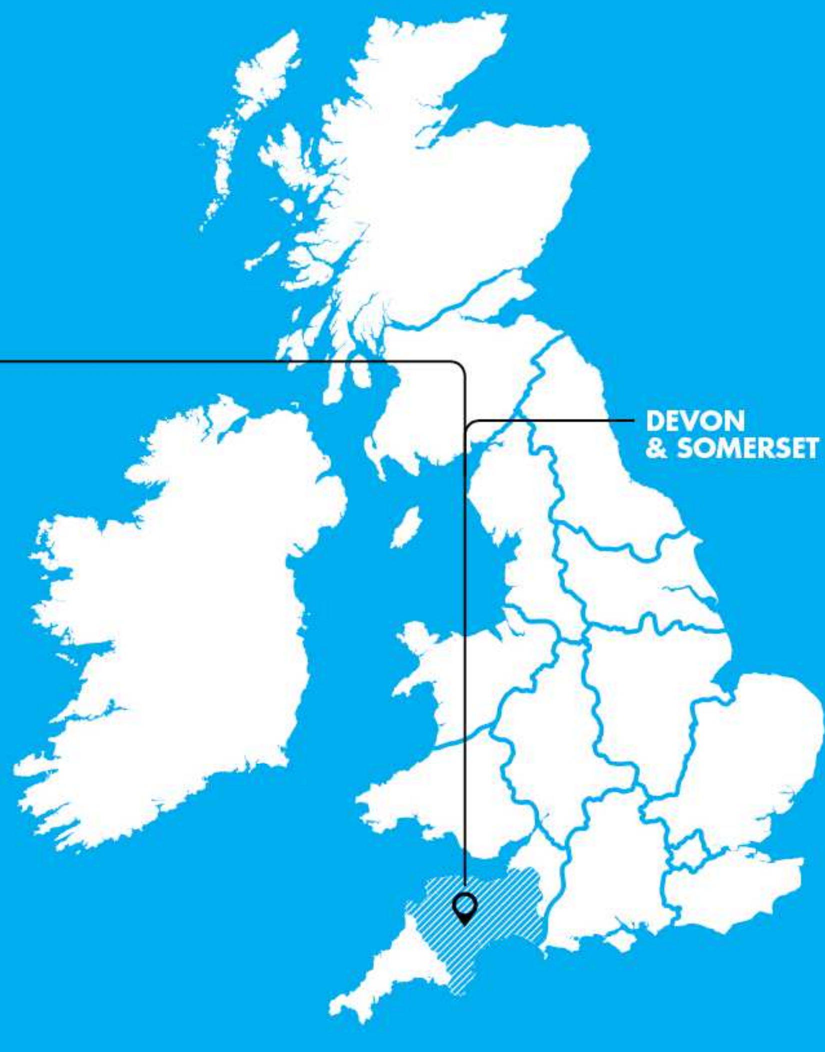
WESTERN POWER DISTRIBUTION

NETWORK EQUILIBRIUM

BALANCING GENERATION AND DEMAND



PROJECT PROGRESS REPORT
REPORTING PERIOD:
DECEMBER 2016 – MAY 2017

LCN Fund
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Contents

Glossary

Term	Definition
ABSD	Air Break Switch Disconnector
AC	Alternating Current
AIS	Air Insulated Switchgear
APT	Advanced Planning Tool
AVC	Automatic Voltage Control
BAU	Business as usual
BSP	Bulk Supply Point
CB	Circuit Breaker
CT	Current Transformer
DC	Direct Current
DG	Distributed Generation
DNO	Distribution Network Operator
EHV	Extra High Voltage
ENA	Energy Networks Association
ER	Engineering Recommendation
EU	European Union
EVA	Enhanced Voltage Assessment
FPL	Flexible Power Link
FTP	File Transfer Protocol
GB	Great Britain
GIS	Gas Insulated Switchgear
HSOC	High Set Overcurrent
HV	High Voltage
IDMT	Inverse Definite Minimum Time
IPR	Intellectual Property Register
ITT	Invitation to Tender
LCT	Low Carbon Technologies

LV	Low Voltage
LVAC	Low Voltage Auto Changeover
NMS	Network Management System
NOP	Normal Open Point
OCEF	Overcurrent Earth Fault
OHL	Overhead Line
OLTC	On Load Tap Changer
RTU	Remote Terminal Unit
SCADA	Supervisory Control and Data Acquisition
SDRC	Successful Delivery Reward Criteria
SLD	Single Line Diagram
SVO	System Voltage Optimisation
TSDS	Time Series Data Store
UK	United Kingdom
VLA	Voltage Level Assessment
VT	Voltage Transformer
WG	Working Group
WPD	Western Power Distribution

1 Executive Summary

Network Equilibrium is funded through Ofgem's Low Carbon Networks Second Tier funding mechanism. Network Equilibrium was approved to commence in March 2015 and will be complete by 14th June 2019. Network Equilibrium aims to develop and trial an advanced voltage and power flow control solution to further improve the utilisation of Distribution Network Operators' (DNO) 11kV and 33kV electricity networks in order to facilitate cost-effective and earlier integration of customers' generation and demand connections, as well as an increase an customers' security of supply.

This report details progress of the project, focusing on the last six months, December 2016 to May 2017.

1.1 Business Case

The business case for Network Equilibrium remains unchanged. The request for low carbon load and generation connections in the project area, Somerset and Devon, continues to grow.

1.2 Project Progress

This is the fifth progress report. The period covered in this report is focussed on the full transition from the design to the build and delivery stage, in respect of the technologies and site enabling works.

During this reporting period, In January, SDRC-4, Trialling and demonstrating the EVA method was completed and submitted to Ofgem. This document presented the benefits of a potential adjustment of statutory voltage limits, quantification of the expected capacity to be released from each of the Network Equilibrium methods and provide recommendations for the modelling of the SVO and FPL advanced planning tools.

Following the Siemens' SP5 system, to support the delivery of the SVO, reaching the design freeze stage in the previous reporting period, this reporting period has focussed on the building and testing of the system to be installed and tested on WPD servers in the next reporting period. Three of the SVO sites in this reporting period have had all the on-site works completed with a further two well underway. This has been a significant milestone, enabling confidence in the two differing SVO design methodologies to be proven in practice.

The design of the ABB FPL device was completed in February of this reporting period and since this point the device's power electronic element of the complete system has been built and tested. Also within this reporting period a new switchroom has been built at the FPL site, Exebridge substation, and the new 33kV switchgear installed and commissioned.

During this reporting period Network Equilibrium has also made significant progress working towards the next three SDRCs 5 and 6.

1.3 Project Delivery Structure

1.3.1 Project Review Group

The Network Equilibrium Project Review Group met once during this reporting period. The main focus of this meeting was the resource and delivery requirements associated with the project as it transitions to the build phase.

1.3.2 Resourcing

The resourcing of the project remains as described in the previous reporting period, where the design team is led by WPD engineers and supported by WSP|PB engineers.

1.4 Procurement

The procurement activities for Network Equilibrium focus on the SVO and FPL methods. Throughout the project supporting procurement activities will take place in order to facilitate the successful delivery of all project methods; however, there are two formal procurement activities as part of the project.

Manufacturer	Technology	Applicable Substations	Anticipated Delivery Dates
Siemens	SVO System	16 Substations (Installed in 1 central location)	November 2017
ABB	FPL	Exebridge	April 2018

1.5 Installation

Following the completion of the detailed design SDRCs the next reporting period will see the first elements of installation works progressed. These first installation activities have been:

- Three complete SVO Relay site installation;
- Cable and Overhead Line diversionary works at Exebridge; and
- Construction of a new switchroom and installation of 33kV switchgear at Exebridge.

Into the next reporting period the change and upgrading of the AVC relays will continue and the FPL site will have significant civil construction activities undertaken in preparation for the delivery of the FPL in early 2018.

1.6 Project Risks

A proactive role in ensuring effective risk management for Network Equilibrium 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 Network Equilibrium as captured in our Risk Register along with an update on the risks captured in our last six monthly project report. Section 8.2 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 6 of this report.

A key aim of Network Equilibrium 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 the learning of all three methods' progress and specifically the APT developments captured within the production of SDRC-4.

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 focus of Network Equilibrium is to balance voltages and power flows across the distribution system, using three Methods to integrate distributed generation within electricity networks more efficiently and delivering major benefits to distribution customers.

The Problem that Network Equilibrium addresses is that electricity infrastructure in the UK was originally designed and developed for passive power distribution requirements. As a result, the integration of significant levels of low carbon technologies (LCTs) within our present electricity networks can cause voltage management and thermal issues. For business as usual (BAU) roll-out we need to develop solutions, which take a strategic engineering approach, considering the whole system and not solving constraints on a piecemeal basis. The Problem will be investigated using three Methods, and their applicability to 33kV and 11kV distribution networks assessed. Each will involve testing within South West England:

(1) Enhanced Voltage Assessment (EVA);
(2) System Voltage Optimisation (SVO); and
(3) Flexible Power Link (FPL).

The aims of Equilibrium are to:

- Increase the granularity of voltage and power flow assessments, exploring potential amendments to ENA Engineering Recommendations and statutory voltage limits, in 33kV and 11kV networks, to unlock capacity for increased levels of low carbon technologies, such as distributed generation (DG);
- Demonstrate how better planning for outage conditions can keep more customers (generation and demand) connected to the network when, for example, faults occur. This is particularly important as networks become more complex, with intermittent generation and less predictable demand profiles, and there is an increased dependence on communication and control systems;
- Develop policies, guidelines and tools, which will be ready for adoption by other GB DNOs, to optimise voltage profiles across multiple circuits and wide areas of the network;
- Improve the resilience of electricity networks through FPL technologies, which can control 33kV voltage profiles and allow power to be transferred between two, previously distinct, distribution systems; and
- Increase the firm capacity of substations, which means that the security of supply to distribution customers can be improved during outage conditions, leading to a reduction in customer interruptions (CIs) and customer minutes lost (CMLs).

