Approved	Complete
28.11.2014	KPI	FLMT Policies Approved	Complete

2.4 Substation Selection Update

The design phase for FlexDGrid selected 10 and 5 sites for the installation of FLMs and FLMTs respectively, from 18 sites originally identified as part of the detailed design phase of the project.

Perry Barr 132/11kV substation was selected as it was a preferred site suitable for the installation of a FLM. However, following enabling works it has been established that due to existing ground conditions significant civil works will be required to install the FLM and 11kV switchgear. It has been identified that substantial cost savings can be achieved if the site was replaced with another within the FlexDGrid project area.

Nechells West substation has been identified as the most suitable replacement substation for Perry Barr. It has similar fault level restrictions to Perry Barr and available space for the installation of FLM equipment.

2.5 FLM Testing

In May 2014, WPD witnessed the testing of the FLM at S&C's testing facility. The device was tested for electrical and mechanical robustness, such as lightning impulse testing, along with testing of the accuracy of the Fault Level readings that the device generates compared to a measured, bolted, fault produced in the laboratory.

The FLM was operated on the test network and passed all tests for mechanical and electrical operation. However, during the testing of the FLM a combination of software issues was identified. This caused the Fault Level readings, produced by the FLM, to be outside the tolerances specified in the contract (5% difference from the measured fault). The results for the Peak and RMS Fault Level were 50% and 30% different from the measured test faults respectively. For this reason the device failed the Factory Acceptance Test (FAT).

Following the results of the tests, further investigations have been carried out by S&C and WPD to fully understand the issues experienced and provide a suitable solution. A correction to the calculation software has since been applied and using computer models and simulations S&C has demonstrated that the FLM can meet the accuracy requirements specified in the contract. The key change focusses on the data points used to analyse the disturbance to generate the Fault Level values. Due to the length of the pulse being reduced, around 5ms, which further reduces the potential for any unwanted customer effects, originally the final data point fell outside of the disturbance period, meaning that inaccurate results were repeatedly produced. This is illustrated in Figure 2-1. A retest of the full FLM device, with the refined algorithm, has been arranged for February 2015 in order that the FLM performance can be verified against actual faults under laboratory conditions.

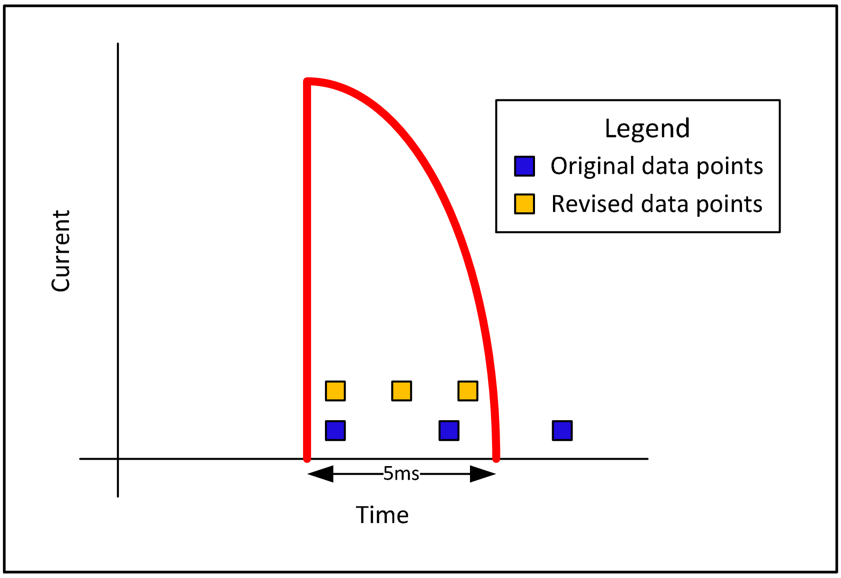


Figure 2-1: FLM pulse under test

As the problems identified were software related and S&C demonstrated robustly that the required changes in the calculation algorithm could be successfully completed, it was decided to continue with the installation of the FLMs to prevent potential project delays and significant cost increases.

2.6 FLM Installation Phase – Method Beta

The previous progress report for the period December 2013 to May 2014 gave a summary of the design work that has been completed and the installation start dates for eight of the ten substations selected for installation of FLMs. With the replacement of Perry Barr substation by Nechells West substation selected, additional design work has had to be carried out, which was completed in November 2014 with a planned site energised date of March 2015.

Construction works have started at all seven remaining sites and two FLMs are now commissioned and energised. At the remaining two sites that have been tendered, the FLMs are scheduled for commissioning by the end of February 2015. Table 2-2 below lists the sites and the FLM energisation date or the forecast date.

Table 2-2 - Energisation dates for FLM sites

Substation	Status	Energisation Date
Elmdon	Energised	14/10/2014
Chad Valley	Energised	02/12/2014
Castle Bromwich	Under construction	January 2015*
Kitts Green	Under construction	January 2015*
Shirley	Under construction	January 2015*
Chester Street	Under construction	February 2015*
Hall Green	Under construction	February 2015*
Nechells West	Under construction	March 2015*
Bournville	Under Design	June 2015*
Sparkbrook	Under Design	June 2015*

*Forecast energisation dates

Due to the FLM integration at both Bournville and Sparkbrook being linked to the integration of the FLMT the installation dates for these two sites is significantly later. The expected FLM installation date is June 2015 for Bournville and Sparkbrook, which is driven by the installation date for 11kV switchgear.

Contracted labour has been used to deliver both the civil and electrical elements of the work on site due to constraints on existing WPD resource delivering the existing DPCR5 programme and preparing for the delivery under RIIO-ED1. Despite a competitive tender process the costs for carrying out this work are significantly greater than had been anticipated. These costs are being actively managed and monitored against the original cost allocation as part of the project's bid documentation.

Photos of the FLM installation and commissioning at the commissioned sites are shown below.

Figure 2-2: Commissioning of Elmdon PMIR

Figure 2-3: Commissioning of Elmdon FLM Cubicle

2.7 FLMT Installation Phase Overview – Method Gamma

During the current reporting period significant steps have been made in progressing the design and installation of FLMTs at the five FlexDGrid sites. Weekly progress telephone conferences and regular design meetings have been held with all three manufacturers to ensure the design and installation activities are kept on schedule. Currently all FLMTs are on schedule to be delivered to the programme dates identified in the supplier contracts.

A rigorous design review process for all technologies to ensure compliance with Health and Safety Legislation and best industry practice has been employed. In addition, conformance with the latest WPD equipment specifications and standards has been required where ever possible. Although this process has resulted in the design review process taking longer than anticipated, early submission of design documents has meant that projected FLMT energisation dates have not been effected.

2.8 GridON Pre-Saturated Core FCL

2.8.1 Construction Work

The first FLMT to be connected to the 11kV network for FlexDGrid is the pre-saturated core FCL, manufactured by GridON, at Castle Bromwich substation. In the previous reporting period the tender for the civil and electrical installation had been awarded and activities had recently commenced on site. During the last six months a significant portion of the construction work has been completed, including:

- Installation, commissioning and energisation of new 11kV switchgear;
- Installation, commissioning and energisation of a new earthing transformer;
- 11kV cable installation for FLM and FLMT;
- Protection modifications;
- Civil work for FLM and FLMT rooms; and
- Commissioning of FLM.

The pictures below show the stages of construction work undertaken to date.

Figure 2-4 - Removal of FLM wall to install equipment

Figure 2-5: Removal of wall ready for FCL installation

Figure 2-6: Concrete plinth being prepared for extension to accommodate FCL

Figure 2-7 - Extended plinth for FCL installation

The construction work is now entering the final stages involving the commissioning and energisation of the FLMT. This is due to be completed by the end of February 2015.

2.8.2 FLMT Build, Testing and Delivery

The pre-saturated core FCL is currently on schedule to be energised in February 2015. Table 2-3 below shows the key milestones for the device.

Table 2-3 - Key milestones for Pre-Saturated FCL

Activity	Status	Actual / Forecast Date
Device Build	Complete	22/07/2014
Successful Testing	Complete	06/09/2014
Delivery to Site	Complete	09/12/2014
Energisation	In progress	27/02/2015*

*Forecast energisation date

The construction and assembly of the FCL was undertaken in Wilson Transformer Company's factory in Melbourne, Australia. The FCL was built and prepared for initial factory tests on 22nd July 2014 ready for shipping to Sydney for short circuit testing.