2.2 Project Progress

This is the fifth progress report. The focus of this reporting period was continuing the build phase of the project in relation to the SVO and FPL deliverables and submitting SDRC-4 to successfully capture and support the learning generated as part of the EVA method. The reporting period has seen a change in approach to the support and delivery of critical inputs to the SVO method. Originally the model inputs to be enable the SVO system to be finalised were to be developed based on the TNEI models created for the APT, however, due to capacity and capability this has not been possible, therefore WSP, who are already providing engineering resource are further supporting this activity. This is also the case for the SVO and FPL plugin in modelling requirements; through the delivery of SDRC-4 it was identified that significant improvements to the plugin models could be made and to ensure that a fast track to business as usual can be achieved a further development is to be carried out in Siemens' PSS/E software. The SVO method has focussed on the building and testing of the Siemens SP5 system, which is to be installed and tested on WPD servers in the next reporting period. Three of the SVO sites in this reporting period have had all the on-site works completed with a further two well underway. This has been a significant milestone, enabling confidence in the two differing SVO design methodologies to be proven in practice. The design of the ABB FPL device was completed in February of this reporting period and since this point the device's power electronic element of the complete system has been built and tested. Also within this reporting period a new switchroom has been built at the FPL site, Exebridge substation, and the new 33kV switchgear installed and commissioned.

2.3 Enhanced Voltage Assessment

Enhanced Voltage Assessment (EVA) consists of two parts. Part 1 is the Advanced Planning Tool (APT) and part 2 is the Voltage Limits Assessment (VLA) work package.

Part 2 of EVA had been completed previously, therefore in this reporting period work was focused on the Advanced Planning Tool and the completion of the studies required for Successful Delivery Reward Criteria (SDRC) 4 - Trialling and demonstrating the EVA method. The SDRC-4 studies enabled the further detailed assessment of the tool's functionalities and offered valuable learning on its performance. This learning shaped the plan for the further development and usage of the tool.

2.3.1 Advanced Planning Tool

The APT is the first part of EVA and involves the creation of a planning tool which aims to enable better network and outage planning of distribution networks with increasing penetration of variable generation and demands. This will be achieved through the tool's advanced functionalities. These include the production of estimated power flows using weather forecasts and the network analysis using typical demand and generation profiles.

Progress since previous reporting period

In January 2017 SDRC-4, Trialling and demonstrating the EVA method was submitted. This progress report provides an overview of the various elements covered in SDRC-4 and explains how the performance of the tool was assessed through the studies completed, determining the functionalities of the tool that are ready to use and the areas that require improvement.

Tool Functionalities

After the provision of the latest version of the APT by TNEI in December 2016, the following tool functionalities were examined and tested:

- Network demand and generation capacity evaluation: This was simulated at a number or Primary substations and BSPs.
- Simulation of the SVO plugin: This was simulated at a number of BSPs and Primaries.
- Simulation of the FPL plugin: This was simulated at a number of normal open point locations in the 33kV and 11kV networks.

The learning obtained from the testing of the above functionalities will be demonstrated in the following sections of this report.

Validation of the forecasting functionality of the APT

One of the novel functionalities of the APT is the production of the expected network constraints for the following two days. Being able to predict the network operation in the short term is becoming increasingly important as it will play an important part in the changing role of Distribution Network Operators, potentially enabling them to improve outage planning and the management of generation connections to make the most of the available network capacity. Therefore, work was focused on assessing the forecasting functionality of the APT to provide learning on the suitability of the forecasting methodologies followed. The forecasting functionality of the APT is based on the usage of 48-hour weather forecasts to produce forecasted demand and generation profiles for the following two days. As shown in Figure 2-1, the Met Office provides the weather forecasts to the APT (on a daily basis) and then the APT produces the forecasted feeder demands of all substations and the forecasted output of generation connections. These forecasts are then used in the load flow calculations which produce the expected network constraints for the next 48 hours.

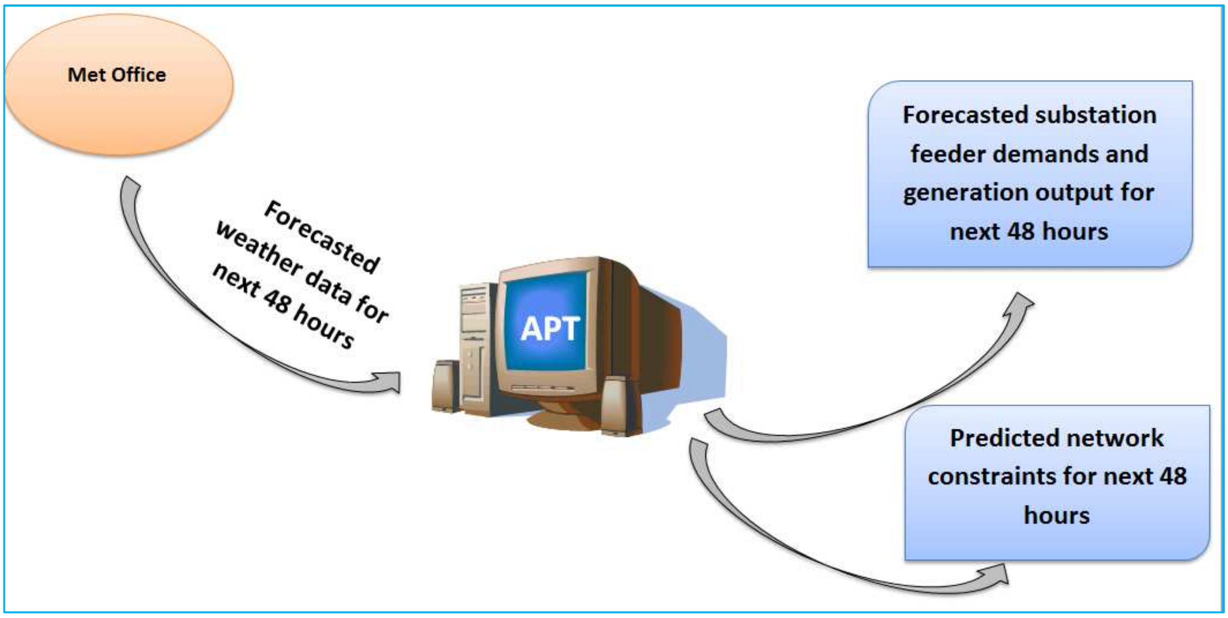


Figure 2-1 APT Forecasting Overview

Results were collected from the daily production of the 48-hour ahead forecast profiles which are currently being processed by WSP (formally Parsons Brinckerhoff) to evaluate the accuracy of the forecasting functionality of the tool. The evaluation methodology involves:

1. Calculating the accuracy of the feeder demand forecasts by comparing the forecasted and actual feeder power flows for two Primary substations and two Bulk Supply Points (BSPs) for a four week period.
2. Calculating the accuracy of the generation forecasts by comparing the forecasted and actual feeder power flows of a number of 33kV and 11kV solar and wind generation connections of different sizes for a four week period.

The accuracy will be calculated using:

$$Accuracy\ (\%) = 100 - (\left|\frac{Actual - Prediction}{Actual}\right| \times 100)$$

With the completion of this validation assessment in Q3 2017, valuable knowledge will be gained on the suitability of using weather forecasts to predict the network operation in the short term. The findings from this work will be obtained and reported in the following reporting period.

Network Capacity Evaluation

The network capacity evaluation functionality of the APT was used to estimate the network capacity of a number of BSP and Primary substations by performing a set of studies. This has offered significant learning on the potential of improving the methodology that was used to evaluate the network capacity.

The original methodology starts by scaling all existing generation until it finds a voltage or a thermal constraint. Once it finds a constraint it stops and captures the generation added up until the previous round, which represents the network capacity estimate. However, if a thermal constraint is found on at least one of the substation's feeders for example as shown in Figure 2-2, then the scaling will stop and the evaluated capacity will still be limited to the value captured in the previous round, even if other feeders have only voltage constraints or no constraints at all.

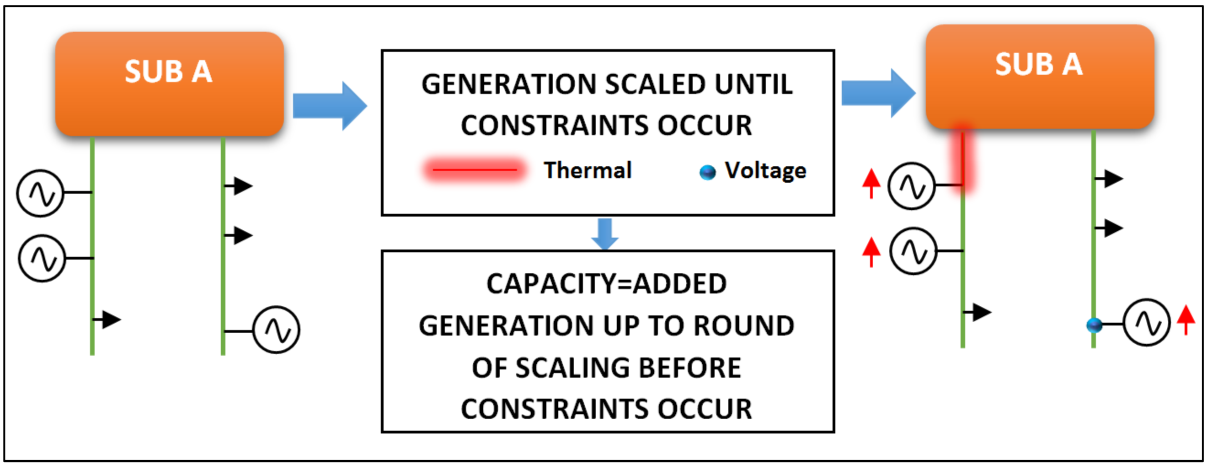


Figure 2-2 Capacity Evaluation Methodology Operation

From the studies performed, the following learning was gained:

- This approach provides a conservative estimation of the network capacity as it considers the substation as whole and not each feeder individually. If only one of the feeders is constrained, the scaling at all feeders stops even if they are not constrained.
- The inability to distinguish between thermal and voltage constraints means that if the voltage profiles of a substation are improved, then the benefits in the network capacity cannot be seen if any of the feeders has thermal constraints.