Short circuit tests on the FCL were performed in AusGrid's accredited High Power TCA Laboratory in Sydney. Testing began on 11th August and the FCL successfully passed all the required tests outlined and witnessed by WPD on 16th August. Table 2-4 provides a summary of the tests carried out.

Table 2-4 - Results from short circuit testing

Test	Prospective Current (kA)	Duration (sec)	Maximum current with FCL in circuit (kA)	Result
Break FL Normal DC Bias	6.85	1	3.87 + 5%	Pass (-8.7% below max)
Break FL Minimum DC Bias	6.85	1	3.87 + 5%	Pass (-12.14% below max)
Peak FL Normal DC Bias	20.66	1	9.68 + 5%	Pass (-0.29% below max)
Current Withstand Full DC Bias	33.4 Peak 13.1 Break	3	N/A	Pass (no damage)

Following the short circuit tests, the FCL was shipped back to Wilson's factory in Melbourne for de-tanking and inspection and the final set of factory tests in the Wilson Transformer Company Power Test Laboratory. The factory tests were based upon the IEC standard 60076-6, for Power Reactors, with additional tests to cover the measurement of the magnetic field and control of the DC bias current. The main tests that were carried out are listed below:

- Functional, auxiliary and wiring checks;
- Winding Resistance, Impedance and Losses;
- AC Withstand;
- Temperature Rise;
- Noise;
- Lightning Impulse; and
- Magnetic Field.

Factory testing was successfully completed on the 6th September and the device was prepared for shipment to the UK. The pictures below show the completed FCL in the test laboratory and subsequent loading on to a ship for transit to the UK.

Figure 2-8: FCL side view with DC cable box

Figure 2-9: FCL side view with AC cable box

Figure 2-10: FCL being transported to Melbourne dockyard

Figure 2-11: FCL on board vessel for transit to the UK

2.9 Nexans Resistive Superconducting FCL

Since the last reporting period significant progress has been made in the design and manufacture of Nexans' resistive superconducting FCLs for both Chester Street and Bournville substations. Superconductor material has now been ordered for both devices. With Chester Street being the first Nexans device to be installed the cryostats, concrete enclosure and other auxiliary equipment have been ordered / manufactured ready for testing in April 2015. Table 2-5 below shows the key milestones for the Nexans FCL devices.

Table 2-5 - Key milestones for Resistive Superconducting FCL

Activity	Forecast Date	
	Chester Street	Bournville
Device Build	26/03/2015	03/06/2015
Successful Testing	09/04/2015	17/06/2015
Delivery to Site	14/04/2015	22/06/2015
Energisation	05/05/2015	13/07/2015

All the major design documents for Chester Street have now been reviewed and approved by WPD including; general arrangements, schematic diagrams, enclosure details, wiring diagrams and piping and instrumentation drawings. Many of these design documents are also common to the Bournville device.

Civil construction drawings and tender documents have been prepared by WPD for the new foundation at Chester Street so that the site is available for the device delivery in April 2015. Civil designs for Bournville have also been prepared for new 11kV switchgear and modifications to the room where the FCL will be located.

11kV switchgear required for Bournville substation has been ordered with an anticipated delivery date in early Q2 2015.

Outline drawings of the Chester Street and Bournville FCLs are shown in the pictures below.

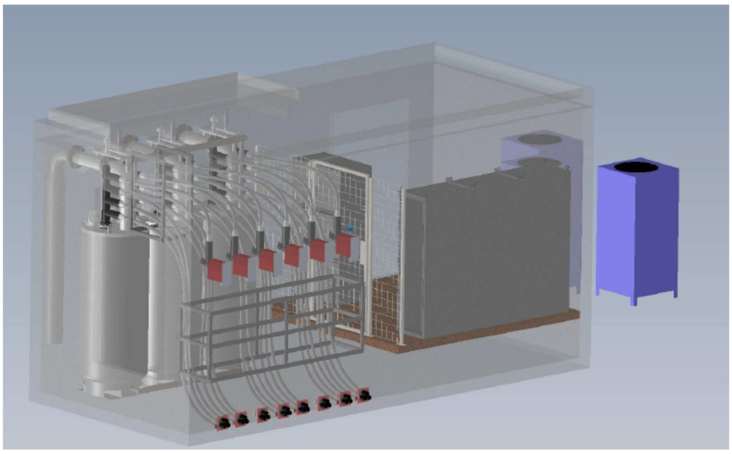


Figure 2-12 - Chester Street FCL front view

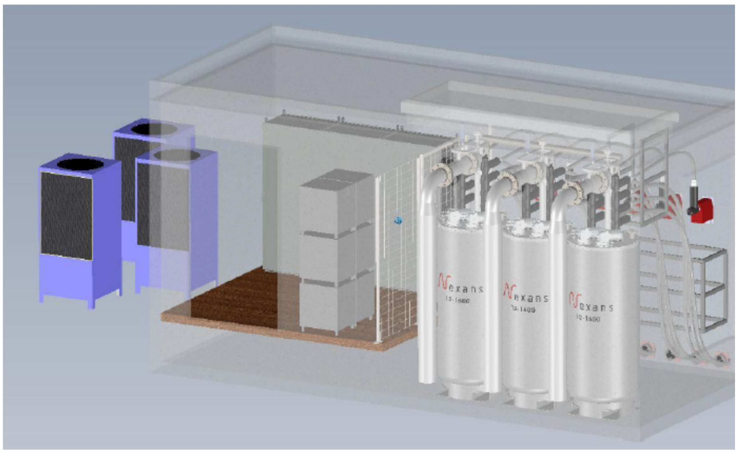


Figure 2-13 - Chester Street FCL rear view

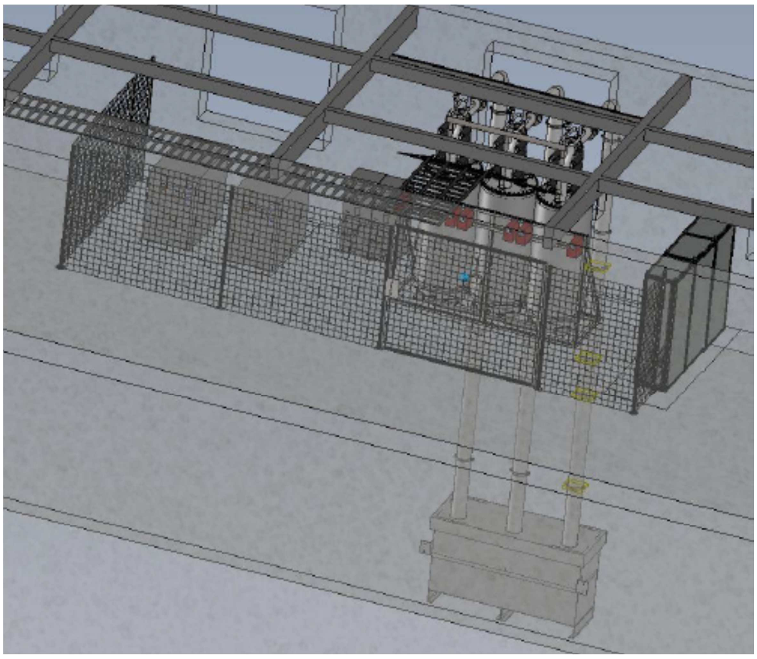


Figure 2-14 - Bournville FCL view

2.10 Alstom Power Electronic FCL

Design for Alstom's Power Electronic Active Fault De-Coupler (AFD) FCL is progressing significantly with the first stage of design completed and approved, with the second stage design currently underway. All major component suppliers have been identified and the devices for Kitts Green and Sparkbrook substations are due to be assembled ready for testing in August 2015 and November 2015 respectively. Table 2-6 below shows the key milestones for the Alstom Devices.

Table 2-6- Key milestones for Power Electronic FCL

Activity	Forecast Date	
	Kitts Green	Sparkbrook
Device Build	24/07/2015	30/10/2015
Successful Testing	28/08/2015	27/11/2015
Delivery to Site	04/09/2015	04/12/2015
Energisation	25/09/2015	29/01/2016

Alstom has built a scaled down prototype of the Power Electronic FCL in their laboratory, in Stafford, to allow simulation of fault scenarios to verify the operation and fail safe mode of the device. Figure 2-15 and Figure 2-16 below show the prototype being used for testing purposes in Alstom's laboratory.

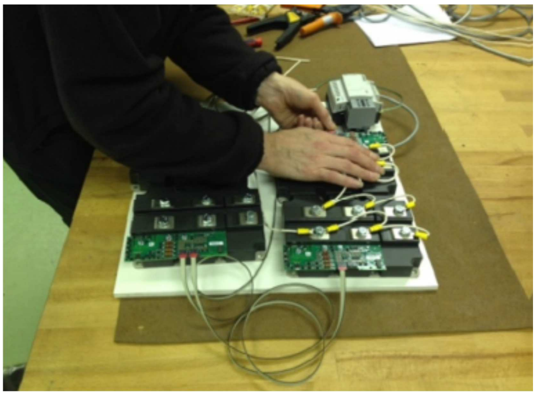


Figure 2-15 - Connection of the Power Electronic FCL prototype

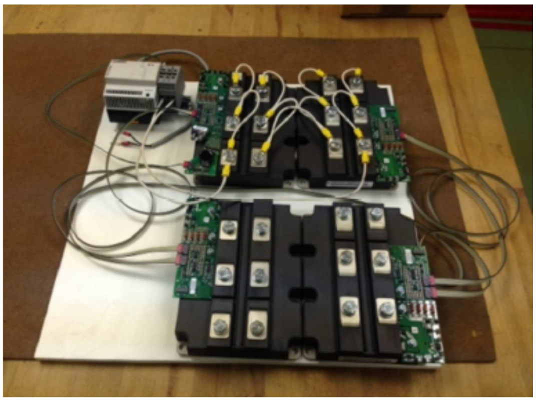


Figure 2-16 - IGBT modules used in the prototype

Once the final design of the AFD is established in early Q1 2015, detailed civil and electrical installation designs will be prepared to cover the works required at Kitts Green and Sparkbrook substations.

2.11 Monitored FL Data vs Modelled FL Data

The first FLM energised at Elmdon has been energised since October 2014 and data has been gathered to allow comparison between monitored and modelled fault levels. The assessment of the monitored values and enhanced models is detailed below.

The FLM at Elmdon is connected to bus section C which is fed from GT2B as shown in Figure 2-17 below.

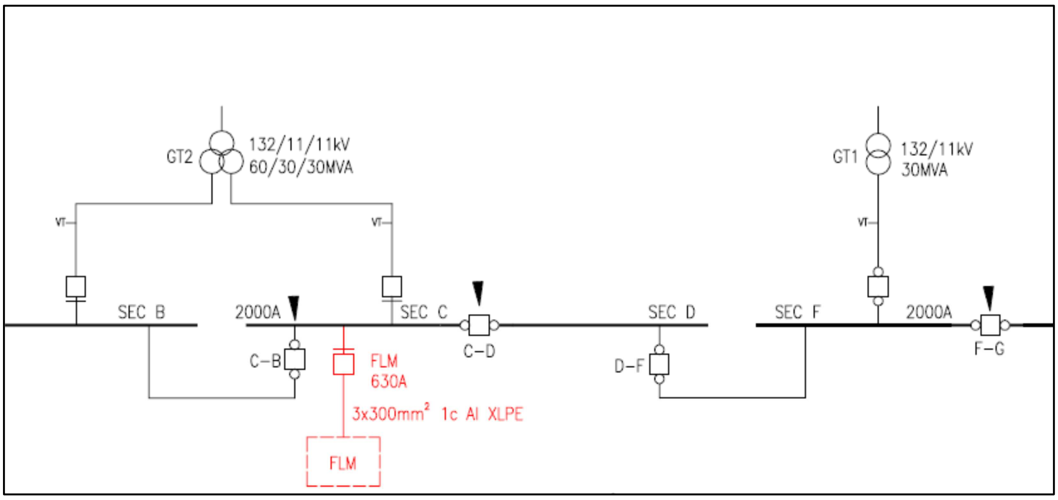


Figure 2-17 - Connection of FLM at Elmdon Substation

As discussed in previous reporting periods, the FLM generates fault level values through detecting a pulse of current and a corresponding change in voltage, created by the PMIR, to calculate the system impedance to enable the Peak and RMS fault levels to be produced. Figure 2-18 shows these waveforms.

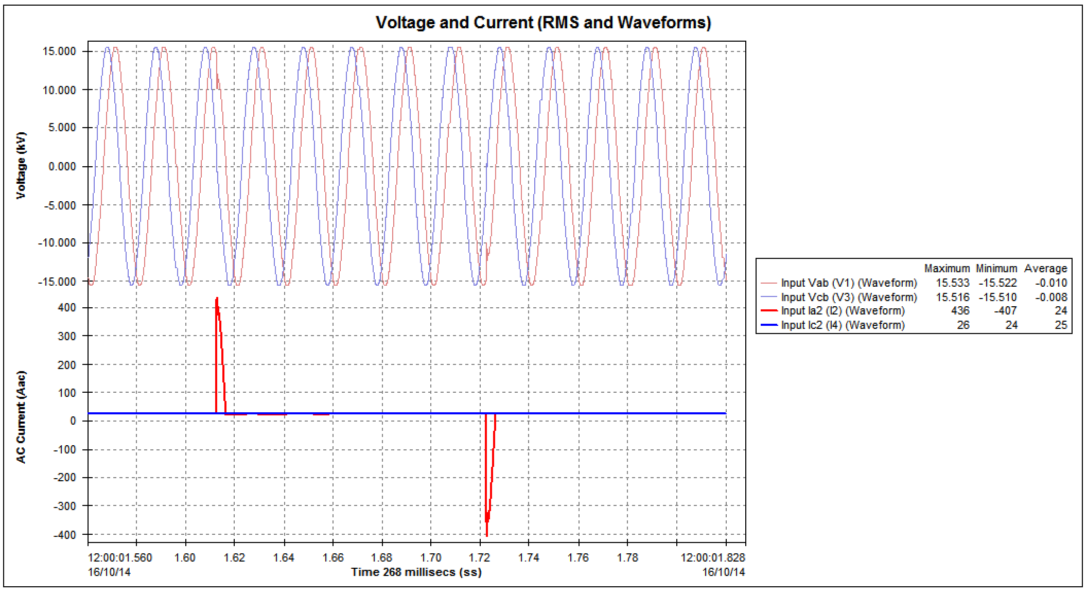


Figure 2-18: V and I waveforms of FLM

From the waveforms as seen in Figure 2-18 the Peak and RMS fault levels are generated. These are provided in a 3D graphical format, which allows the time, fault level and the data confidence value to be presents. Figure 2-19 and Figure 2-20 show the Peak and RMS fault level for a week's operation at Elmdon substation, respectively.