Therefore, the following capacity evaluation methodology is proposed instead:

i. Simulate a generator (called Generator_cap) at the end of each feeder of the substation.

ii. Increase the Generator_cap output on each feeder until a voltage constraint (voltage exceeds statutory voltage limits of +- 6%) or thermal constraint (branch loaded above 100%) is found on each feeder. For example, at a substation with 2 feeders, if feeder 1 shows a constraint but feeder 2 doesn't, stop increasing the generator output on feeder 1 but continue increasing the generator output on feeder 2 until feeder 2 also experiences a constraint.

iii. Record the nature of the constraint (voltage/thermal) and the amount of generation added to the network just before the constraints were caused. This is the network capacity of the substation.

iv. Output the generation capacity of each feeder (in MW) and the nature of the constraint that limits it.

v. Output the total generation capacity of the substation (in MW).

The above methodology considers each feeder and constraint type individually, providing the flexibility that is required in order to get a less conservative capacity estimate and evaluate the capacity benefits gained by removing certain constraints.

This revised methodology will be simulated within PSS/e to enable comparisons of the results obtained with the two different approaches. Additionally, the revised methodology will be used when evaluating the capacity benefits from the trials of the SVO and the FPL technologies.

FPL and SVO Plugins

The FPL and SVO plugins were simulated in the APT at a number of network locations as part of the work completed for SDRC-4. This offered valuable knowledge on the operation of the plugins and indicated the areas of future improvement.

The aim of the FPL and SVO SDRC-4 studies was to simulate their operation and evaluate the capacity that could be released from each technology. This work has shown that:

- In order to be able to assess the operation of the SVO plugin, the following needs to be reported for each analysis period:
    a) Target voltage at each controlled transformer before plugin operated.
    b) Minimum voltage in the network before plugin operated.

   c) Maximum voltage in the network before plugin operated.
   d) New target voltage at each controlled transformer applied by the plugin.
   e) Minimum voltage in the network after the plugin operated.
   f) Maximum voltage in the network after the plugin operated.
- In order to be able to assess the operation of the FPL plugin, the following needs to be reported for each analysis period:
   a) Constraints (voltage/thermal) on the two feeders and substations the FPL interconnects before the plugin operated.
   b) Power transfers (P set point) and reactive power support (Q set points) provided by the plugin.
   c) Constraints (voltage/thermal) on the two feeders and substations the FPL interconnects after the plugin operated.
- As the capacity evaluation methodology followed provided a very conservative estimate of the network capacity and could not consider each feeder/constraint individually, the evaluated capacity release using SVO was underestimated.
- The interaction between the capacity evaluation functionality and the FPL plugin had to be further refined. It is important to ensure that when assessing the capacity benefits of the FPL plugin the capacity of each of the two substations the FPL interconnects is calculated separately. This is to ensure that the transfer of capacity between the two sides is clearly seen.

Additionally, following the initial testing phases of the plugins, it was recognised that when developing plugins for a network planning tool, even though the plugins are initially created and tested on simple networks, emphasis still needs to be given on the testing of the plugins within the tool, on the real network models. This is crucial to ensure that the operation is as expected and there are no issues with the application of the plugins on complicated network models or with their interaction with the other functionalities of the tool.

Network Modelling

From the usage of the tool by WPD, it was found that the model of the network requires improvements to correct a number of inaccuracies found. For example, due to the fact that the EMU database which was used to create the network model into IPSA, does not indicate the connection points of feeders at substations, the process of connecting all substation components together was manual and based on the EMU single line diagrams. In a number of cases, the connections were incorrect resulting in feeders connecting to the wrong substation busbars. TNEI are currently working on correcting these issues. Additionally, it was found that a number of switches, especially bus-section switches and transformer incomers, were missing from the models, indicating that the developed import script requires refinement.

SCADA Functionality

Currently, the APT can perform analysis using typical profiles for the following two and eight weeks. As explained in this report, it can also produce the forecasted network operation for the following two days.

The SCADA functionality of the tool aimed to complete the different sets of analysis that the APT could support, by enabling the user to perform time series analysis using half hourly SCADA data for up to a year. This functionality would also provide the ability of simulating the network operation during the Equilibrium trials, to be able to assess the benefits of the SVO and FPL technology trials. In order to achieve this, it is necessary to be able to map all of the SCADA data into the IPSA model, so that the load flow engine knows all the loads and generation values for the period analysed.

Each SCADA data point is recognised by its ALIAS which is a unique combination of letters and numbers. Therefore, the mapping of all the SCADA data involved linking the ALIAS of each data point to the relevant component in the network model. To perform this linking, TNEI developed a script which using information about each data point, automatically assigned each ALIAS to a point in the network model.

It was found that the procedure developed to perform this linking did not succeed, resulting in a large number of data points not being imported into the model and a number of data points linked to the wrong components.

As the SCADA functionality relies on the correct mapping of the SCADA data to the model, it was decided that it would be removed from the scope of the tool.

Next steps

The usage of the tool, and the studies performed as part of SDRC-4, has indicated the further refinement that is required for the capacity evaluation functionality and the FPL and SVO plugins. Therefore, additional testing is currently being performed by TNEI to improve these areas of the tool. Due to the difficulties with the network model and the operation of the SCADA functionality, it was decided to stop the development of the APT and terminate the contract. However, in order to support the benefits assessment of the technology trials the capacity evaluation, SVO and FPL plugins will be also developed within PSS/e. This, will provide the opportunity to compare the two different implementations and offer additional learning on the various modelling approaches.

2.4 System Voltage Optimisation

The SVO method of Network Equilibrium aims to dynamically manage the voltages in the network to maximise the level of Low Carbon Technologies (LCT) that can be connected to network while maintaining statutory limits.

In this reporting period work has focused on the IT installation preparations, the import of the network models into Spectrum Power 5 and the integration of SP5 into WPD's existing systems by defining its interaction with the Network Management System (NMS).

2.4.1 SVO Software System

Progress since previous reporting period

After determining the network areas that would need to be modelled in Spectrum Power 5 in the previous reporting period, the IPSA model including those areas was provided to Siemens who have completed the import procedure and performed a number of validation checks. In this report, the learning obtained from the model conversion and validation procedures is discussed and the work completed as part of the installation preparations and system integration is presented.

Network Model Import

Spectrum Power 5 will be receiving real-time SCADA data from the NMS, including current, power flow and voltage measurements from the networks of the substations it will be controlling. It will then be importing those measurements into the models of the networks of the substations in order to estimate the power flows and voltages at every point that does not have any measurements. Based on these state estimation results, it will be calculating the optimised target voltage settings that will be sent to the 16 SVO substations.

Therefore, it is very important to ensure that SP5 is able to estimate the state of the network accurately and to do this it relies on the quality of its network models and the mapping of the SCADA data into the models.

The network areas that would need to be modelled in Spectrum Power 5 were included in the IPSA model developed for the APT, since the APT covers the entire Equilibrium area. Due to the fact that the APT was also going to have all of the SCADA data mapped into its model, it was decided to use the APT IPSA model to develop the SP5 network models. After receiving the APT IPSA model, Siemens have extracted the parts of the model representing the SVO network areas and imported them into Spectrum Power 5.

Following the import of the models into Spectrum Power 5, a number of validation checks were performed to ensure that the models converge and the network displays match the diagram layout in IPSA.

As part of the convergence tests, load flow results were produced for each network model in SP5 which were then compared to the IPSA load flow results to ensure that the import of the models was successful. This has shown very small differences between the two sets of load flow results proving the model import.

The display layouts generally matched the single line diagrams of the IPSA model with a few differences that were investigated and resolved. For example, as shown in Figure 2-3, a number of lines were crossing the screen and appeared to have incorrect coordinates. After investigation it was found that this occurred for lines that were connecting to bus sections which had x, y coordinates of 0, 0. Due to the small number of occurrences, this was resolved by manually changing the layout.

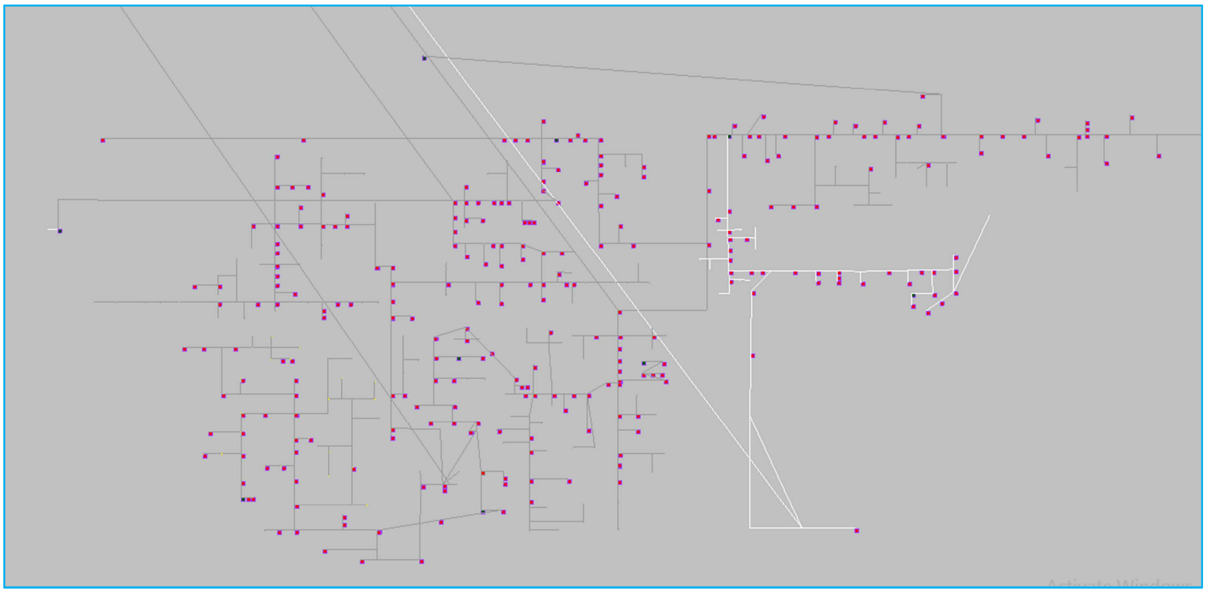


Figure 2-3 SP5 display example (Marsh Green Primary)

In order to check the mapping of the SCADA data points into the SP5 models, a set of instantaneous time-series SCADA data was captured from the NMS system which included the ALIAS of each data point and its value every point in time it changed. This capture was then fed into SP5 to simulate the real-time transfer of SCADA data that would take place in real operation. This exercise was very useful as it indicated the areas where the mapping of the SCADA data required further work.

As the IPSA model that was used in this first import is being refined and to ensure that the models in the SP5 system are as up to date as possible before the testing phases commence, the import procedure will be repeated again with updated IPSA models.

IT Preparations

WPD's Information Resources (IR) team worked closely with Siemens to build the VMWare architecture of the SVO System. The overall architecture is shown in Figure 2-4, which demonstrates the two hardware servers (circled in red colour) on which the various SP5 virtualised servers and User Interfaces (UIs) will be implemented. By the end of this reporting period, all the hardware was installed at WPD's server room at the Bristol office and configured with the required software to ensure that it is ready for the Spectrum Power 5 installation.

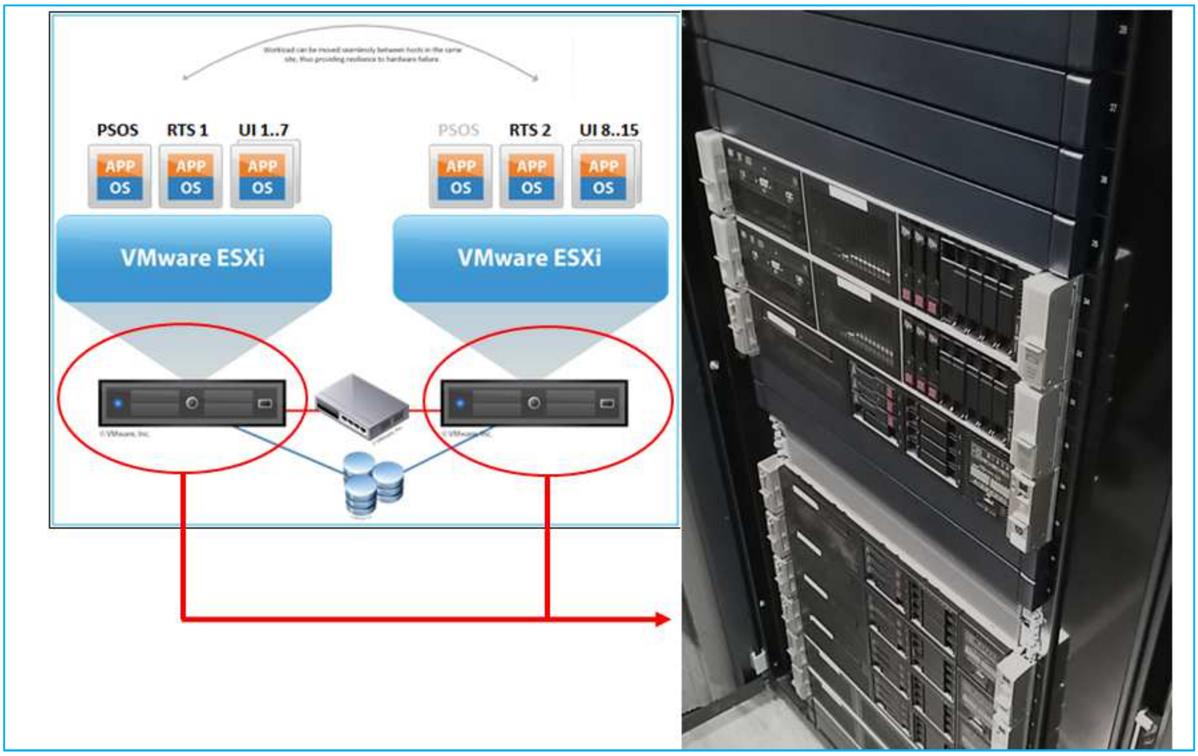


Figure 2-4 SVO VMWare Architecture

Additionally, a VPN connection will be established between Siemens and WPD which will be used during the installation to enable Siemens to access the system to perform the different tasks required. This VPN connection will also be used when the system goes live for any additional support required. In this reporting period, tests have been performed to ensure that the configuration of the VPN connection is correct and reduce the risk of having any remote access problems in the following critical stages of the project.

Model Updating and System Administrator Training

In the beginning of May 2017, the Model Updating and System Administrator training was held at WPD's Bristol office for the NMS engineers who will be the administrators of the Spectrum Power 5 System.

The aim of the training was to enable WPD's NMS engineers to get an overview of the system, practice the model updating procedures, get some experience on the various administration tasks and provide feedback and ideas for improvement of the final system.

Figure 2-5 Model Updater and System Administrator Training May 2017

SVO technology integration and NMS interaction

Significant progress has been made on the preparations for the integration of the SVO technology with the existing systems and the design of its interaction with the NMS.

This piece of work commenced with the Operating Scenarios Specification which is the specification of the actions that would need to be taken by the different parts of the SVO system under various operating conditions. The Operating Scenarios Specification is very important when building technologies that consist of a number of different systems as it defines the responsibilities of each and the interaction between them. SVO, considered as a whole system consists of the site equipment (AVC relays, RTUs), the NMS and Spectrum Power 5. The creation of this document involved the close cooperation of the NMS team, Siemens and the site design team.

Based on the specified SVO Operating Scenarios, the work required to configure the NMS to support its interaction with SP5 was easily identified and planned for delivery in the following reporting period.

2.4.2 Site Installation Activities

In the last reporting period, design work was started for the integration of the SuperTAPP SG relay at 13 substations and the modification of three existing MicroTAPP sites to accept SVO setting groups.

In this reporting period design work was completed for all sites, preparation for installation was undertaken and the first installations were completed and relays commissioned in preparation for the complete SVO system commissioning.

Supertapp SG

During this reporting period, the integration design for the SuperTAPP SG sites was completed and offline manufacture is underway for certain sites to ease installation and minimise outage periods. Work is also on-going to implement the necessary changes to enable the existing communications infrastructure to handle the required SVO controls, alarms and indications prior to the commissioning of the SVO system at each substation.

At the time of this report, installation work at all substations has been programmed, required network outages arranged with all SVO site works scheduled for completion by the end of September 2017.

Colley Lane

In December 2016, an operational issue was discovered with the existing MicroTAPP AVC scheme at Colley Lane 33/11kV substation. Originally selected for modification, the opportunity was created to enable the installation of the SuperTAPP SG instead.

The work on site started on 6th February with the third and final relay commissioned at the site on 24th February. Figure 2-6 and Figure 2-7 below show photos of the installation.

Figure 2-6: Picture of combined T1 and T2 AVC Panel with SuperTAPP SG Installed

Figure 2-7: Picture of T3 AVC Panel with SuperTAPP SG Installed

Since installation, the relays have shown 100% reliability operating in standard mode with no issues identified to date.

The ability to carry out an early, one off, installation of the relay enabled many lessons to be learnt and modifications made to the designs for all remaining sites prior to installation. This included minor changes to control wiring and in how to generate suitable settings to mimic WPDs current operational practices.

Control System Wiring Changes

The external control wiring for the SuperTAPP SG was designed in such a way to maintain existing operational practices, separate from the operation of the SVO. This added an additional layer of complexity but meant WPDs current design convention would be maintained. However due to the internal software of the relay it was not possible to configure the relay to run both systems. Therefore, in discussion with all parties the design was modified so that the existing practice and SVO were meshed together. This meant that the external wiring was simplified as shown in Figure 2-8 below.