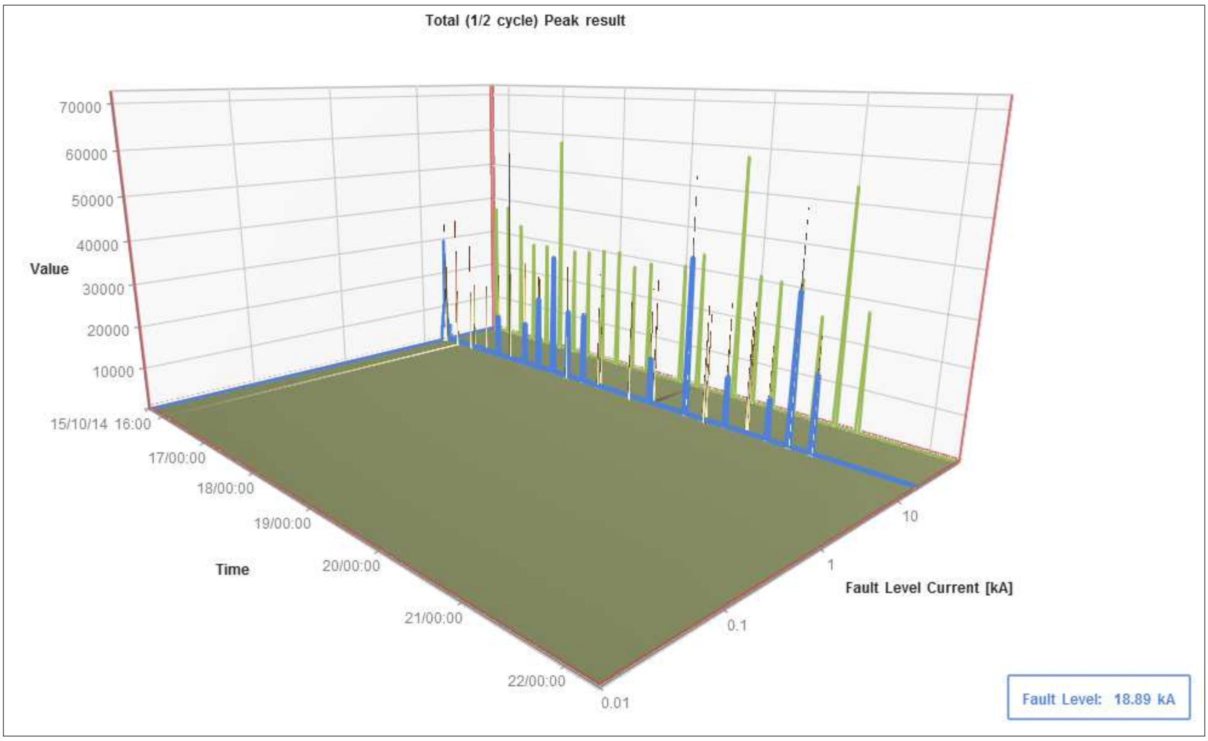


Figure 2-19: Peak fault level graph for 1 week's operation - Elmdon

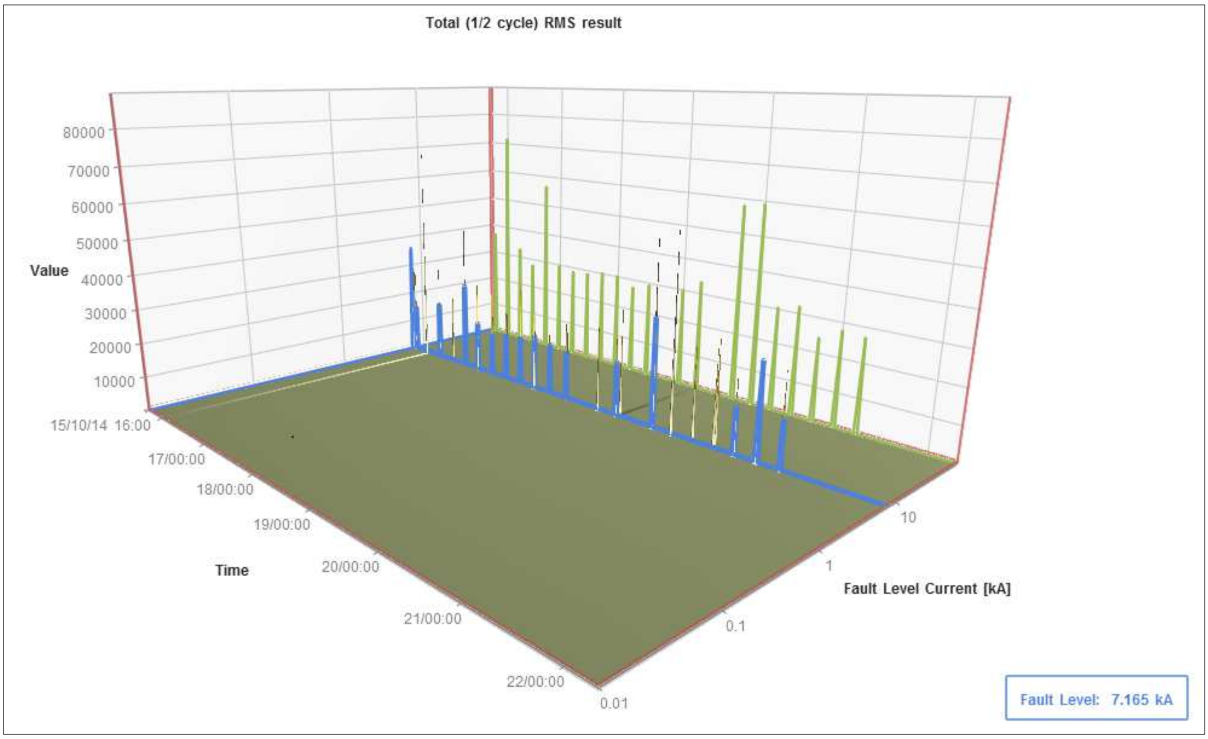


Figure 2-20: RMS fault level graph for 1 week's operation – Elmdon

This data was then used to compare with the enhanced PSS/E models, which have been produced as part of FlexDGrid. Table 2-7 shows the difference between the monitored values and the modelled values, where different load infeed factors have been used. G74 prescribes that 1.0MVA/MVA should be used for LV general load infeed and as such this is the standard used in WPD's modelling, in the project location. Other load infeed factors have been modelled, based on G74 recommendations for HV loads and site specific detail.

It can be seen in Table 2-7 that when a load infeed factor of 2.6MVA/MVA is used then the modelled values most accurately represent the monitored data. This learning supports the ongoing work that is to characterise primary substations by their load types, namely the ratio of domestic, small industrial and commercial and large industrial and commercial to determine a specific load infeed factor, to more accurately model the system fault level.

Table 2-7: Comparison between Modelled and Monitored Fault level values for FLM operation

	Monitored	Modelled – Varying load infeed factors (MVA/MVA)			
	FLM Data	1.0	1.1	2.6	3.2
Peak (10ms) fault level [kA]	19.78kA	18.23kA	18.33kA	19.82kA	20.39kA
Peak model & FLM diff [%]	-	-7.8%	-7.3%	0.2%	3.1%
RMS (10ms) fault level [kA]	7.35kA	6.72kA	6.77kA	7.50kA	7.79kA
RMS model & FLM diff [%]	-	-8.6%	-7.9%	2.0%	6.0%

2.12 Policy Documents – All Methods

The report for the previous period explained the significance of capturing the learning to date for FlexDGrid in the form of policy documents. The four engineering policy documents relating to the connection and specification of FLMs and FLMTs that were summarised in the previous report, have now been authorised by WPD Policy Department and are now "live" on WPD's Intranet for viewing:

EE201 – Fault Level Monitor (FLM) Devices for use on the 11kV Network (FlexDGrid);
EE202 – Fault Current Limiter (FCL) Devices for use on the 11kV Network (FlexDGrid);
SD4R – Application and Connection of 11kV Fault Level Monitors (FLM) devices for FlexDGrid; and
SD4S – Application and Connection of 11kV Fault Current Limiters (FCLs) for FlexDGrid.

These documents have now been made available to all DNOs upon request. The value of creating and sharing these policies is to move a considerable step forward towards FLMs and FLMTs becoming part of main business roll-out.

2.12.1 Operation and Maintenance of FLMs

With the first two FLMs commissioned and connected to the 11kV network, it was important to ensure that procedures were available to staff who would be responsible for the ongoing operation and maintenance of the technologies.

In line with similar equipment connected to WPD's network (such as 11kV circuit breakers), two separate policy documents have been prepared:

- Standard Technique, ST:OC1U – Operation and Control of 11kV FLMs
- Standard Technique, ST:SP2V – Inspection and Maintenance of 11kV FLMs

As part of the deployment of these policies, a presentation to local operational staff was arranged to aid understanding of the policies and the new technologies connected to the 11kV network.

2.12.2 Operation and Maintenance of Pre-Saturated Core FCL

GridON's 11kV Pre-Saturated Core FCL will be the first FLMT to be connected to WPD's network with forecast energisation in January 2015.

In addition to the full suite of documents that make up the "Installation and Operation Manual" provided by the manufacturer, a further two WPD policy documents have been produced to cover the operational and maintenance related activities associated with the FCL:

- Standard Technique, ST:OC1V – Operation and Control of GridON Pre-Saturated Core FCL
- Standard Technique, ST:SP2W – Inspection and Maintenance of GridON Pre-Saturated Core FCL

These two documents were prepared in collaboration with the manufacturer and capture the salient points required to safely operate, control, inspect and maintain the FCL over its lifecycle.

2.12.3 Operation and Maintenance of Resistive Superconducting FCL

The Nexan's Resistive Superconducting FCL will be the second FLMT to be installed on the 11kV network as part of FlexDGrid. Work is currently underway to produce policies to cover the operational and maintenance activities associated with this FCL prior to energisation in May 2015.

2.13 Fault level mitigation technology modelling

The work to develop computer models of the three FLMTs that will be trailed in FlexDGrid has been continued during this reporting period. The aim is to develop tools and methodologies for incorporating the FLMT models in to the existing fault level study process. The developed FLMT models will be compatible with the BaU tools and software employed by WPD's planning engineers for desktop system studies. The exiting fault level study practices consider fault levels at making time and breaking time to evaluate the switchgear capabilities. On this basis, the developed FLMT models are a static model that simulates two snapshots of post-fault network conditions at fault making time (10ms) and fault breaking time (70ms or 90ms).