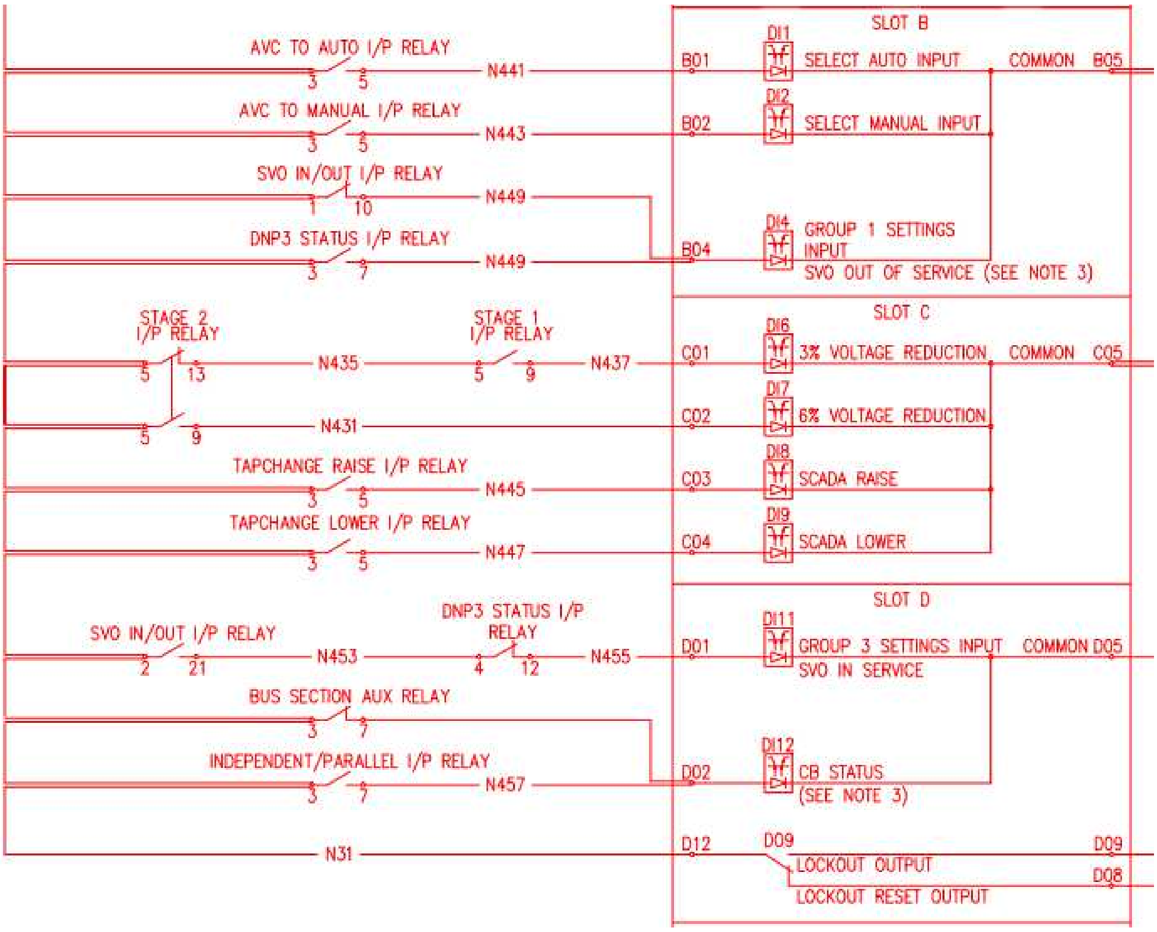


Figure 2-8: Updated logic schematic for the SuperTAPP SG Relay

Virtual Busbar

Existing operational procedures for WPD AVC schemes allow for the manual switching of logic between parallel and independent operation. The relays are designed to communicate and are able through this interface to work together to map out the substation. This internal logic would then counter manual independent or parallel operations as the relays knew if they were connected or not. Therefore a virtual busbar concept was developed to trick the relays into showing the same behaviour as the existing.

Figure 2-9 below outlines the concept deployed. The items in black show the actual substation single line diagram and the items in red show the virtual single line diagram that was developed. The green lines show how the operation of the actual circuit breakers on site drives changes in the virtual circuit breakers to determine if the corresponding transformer is operating in parallel or independent mode.

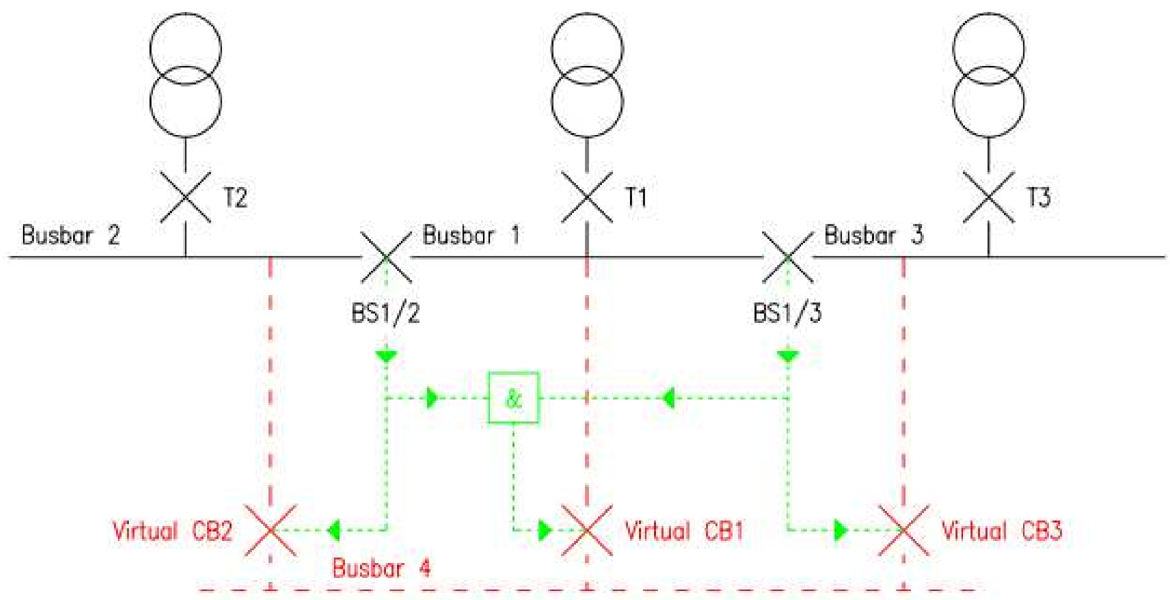


Figure 2-9: Outline SLD of Virtual Busbar Solution for SuperTAPP SG Settings

Each relay receives the beaker status of the bus-section that connects it to its neighbour. By configuring the settings a certain way each relay believes their transformer is linked to the others via a imaginary busbar. This allows the each relay to drop in and out of operating modes without affecting the mode and operation of any of the other relays.

On Site SVO Communications

The SVO communications via the DNP3 interface on site has been on soak since installation to test its performance. After two months there had been a couple of loss of communications events between the relay and RTU.

In order to fully diagnose the communications system, the limit of missed polls from the RTU before failure was set at two. Under normal operation, the number of missed polls before issuing a failure alarm would be closer to ten. During the tests no case of communications failure lasted more than ten polls, therefore it is not envisaged that any loss of communications events will occur within the site under normal operation.

Paignton BSP Installation

Following the first installation of the SuperTAPP SG relay, the lessons learnt were incorporated into the remaining designs. The next installation was completed at Paignton BSP on the 26th May 2017. The equipment was constructed off site in order to minimise the outage period and provide an easier installation.

Figure 2-10: Paignton GT1 SuperTAPP SG during commissioning

Being the first BSP site to be commissioned there were some lessons learnt, mainly with the configuration differences in settings between Primary and BSP sites.

MicroTAPP

During this period installation and commissioning works were completed at the two remaining MicroTAPP sites, Waterlake and Lydeard St Lawrence. This involved the building of an SVO control box and modifications to the internal wiring of the AVC panel to enable selection of the various settings groups within the relay. Figure 2-11 below shows a picture of the SVO control box installed at Lydeard St Lawrence.

Figure 2-11: SVO MicroTAPP Control Panel at Lydeard St Lawrence

Network Monitoring

Following the identification of locations and design options in the previous reporting period work has started in this period to complete the required radio surveys and develop a common installation panel that can be used at any location.

Monitoring Panel Design

Outline panel designs and schematics were developed by the Equilibrium team in conjunction with WPD engineers. For overhead line installations, the panel is designed to take a direct VT input, reporting back the 11kV voltage. For distribution substations, the panel is designed to receive the LV Volts and Current from the transformer and by applying the known transformer impedance, calculate the 11kV voltage on the HV side.

The panel is currently undergoing further development by a manufacture with the initial prototype to be tested and site installations to start in the next reporting period.

Radio Survey

In order to allow each monitoring panel to communicate measurements back to the Network Management System, a radio communications network is required. This involves linking each monitoring panel back to a substation RTU. Initial studies showed that the power of the selected radio, due to the distances and topography of the area, would require many repeater stations and would not be cost effective. Studies are currently on-going with a more powerful radio that should limit the number of repeater stations required.

Next Steps

The next reporting period will focus on the updating of the Spectrum Power 5 network models, the installation of the system on the SVO hardware (located in WPD's Bristol office) and the testing of the system prior to go-live in December 2017. The site activities will continues, whereby in the next reporting period all SVO site installation works will be completed in preparation for go-live. Finally, work will commence on the production of suitable policies to enable the work carried out as part of the project to be suitably replicated post project and provide technical support during the project's trial phase.

Table 2-1: SVO Sites and Commission Dates

Substation	SVO Site Commission Date	Status
Colley Lane	24/02/2017	✓
Waterlake	24/02/2017	✓
Lydeard St Lawrence	03/03/2017	✓
Paignton	26/05/2017	✓
Bridgwater	09/06/2017	
Exeter City	07/07/2017	
Tiverton Moorhayes	28/07/2017	
Taunton	18/08/2017	
Dunkeswell	25/08/2017	
Bowhays Cross	01/09/2017	
Tiverton BSP	08/09/2017	
Millfield	08/09/2017	
Exeter Main	22/09/2017	
Nether Stowey	22/09/2017	
Marsh Green	29/09/2017	
Radstock	06/10/2017	

2.5 Flexible Power Link

2.5.1 Overview

During the last reporting period the design of the FPL system had started with ABB submitting documentation for Detailed Design Stage 1. The design submission was reviewed and after several iterations it was approved in late December 2016. Designs were also completed for the enabling works and the installation of the new 33kV switchroom.

In this reporting period there has been significant progress on the ABB FPL design and construction works is under way at Exebridge to enable the connection of the FPL. Further details of the progress can be found in the following sections.

2.5.2 Technology

ABB's design for the FPL was split into two stages which allowed WPD to have the opportunity to comment on and amend the design before the system is manufactured. Detailed Design Stage 1 covered the outline design of the FPL focussing primarily on the interface between WPD and ABB. Information was provided to ABB in Stage 1 to allow them to design the FPL according to the requirements at Exebridge and the subsequent designs were prepared and submitted for review in Detailed Design Stage 2.

Detailed Design Stage 2

Detailed Design Stage 2 was submitted in six distinct work packages during January and February 2017. The following six work packages had to be reviewed by WPD and comments addressed by ABB before it could be approved:

- WP1 – Harmonic Mitigation Concept;
- WP2 – Interface Schematics and Diagrams;
- WP3 – Protection Design;
- WP4 – Equipment Layout and Component Information;
- WP5 – Transformer; and
- WP6 – Method Statements.

WP1 – Harmonic Mitigation Concept

The FPL requires 33kV AC filters to be connected on either side of the back-to-back AC to DC converter to mitigate the effect of harmonics generated by the FPL. ABB designed the harmonic filter following submission of background harmonic data present on WPD's existing network. The filter was designed according to Engineering Recommendation G5/4 and this was checked by WPD and subsequently approved as part of Detailed Design Stage 2. Figure 2-12 and Figure 2-13 show the additional voltage distortion at either side of the FPL which can be seen to be within the limits of G5/4.

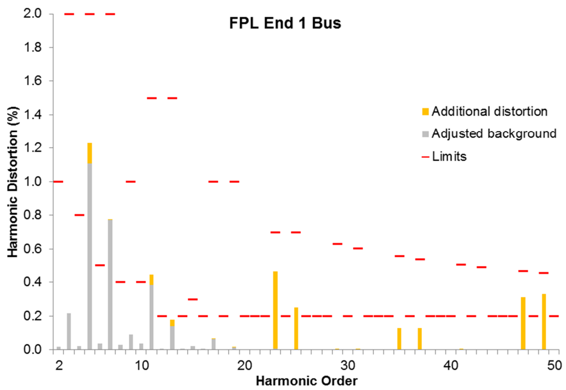


Figure 2-12: Voltage distortion results at FPL 1

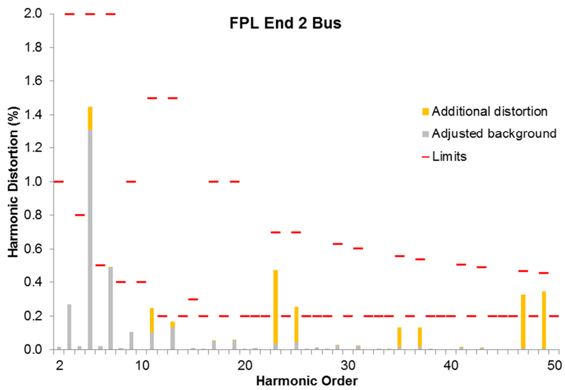


Figure 2-13: Voltage distortion results at FPL 2

WP2 – Interface Schematics and Diagrams

The first submission of the schematics and diagrams for the FPL protection and control system were received during Detailed Design Stage 2. These schematics and diagrams covered all the interfaces and connectivity for all the FPL components from the individual connections to the IGCT modules to the incoming 3-phase LV supplies. Due to the detailed nature of the information in this work package the drawings had to be reviewed in conjunction with other documentation to get a holistic view of the device.

WP3 – Protection Design

Updated protection functions and settings were submitted in Detailed Design Stage 2. WPD took the opportunity to consolidate the protection functions at the interface point as there were over 100 events that could be logged and sent over SCADA. The events were grouped into 20 separate signals which will provide WPD Control Engineers with enough detail to make informed decisions remotely following an event. All signals will be made available at locally at Exebridge through the FPL HMI for site personnel to access.

WP4 – Equipment Layout and Component Information

ABB were provided with a CAD model of the Exebridge site during Detailed Design Stage 1. Using this information ABB produced a model of the equipment layout which includes: 33/3.25kV converter transformer and noise enclosure, PCS 6000 container, 33kV harmonic filter and heat exchanger. The positions of the individual items of equipment required fine tuning to allow for sufficient clearance for installation and maintenance. A 3D model of the FPL equipment layout can be seen in Figure 2-14.

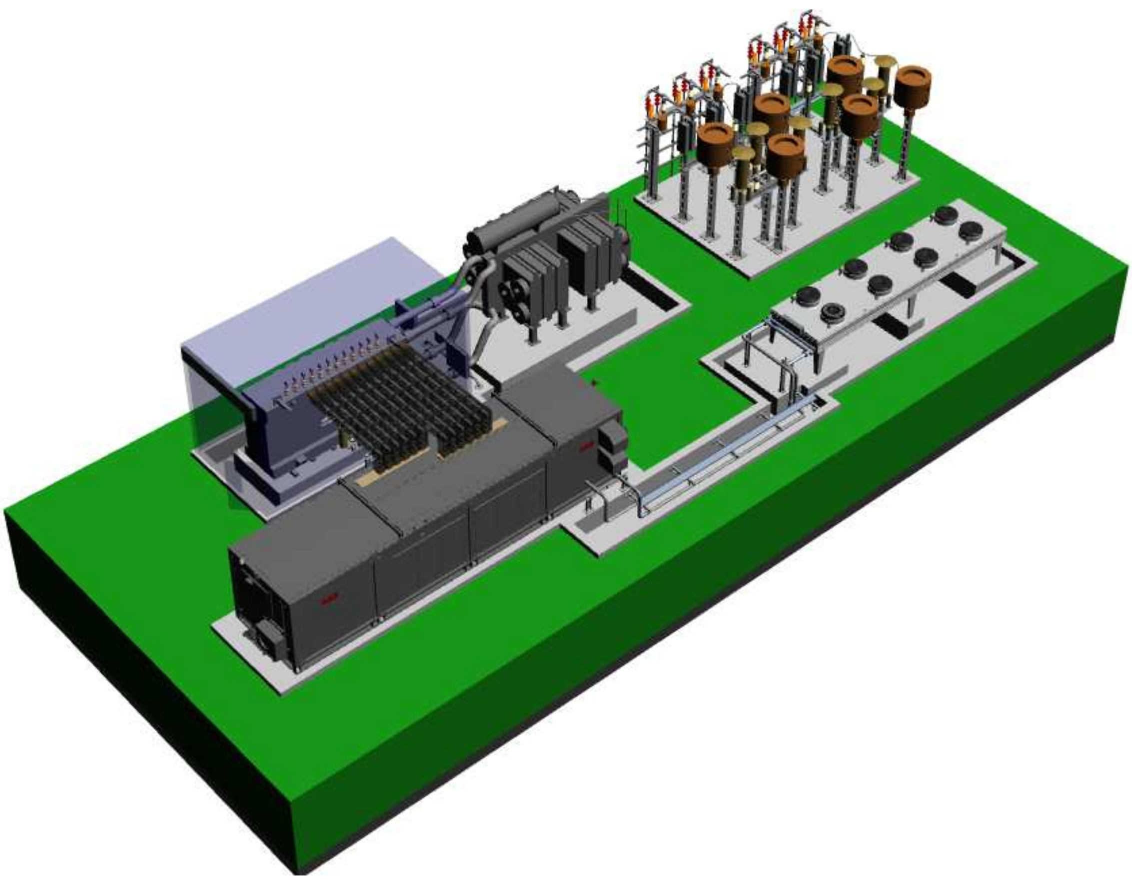


Figure 2-14: 3D model of FPL equipment layout

WP5 – Transformer

The output from the back-to-back AC to DC converter is stepped up from 3.25kV to 33kV through two transformers at either side of the converter. ABB are sourcing the transformer from Končar DS&T Zagreb, who specialise in the design transformers for this application. Both transformers will be located in a single tank as this will provide substantial cost savings (including testing, manufacture and installation). The operational risk of having both transformers in one tank is not an issue as failure of either transformer would result in the FPL having to be disconnected from the system. The design of transformer has now been approved and shall be manufactured and ready for testing in September 2017. The general arrangement for the transformer can be seen in Figure 2-15.

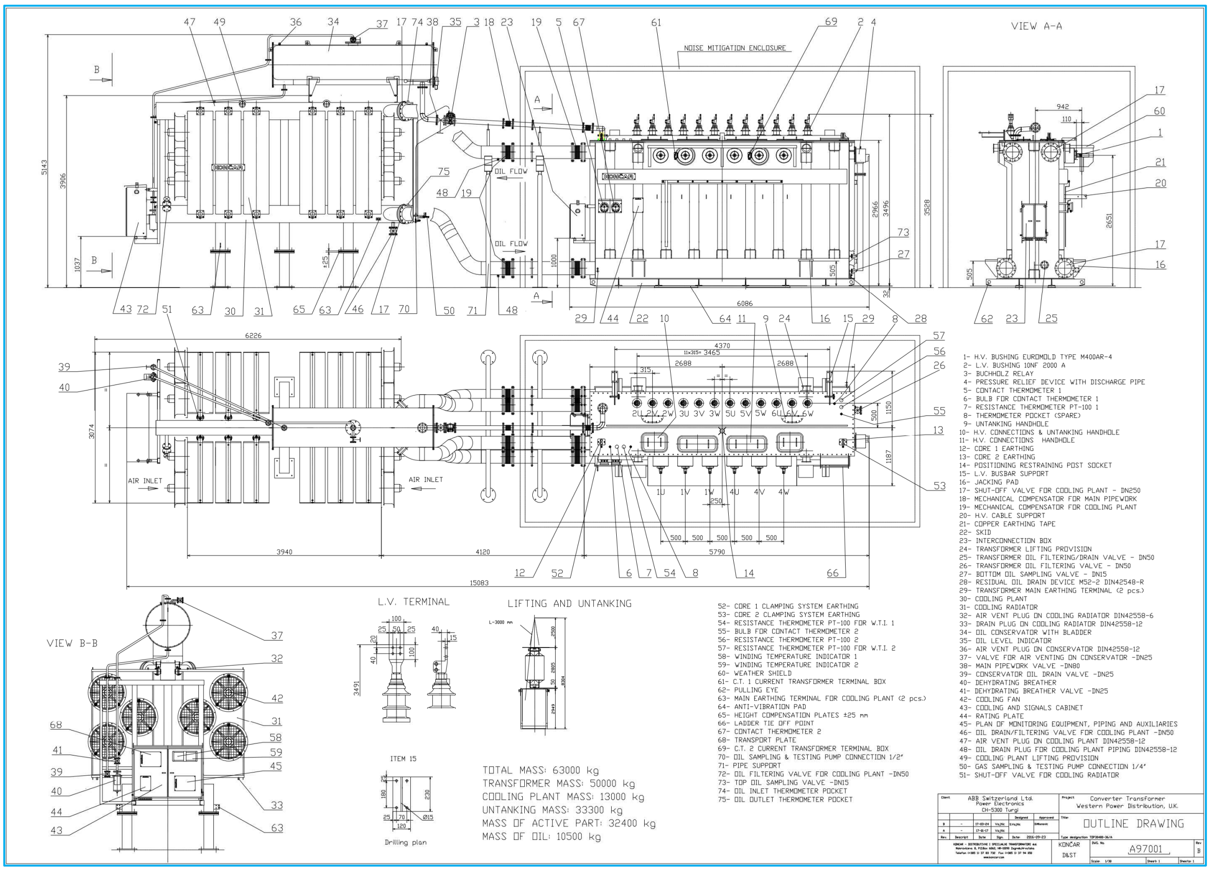


Figure 2-15: General arrangement of Converter Transformer

WP6 – Method Statements

WPD requested ABB to provide example Method Statements for transportation, installation, testing and de-commissioning of the FPL as part of Detailed Design Stage 2. ABB submitted these for comment and WPD have reviewed these ready for the final Method Statements to be submitted nearer to testing and installation.