2.13.1 FLMTs performance data

In order to model the performance of the three FLMTs, the FLMT manufacturers were requested to provide the prospective impedance of the device at pre-fault and post-fault conditions for different network scenarios. This data was used to create a FLMTs' impedance look-up table that are then input to the FLMT static models, developed in FlexDGrid, to accurately calculate the fault level values post FLMT installation.

2.3.1.1 Pre-Saturated Core FCL

The PSCFCL device behaviour during fault conditions depends on the pre-fault magnetisation level of the device and the fault current flowing in the primary winding (AC winding) of the PSCFCL. The pre-fault magnetisation level of the device is controlled by the DC current in the secondary winding, which is adjusted based on the PSCFCL's loading in normal condition.

In order to develop a static model for the PSCFCL, GridON, the PSCFCL manufacturer, was requested to provide the prospective PSCFCL's impedance at fault making time and fault breaking time for different network scenarios. These network scenarios include different PSCFCL loadings in normal conditions and differing prospective fault currents. Prospective fault current is the fault current before insertion of FLMT device.

As an example, Figure 2-21 shows the data obtained for PSCFCL's prospective reactance for one of the network scenarios in which the prospective breaking fault currents is 10kA, the network X/R ratio is 23.5 and a pre-fault PSCFCL loading of 1000A.

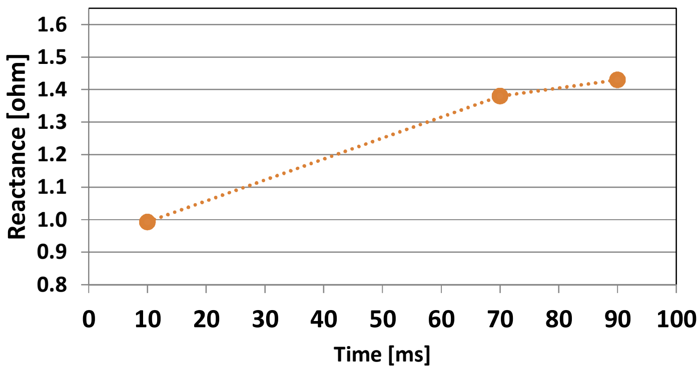


Figure 2-21 - PSCFCL reactance - prospective breaking fault current is 10kA, X/R ratio is 23.5 and pre-loading is 1000A

Data analysis showed that the behaviour of the PSCFCL device is very non-linear. In order to improve the accuracy of the modelling of this device, GridON has been requested to provide the prospective PSCFCL impedance for additional network scenarios, which will enable the PSCFCL's accuracy to be further increased.

2.3.1.2 Resistive superconducting FCL

The RSFCL device is designed to insert a high resistance in the network when the temperature of the superconductor exceeds a critical value. The temperature of the RSFCL device is kept under the critical temperature, during normal conditions, using liquid nitrogen. However, during a fault condition the superconductor temperature goes beyond this critical level. Therefore, the impedance of the RSFCL device during a fault is almost independent of the RSFCL's loading in pre-fault condition.

In order to develop a static model of the RSFCL, Nexans, the RSFCL manufacturer, provided the prospective RSFCL's impedance at fault making time and fault breaking time for different network scenarios. These network scenarios include different prospective peak and breaking fault currents.

The results of analysis on data provided by Nexans showed that the RSFCL impedance at make fault time and break fault time can be estimated using the graphs shown in Figure 2-22 and Figure 2-23, respectively.

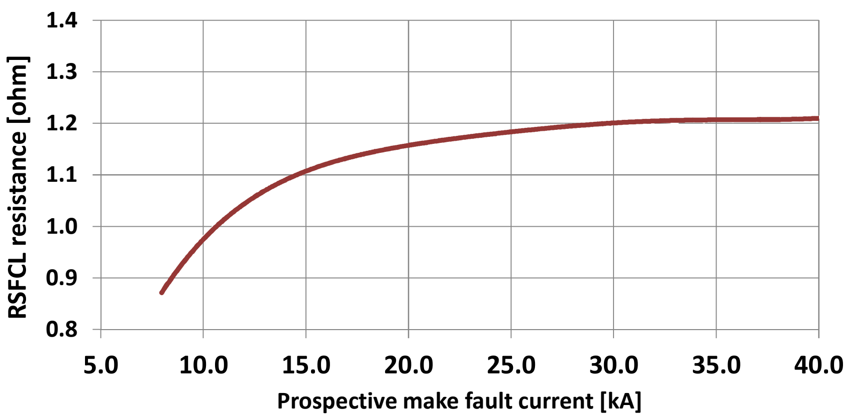


Figure 2-22 - RSFCL resistance at make time for different make fault levels

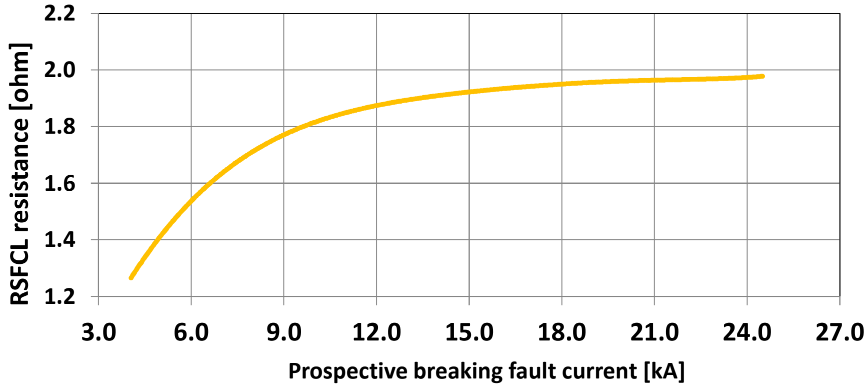


Figure 2-23 - RSFCL resistance at break time for different break fault levels

2.3.1.1 Power Electronic FCL

The principle of the PEFCL's performance is similar to a very fast acting circuit breaker that can disconnect the branch where it is installed under fault condition. Unlike the PSCFCL and RSFCL, the PEFCL does not insert any impedance in the network during fault condition. The breaking time of the PEFCL is also very fast in that it disconnects the circuit even before the transient fault current reaches its first peak value (fault making time). Therefore, the same behaviour as a fast acting circuit breaker will be considered for the purpose of PEFCL modelling, i.e. where it disconnects the system in less than 10ms.

2.13.2 PSS/E FLMT model

A PSS/E model for each of the FLMTs has now been developed and incorporated into the WPD BaU fault level assessment process. Figure 2-24 shows the methodology used to enhance the BaU process and incorporate the FLMT models. A python script based on ER G74 is used by WPD planning engineers for BaU fault level calculations. The developed FLMT models are coded in Python to ensure compatibility with the existing BaU tools. In summary, the following specifications are considered for the developed FLMT models:

- Provide a compatible tool with existing BaU process for planning engineers to calculate make and break fault levels for fault level assessment or connection studies;
- Simulate the behaviour of the three FLMTs (PSCFCL, RSFCL and PEFCL) in two snapshots of post-fault network conditions, fault making time and fault breaking time;
- Use a look-up table approach to estimate the prospective impedance of FLMTs; and
- Report calculated fault levels in similar format as BaU WPD G74 script.