Finalising Detailed Design Stage 2

All work packages were reviewed during a three day face to face design meeting between WPD and ABB during 28 February to 2 March 2017. The face to face design meeting provided a useful platform for discussing and agreeing design amendments as comments are normally discussed over teleconferences which can be cumbersome for reviewing detailed technical documents.

ABB resubmitted the design packages after the face to face meeting and Detailed Design Stage 2 was agreed and finalised in early March 2017.

Equipment Testing

The FPL converter is subject to rigorous testing before it can be shipped to site. Tests on the power electronic converter elements shall be carried out in accordance with IEC 60146-1 and IEC 60146-2. The transformer shall be tested in accordance with the relevant parts of IEC 60076 and IEC 61378. The testing regime for the FPL is split into four main parts:

(i) Converter Frame Testing – this is the first step of the testing regime whereby the converter components are tested in isolation to confirm the current, voltage and thermal performance of the IGCTs and associated equipment.
(ii) Software Testing – The next stage of testing involves verification of the software configuration used to control and operate the FPL. This test is performed on ABB's bespoke workstation and does not need any other components of the FPL to be tested at the same time.
(iii) Container Testing – This is the final stage of the FPL converter testing with all the components housed inside the FPL container. A full function test will be carried out as all the protection and control systems will be connected.
(iv) Transformer – The converter transformer shall be tested in Končar's factory in Zagreb to verify its current, voltage and thermal performance.

Other smaller individual components, such as the heat exchanger, shall be tested independently by the manufacturer and test certification supplied accordingly.

Converter Frame Testing

During May 2017 the FPL converter frame successfully underwent testing at ABB's testing laboratory in Turgi, Switzerland. As explained in the previous section, the converter frame testing is carried out to confirm various parameters of the converter design. The converter frame testing is one of the most critical parts of the testing process with the following items being of particular interest:

- Insulation Test – confirms that the converter has sufficient levels of insulation for normal and abnormal voltages that could occur.
- Rated Output Test – verification that the components of the system can operate at the maximum operating current (1800A) and dc link voltage (±2500V).
- Power Loss Determination – in conjunction with Rated Output Test, confirm the power losses through the device are within the contracted values.
- Temperature Rise – in conjunction with the Power Loss Determination, confirm that the cooling medium and component temperatures do not exceed limits and are temperatures remain stable.

The tests were witnessed by WPD experts and the converter frame successfully passed all the tests detailed in the specification. Photographs from testing can be seen in Figure 2-16 and Figure 2-17 below.

Figure 2-16: Converter Frame prepared for testing

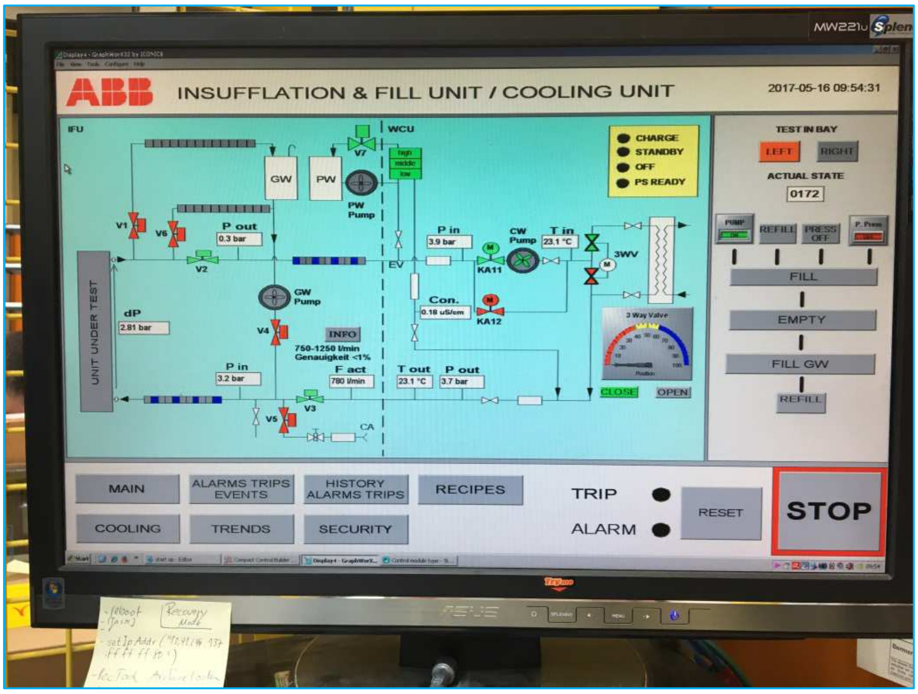


Figure 2-17: HMI display in the laboratory

2.5.3 FPL Network Integration

Significant progress has been made at Exebridge substation in preparation for the delivery of the FPL equipment during this reporting period. The enabling works have been completed and work is on-going to construct the new switchroom to house the 33kV switchgear. Protection designs have also been prepared to integrate the FPL with the surrounding network.

Site Progress

During the last reporting period designs had been prepared to remove the two pole mounted transformers and improve the access arrangements at Exebridge substation. These works improve the overall safety of the site for the installation of equipment in the future. Figure 2-18 shows the installation of the new substations to replace the pole mounted equipment.

Figure 2-18: Installation of Distribution Substations during February 2017

The old 33kV outdoor compound at Exebridge has to be removed to create sufficient space for the installation for the FPL equipment. A tender for the construction of the new switchroom to house new 33kV indoor switchgear was awarded to Blyth Construction in January 2017. Work began on site in early February 2017 and the building was complete in May 2017. New Siemens NXPLUS 33kV switchgear was installed following completion of the building and is currently being commissioned. Photographs of the installation can be seen in Figure 2-19 and Figure 2-20 below.

Figure 2-19: Construction of 33kV switchroom in early May 2017

Figure 2-20: 33kV switchgear being installed at Exebridge

The next stage of the site works involves transferring the existing 33kV circuits from the old 33kV compound over to the new 33kV switchgear. A stage by stage plan has been prepared to carefully transfer each circuit individually whilst ensuring that Emergency Return To Service (ERTS) times are kept to a minimum. The old 33kV compound shall be decommissioned and all structures removed following transfer of all the 33kV circuits.

Earthing Survey

A site visit in early February 2017 identified some inconsistencies between the earthing records and physical equipment at Exebridge. Due to safety concerns associated with the issues an earthing survey was commissioned to check the status of existing earthing and plan for the installation of new earthing for the FPL equipment. The survey recommended that additional earthing shall be installed around the existing transformers and that some existing handrails shall be replaced by an equivalent made from GRP. Figure 2-21 shows the outline design for earthing at Exebridge.