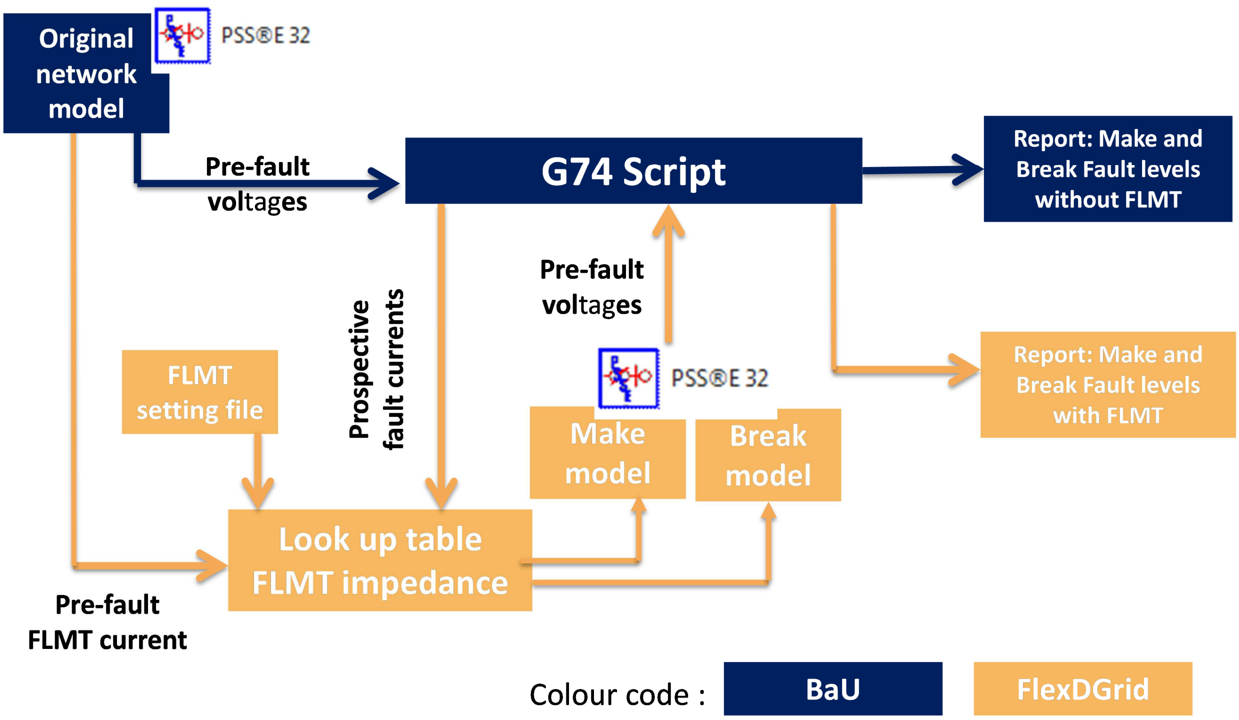


Figure 2-24 - Methodology to incorporate FLMTs models into BaU fault level assessment process

2.14 Fault level guidance tool

As part of method Alpha, Enhanced Fault Level Assessment, an “HV fault level guidance tool” was developed for WPD planning engineers who do not have access to power systems analysis software for connection studies. This tool works in conjunction with an “HV fault level report” that has been also developed as part of FlexDGrid. The interface of the “HV fault level guidance tool” is shown in Figure 2-25. This tool aims to reduce the time and effort that is spent on data gathering and network modelling for connection studies. The “HV fault level guidance tool” has the following functionalities:

1- User interface to read the latest “HV fault level report”: This updates the latest fault levels at distribution substations and primary substations. In addition the “HV fault level report” contains the equivalent impedance from every distribution substation to the corresponding upstream primary substation;
2- User interface to select the distribution substation where the new generator will be connected: After selecting the connection point the relevant switchgear ratings, existing fault levels and equivalent network impedance will be automatically populated in “Fault Level Guidance Tool” interface;
3- Calculate the fault levels at the connection point and upstream primary substations after generator connection;
4- Provide a single line diagram representing the connection point along with the network data and calculated fault levels; and
5- User interface to directly email (via Microsoft Outlook) the calculation results and single line diagram to relevant person(s).

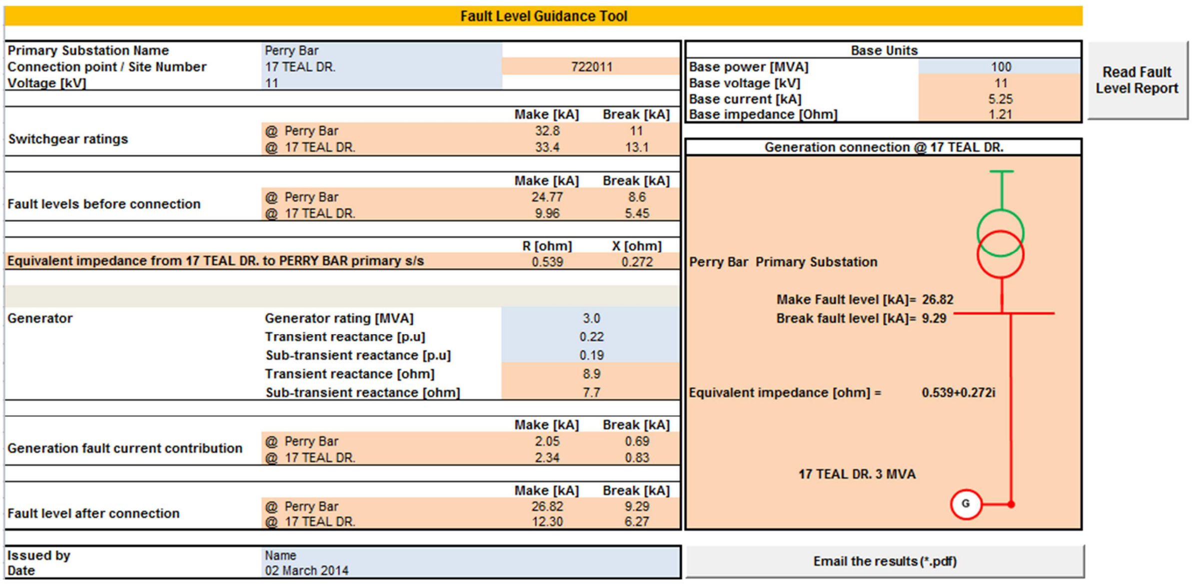


Figure 2-25 - User interface of “Fault Level Guidance Tool”

2.15 UoW Socio-Economic Research

During the project, the University of Warwick will conduct research work on the socio-economic impact of Combined Heat and Power (CHP) integration and Fault Level Mitigation, with specific focus on low income households in the Birmingham area. Following this analysis, further research work will be done to assess the social and economic benefits of FlexDGrid.

2.15.1 Achieved sample size and representativeness

Following a pilot telephone survey conducted between April 20th and May 1st, the full customer survey took place between 12th May and 9th June. The target population consisted of residential energy users in the Birmingham City area. The survey data was received by Warwick Business School on 19th June.

The survey covered the following postcodes: B1-B21, B23-B36, B38, B42-B45, B90 and B91 with an overall population of 798,114. The sample size achieved in the survey was 800 completed questionnaires in total. The analysis of the representativeness of the sample indicated no systematic bias in terms of geographical location of respondents.

It should be noted that the sample contains low proportions of young, single people in one person households and those who are renting or living in flats, compared to the whole population of Birmingham. This does not constitute a concern in relation to the objectives of the survey as these categories are less likely to be involved in the decision to connect to a district heating system, at least in the near future.

2.15.2 Main socio-economic characteristics of the sample

The achieved sample presents similar proportions of population across several demographic characteristics in comparison to the population of both Birmingham and the whole of England. This implies that the results of the statistical analyses to be undertaken as part of the research project can be extrapolated to wider areas of the population, beyond Birmingham. Indeed the sample has achieved realistic distributions of respondents across income and deprivation levels, economic activity, ethnic origin, marital status, household composition and educational attainment.

An example is provided in Table 2-8, which presents the distribution of ethnic origin in comparison with the whole population of Birmingham and England.

Table 2-8 - Ethnicity proportions surveyed

Ethnicity	England	Birmingham	Survey
White (Total)	85.4	56.6	68.5
Mixed/multiple ethnic group	2.3	4.5	2.9
Asian/Asian British	7.8	27.4	16.5
Black/African/Caribbean/Black British	3.5	9.3	8.5
Other ethnic group	1.0	2.1	1.6
Refused to say			2.0

Importantly the sample has also achieved good levels of participation across different deprivation measures, as illustrated for example in Table 2-9, which presents the percentages of respondents and member of the wider population who are in receipt of benefits, where slightly higher proportions of respondents in receipt of carers, disability, income support and pension credit than in Birmingham and England were observed.

Table 2-9 - Benefits proportion surveyed

Benefits	England	Birmingham	Survey
Carers allowance	2.0	1.9	2.8
Disability living allowance	6.2	8.7	9.9
Employment support allowance	6.0	4.6	3.0
Income support allowance	2.8	2.8	3.1
Job seekers allowance	3.5	4.5	3.0
Pension credit	7.3	5.5	6.0

A more detailed analysis of the socio-demographic characteristics of the sample has been undertaken from August onwards. The full set of results for this analysis will reported by the end of the year.

The preliminary analysis of the survey data has revealed that our sample contains around one third of households who could be considered as fuel poor on the basis both of the traditional measures for fuel poverty (i.e. households spending 10% or more of their income on fuel) and the subjective measure based on the respondents expressing the desire to keep the house warmer during the winter months.

Overall 31% of the respondents in our sample have expressed concerns about their ability to afford energy bills, especially in the winter. On the other hand only about 20% of the households in the sample can be defined as fuel poor, according to the (low income – high cost) index proposed in the Hills Review on Fuel Poverty (2012). 17% of the households in the sample use pre-payment meters for at least one of their fuels, which is line with the Government data of 15% and 16%, for gas and electricity respectively, for the whole of England.

The availability of information about actual expenditure on fuel and need to spend will allow the researchers to undertake a rigorous analysis of the behaviour of the fuel poor and the most vulnerable in society and to assess the potential impact of an expansion of the district heating scheme on these socio-economic categories as the research project progresses.

2.15.3 Energy efficiency and technology adoption

The analysis of responses across the whole sample has also revealed that about 40% of respondents have previous experience of having a heating system installed in the house; however there as a high variation in the respondents' estimates of both installation and maintenance costs for heating system was detected in the responses to the survey.

Nearly two-thirds of respondents indicated that they would consider joining a district heating schemes, but under a variety of conditions and for different reasons which will be explored more in detail in the next phases of the research.

The most prevalent form of heating system owned or used by the surveyed households is a combination boiler. The three most common forms of energy efficiency 'technologies' reported by the respondents are loft insulation, double glazing and combination-boilers, with only a quarter of respondents having cavity wall insulation and 3% having solar panels in the home. The main reason for not installing cavity wall insulation was associated with the age of the building which made the installation unsuitable (or very expensive).

The economic categories most likely to have loft insulation in the home were those at the low and high end of the income distribution; while low income households were less likely than other social groups to have cavity wall insulation in their home.

These are initial results arising from a descriptive analysis of the survey data. These findings will be investigated more in depth as the project progresses, together with other information contained in the survey. Furthermore the survey data will be linked with relevant national level data, in order to achieve the key research objectives of the project.

3 Business Case Update

There is no change to the business case. The business case was to facilitate the increased connection of DG, specifically combined heat and power (CHP), in urban HV networks. This is still applicable.

4 Progress against Budget

Table 4-1 - Progress against budget

	Total Budget	Expected Spend to Date Nov 2014	Actual Expenditure to date	Variance £	Variance %
Labour	**1809.49**	**981.82**	**486.22**	**-495.60**	-50%[1]
WPD Project management	320.00	142.34	128.45	-13.89	-10%
Detailed Investigation of Substation for Technology Inclusion	71.26	71.26	0.00	-71.26	-100%
Detailed Investigation of Technologies	71.14	71.14	29.43	-41.71	-59%
Detailed design of substation modifications for Technology Inclusion	72.43	72.43	0.00	-72.43	-100%
Determine Enhanced Assessment Processes	71.88	71.91	0.00	-71.91	-100%
Create Advanced Network Model	72.32	72.48	0.00	-72.48	-100%
Installation of Fault Level Measurement Technology	5.75	2.21	0.00	-2.21	-100%
Installation of Fault Level Monitoring Technology	296.65	151.43	148.23	-3.20	-2%
Installation of Fault Level Mitigation Technology	445.10	180.49	172.80	-7.69	-4%
Installation of VCU Technology	148.11	43.91	0.00	-43.91	-100%
Capture, Analyse Data and performance	234.85	102.22	7.31	-94.91	-93%
Equipment	**9779.63**	**5273.05**	**3237.37**	**-2035.68**	-39%
Procurement of Fault Level Measurement Technology	117.01	117.01	128.96	11.95	10%[2]
Installation of Fault Level Measurement Technology	9.58	8.26	8.52	0.26	3%
Procurement of Fault Level Monitoring Technology	1554.99	1554.65	412.76	-1141.89	-73%[3]

Installation of Fault Level Monitoring Technology	494.52	282.00	247.10	-34.90	-12%[4]
Implementation of Real Time Modelling	3.76	1.60	0.36	-1.24	-77%[5]
Procurement of Fault Level Mitigation Technology	5830.14	2530.14	2151.05	-379.10	-15%[6]
Installation of Fault Level Mitigation Technology	741.84	290.81	288.01	-2.80	-1%
Procurement of VCU technologies	777.86	414.69	0.00	-414.69	-100%[7]
Installation of VCU Technology	246.85	73.18	0.00	-73.18	-100%[7]
Equipment to enable modelling and technology installation	3.08	0.70	0.61	-0.09	-13%[8]
Contractors	**1927.36**	**1004.54**	**950.70**	**-53.84**	**-5%**
PB Project Support	340.94	137.85	101.00	-36.85	-27%[9]
Detailed Investigation of Substation for Technology Inclusion	96.14	96.14	103.60	7.46	8%
Detailed Investigation of Technologies	102.89	102.89	107.98	5.09	5%
Detailed Design of Substation Modifications for Technology Inclusion	48.85	48.85	51.04	2.19	4%
Determine Enhanced Assessment Processes	64.85	64.81	65.88	1.07	2%
Create Advanced Network Model	51.38	51.20	52.00	0.80	2%
Implementation of Real Time Modelling	350.94	202.08	193.98	-8.10	-4%
Capture Monitored & Measured Data	49.61	18.49	16.98	-1.51	-8%
Analyse Monitored and Measured Data	157.49	53.59	49.65	-3.94	-7%
Verify and Modify Advanced Network Models	253.89	129.76	122.17	-7.59	-6%
Gather Performance of Mitigation Technologies	50.07	8.56	0.02	-8.54	-100%[10]
Knowledge Capture and Learning Dissemination	281.62	65.20	67.80	2.60	4%
Procurement & Installation Support	78.69	25.11	18.60	-6.51	-26%[11]
IT	**57.73**	**53.40**	**21.27**	**-32.12**	**-60%**
IT Costs	57.73	**53.40**	**21.27**	-32.12	-60%[12]
IPR Costs	**3.29**	**0.45**	**0.41**	**-0.04**	**-9%**
IPR Costs	3.29	**0.45**	**0.41**	-0.04	-9%

Travel & Expenses	**465.62**	**216.17**	**196.25**	**-19.92**	**-9%**
Travel & Expenses	465.62	216.17	196.25	-19.92	-9%
Contingency	**1407.05**	**814.98**	**0.00**	**-814.98**	**-100%**
Contingency	1407.05	814.98	0.00	-814.98	-100%
Other	**27.21**	**12.42**	**3.95**	**-8.47**	**-68%**
Other	27.21	12.42	3.95	-8.47	-68%
TOTAL	**15477.38**	**8356.82**	**4896.17**	**-3460.65**	**-41%**

Note 1 - *All Labour costs to date are underspent due to previously documented change in split of activities between WPD internal staff and Parsons Brinckerhoff*
Note 2 – *Additional features were provided with the technology to ensure they were transferrable between substation sites*
Note 3 – *Staged payments for technology have been included to reduce the project risk*
Note 4 – *Work has been completed to this value, however, invoicing has not been completed*
Note 5 – *Equipment has not been required at this stage*
Note 6 – *Cost has been invoiced by manufacturer but not proceed until December*
Note 7 – *Due to the FLMT designs VCUs are not currently required*
Note 8 – *Underspend due to number of FLMs currently installed*
Note 9 - *Additional WPD resource has taken up this element of work*
Note 10 – *FLMTs have not yet been installed*
Note 11 – *Installation work has been delayed as described in document*
Note 12 – *Existing WPD IT has been used to date – as technologies are installed additional IT will be required*

5 Successful Delivery Reward Criteria (SDRC)

During this third reporting period there have been no additional SDRCs completed (none were planned).

The six previously completed SDRCs are available on WPD's Innovation website.

5.1 Future SDRCs

Table 5-1 captures the remaining SDRCs for completion during the project life cycle.

Table 5-1 - SDRCs to be completed

SDRC	Status	Due Date	Comments
SDRC-7 Open-loop test of FLMs	Green	31/12/2015	On track
SDRC-8 Open-loop test of FLMTs	Green	31/12/2016	On track
SDRC-9 Closed-loop test of FLMs & FLMTs	Green	31/12/2016	On track
SDRC-10 Analysis & Benefits	Green	31/12/2016	On track
SDRC-11 Novel commercial aggs	Green	31/03/2017	On track

Status Key:	
Red	Major issues – unlikely to be completed by due date
Amber	Minor issues – expected to be completed by due date
Green	On track – expected to be completed by due date

6 Learning Outcomes

Learning outcomes have been detailed in all six SDRCs submitted and approved to date (SDRC1-6).

The production and internal WPD publication of the policies as described in Section 2.12 has generated a significant amount of learning. This learning, which is available to other DNOs, upon request, centres on the specification requirements of both FLM and FLMTs and the process for connecting and applying these technologies on to a DNOs' 11kV network.

Network modelling work to understand how the fault level changes as the network changes has been a key learning point. Building on previous learning around the sensitivity analysis of parameters to fault level extensive learning has been gathered as to what connections and operating regimes affect fault level and how. In the next reporting period this learning will be built on to propose primary substation types to increase the accuracy of fault level modelling based on a selection of fault level infeed values dictated by the substation's characteristics.

In this reporting period learning has been shared at the LCNI Conference in Aberdeen on the 21st October and at Northern Powergrid's Fault Current Limiter dissemination event on the 2nd October.

7 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.

No relevant foreground IP has been identified and recorded in this reporting period.

8 Risk Management

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
- ✓ Monitoring and updating of risks and the risk controls.

8.1 Current Risks

The FlexDGrid risk register is a live document and is updated regularly. There are currently 60 live project related risks. Mitigation action plans are identified when raising a risk and the appropriate steps then taken to ensure risks do not become issues wherever possible. In Table 8-1, we give details of our top five current risks by category. For each of these risks, a mitigation action plan has been identified and the progress of these are tracked and reported.

Table 8-1 - Top five current risks (by rating)

Risk	Risk Rating	Mitigation Action Plan	Progress
Suppliers can't meet agreed functional specifications	Severe	Early engagement and rigorous tendering process	As per Section 2.5 re-testing of the FLM is planned. All other testing has been successful
Using external construction resource results in a higher build price	Severe	Cost of using external resources has been factored into costing at outset	Costs are currently above anticipated, however are still within the project's allowance
Third parties interfere with site works	Severe	Ensure that expensive items are not stored on site. Consider installing CCTV or employing other security measures during construction work	To date no third party interference has taken place. 24hr Security is being employed as required
PB may be sold by BB	Severe	Unable to mitigate - ensure all documentation is up to date and project learning captured	All documentation is robustly captured along with project learning
University of Warwick - understanding of the agreed work package tasks is incomplete or inaccurate	Severe	University of Warwick have put a process in place to ensure their understanding of WPD expectations for each deliverable up front and an ongoing process throughout each deliverable to continuously check they are meeting with the agreed deliverables	Situation is being monitored. The engineering department still don't have a full understanding of the project's requirements and their role in supporting successful delivery

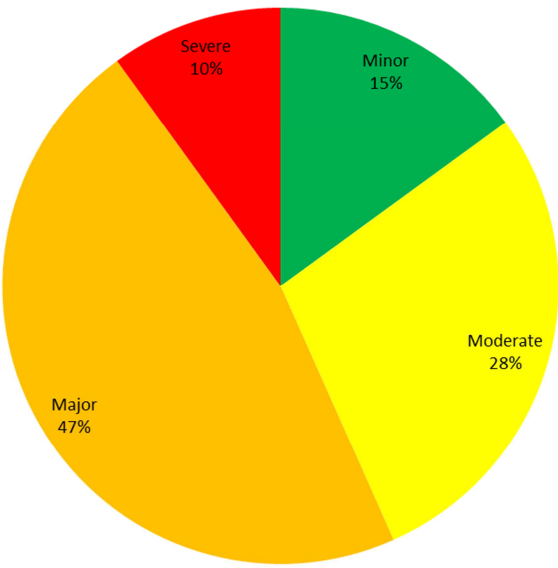
Table 8-2 provides a snapshot of the risk register, detailed graphically, to provide an on-going understanding of the projects' risks.

Table 8-2 - Graphical view of Risk Register

Likelihood = Probability x Proximity	Certain/Imminent (21-25)	0	1	2	2	0
	More likely to occur than not/Likely to be near future	0	0	5	2	0
	50/50 chance of occuring /Mid to short term (11-15)	0	0	5	5	0
	Less likely to occur/Mid to long term (6-10)	0	2	5	11	1
	Very unlikely to occur/Far in the future (1-5)	1	1	5	10	2
		1. Insignificant changes, re-planning may be required	2. Small Delay, small increased cost but absorbable	3. Delay, increased cost in excess of tolerance	4. Substantial Delay, key deliverables not met, significant increase in time/cost	5. Inability to deliver, business case/objective not viable
		Impact				
	Minor	Moderate	Major	Severe		
Legend	9	17	28	6	**No of instances**	
Total	60				No of live risks	

Table 8-3 provides an overview of the risks by category, minor, moderate, major and severe. This information is used to understand the complete risk level of FlexDGrid.

Table 8-3 - Percentage of Risk by category



8.2 Update for risks previously identified

Descriptions of the most significant risks, identified in the previous six monthly progress report, are provided in Table 8-4 with updates on their current risk status.

Table 8-4 - Top five risks identified in previous six monthly report

Risk	Previous Risk Rating	Current Risk Rating	Comments
Cost of the technologies increase after contract signature	Moderate	Minor	This has not arisen to date. Contracts are built to ensure product is designed to site specification
FlexDGrid FLMT or FLM fails and confidence is lost in the project	Major	Major	Confidence has been built in the technology and issues arising aren't causing major issues
The operation of FLMTs cannot be validated	Major	Major	First FLMT testing showed that validation of performance can be achieved in a lab. Real network testing is still required however
Injury to third party from property, equipment or site activities	Major	Major	All activities are carried out under a defined and documented work instruction and RAMS are also in place
Sites become unavailable due to other business requirements	Moderate	Moderate	Significant work has been carried out to ensure that the sites are currently not planned to have any significant work carried out.

Descriptions of the most prominent risks, identified at the project bid phase, are provided in Table 8-5 with updates on their current risk status.

Table 8-5 - Top five risks identified at the project bid phase

Risk	Previous Risk Rating	Current Risk Rating	Comments
Insufficient WPD resource for project delivery	Minor	Moderate	Specific WPD staff have been assigned to manage and deliver the construction aspects of the project
Partners and supporter perception of the project changes	Minor	Minor	Detailed schedules of work (SoW) have been produced for the complete project activities with both PB and UoW. These SoWs are the basis of the contractual collaboration agreements between each party
Cost of high costs items are significantly higher than expected	Closed	Closed	Closed as per previous 6 monthly reports
No suitable FLMTs will be available	Closed	Closed	Closed as per previous 6 monthly report
No suitable FLMs will be available	Closed	Closed	Closed as per previous 6 monthly report
The overall project scope and costs could creep	Minor	Minor	The scope of the project has been well defined in the initial delivery phase of FlexDGrid, which has been represented and documented in the SoWs with each party. This has significantly controlled this risk and therefore the cost of delivery. All potential scope creep is managed at project management level, where a decision is made as to the viability of inclusion and/or recommendation for future work
A partner may withdraw from the project or have oversold their solution	Moderate	Minor	A contractual collaboration agreement is in place with both PB and UoW for the project. Delivery of six SDRCs to date has delivered confidence that project partners can provide the required solution
The project delivery team does not have the knowledge required to deliver the project	Minor	Minor	Project partners have provided personnel with significant experience in all project areas. A review of individual's CVs takes place prior to their engagement with the project. Construction also have significant experience in the activities to be undertaken as part of the project

9 Consistency with Full Submission

During this reporting period the same core team from both WPD and PB have been used, which has ensured that there has been consistency and robust capturing of learning from the previous reporting period. This has ensured that the information provided at the full submission stage is still consistent with the work being undertaken in the project phase.

The scale of the project has remained consistent for all three methods:

- **Alpha** – Build advanced network model of FlexDGrid network;
- **Beta** – Install ten Fault Level Monitors at Birmingham Primary Substations; and
- **Gamma** – Install five Fault Level Mitigation Technologies at Birmingham Primary Substations.

Each of the six completed SDRCs to date has been completed on, or before, schedule, ensuring that the proposed delivery plan at the full submission stage is still applicable in project delivery.

10 Accuracy Assurance Statement

This report has been prepared by the FlexDGrid Project Manager (Jonathan Berry), reviewed by the Future Networks Team Manager (Roger Hey), recommended by the Policy Manager (Paul Jewell) and approved by the Operations Director (Philip Swift).

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.