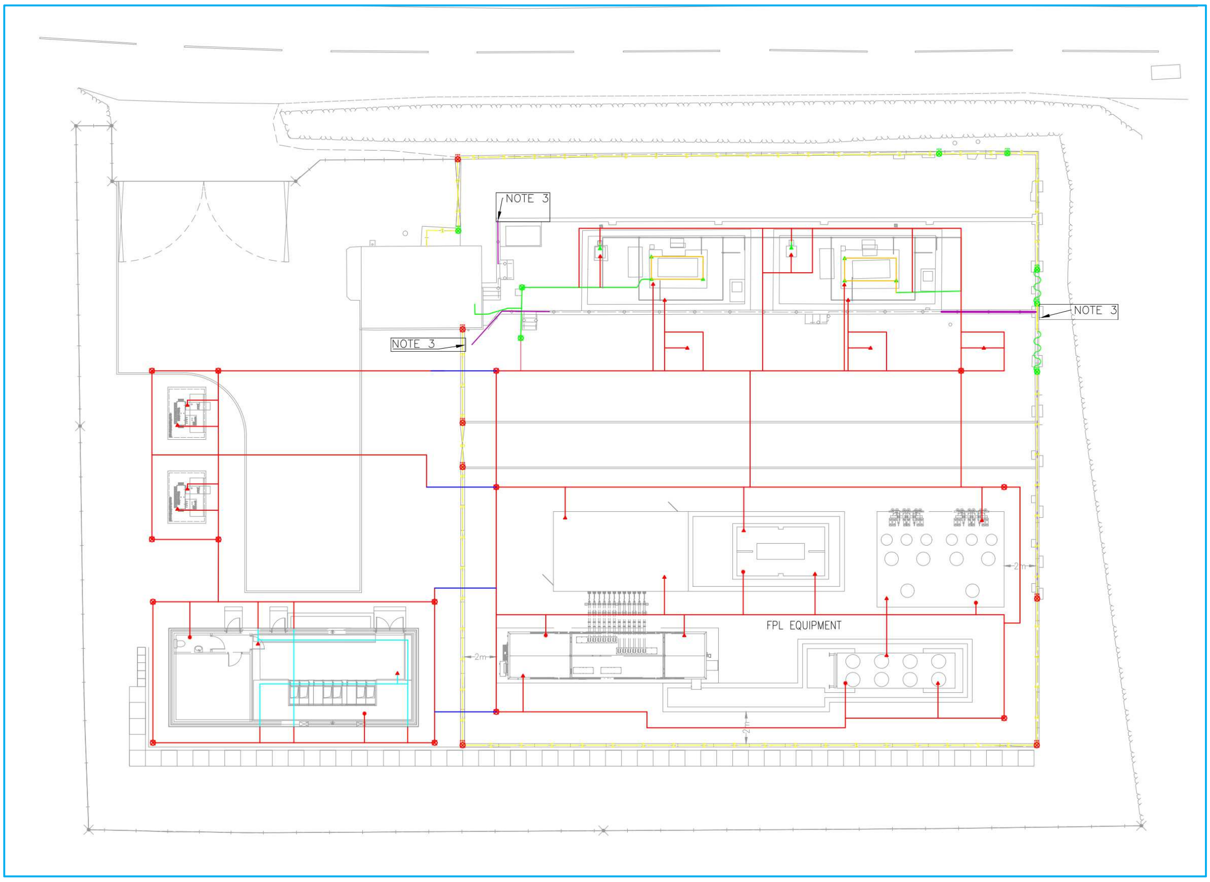


Figure 2-21: New earthing design for Exebridge Substation

Intertripping Design

The FPL does not contribute significantly to fault level and therefore it was determined that any faults on the 33kV network should result in the FPL tripping to ensure that the FPL does not feed a fault. The built-in FPL protection system will monitor the incoming 33kV supplies and trip the FPL should a disturbance in voltage, current and/or frequency be detected. However, to provide additional assurance that the FPL is tripped for a 33kV feeder fault, an intertrip scheme shall be installed at the surrounding substations so that tripping of a remote 33kV circuit breaker will trip the FPL automatically. Figure 2-22 shows the proposed intertrip scheme between Exebridge and South Molton, Wivelscombe and Taunton.

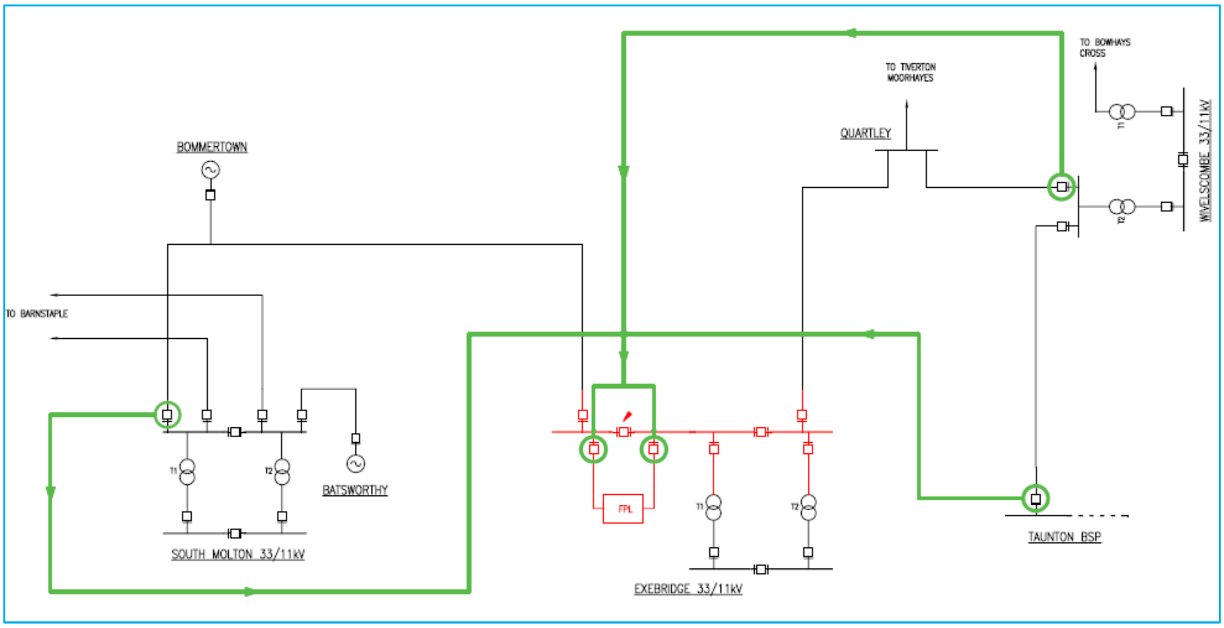


Figure 2-22: Intertripping diagram to be updated

The intertrip scheme for the FPL will be implemented over an existing optical fibre link routed between Barnstaple and Taunton BSPs. Works have now started at Exebridge, South Molton and Wiveliscombe to divert and terminate the optical fibre into the switchroom buildings to facilitate the communications channel for the intertripping scheme.

2.5.4 FPL Control Module

Network Equilibrium's FPL will be used to transfer active power (P) between two separate 33kV networks and will also provide independent reactive power (Q) support on both sides.

The amount of active power to be transferred (P set point) and reactive power to be absorbed/supplied (Q set points) will be determined dynamically, in real-time by an external control system which will then send the calculated set points to the FPL.

This external control system will have a complete view of the network operation by receiving real-time information including power flows, voltages and currents. Using the received information, the active power to be transferred and the reactive power to be supplied/absorbed will be determined such that any network thermal or voltage constraints are removed. Siemens' Spectrum Power 5 will be used for this purpose and will communicate with Western Power Distribution's (WPD's) Network Management System (NMS) to exchange all necessary information.

Progress in this reporting period

Since the commencement of the work with Nortech in October 2016, significant progress has been made on the Design of the FPL Control Module. This project progress report demonstrates the work completed as part of the design and presents the learning gained in the process.

ICCP Design

As shown in Figure 2-23, the FPL Control Module will be communicating with the NMS over an ICCCP link to receive real-time SCADA measurements and then send back the calculated power transfers (P set point) and reactive power support (Q set point) which will be forwarded to the FPL device via the existing communications infrastructure.

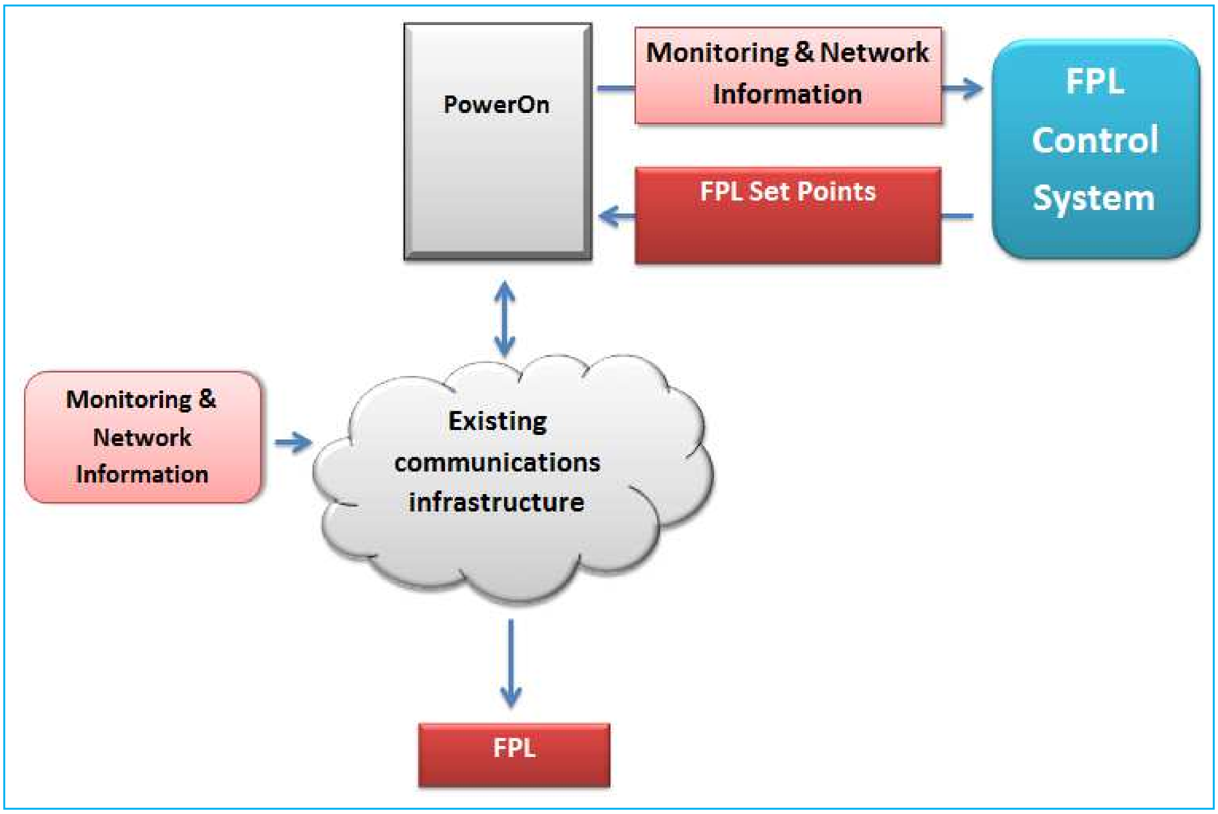


Figure 2-23 FPL technology architecture

Nortech have worked with the NSM team to perform a number of tests in order to determine the required configuration of the ICCP link and de-risk its implementation. This involved setting up an ICCP simulator communicating with the NMS and capturing the ICCP traffic. This captured ICCP traffic was very important as it verified the format of the data that would form the inputs to the FPL Control Module and the required format of the controls that the FPL Control Module will need to produce.

IPSA Model Requirements

It was decided that the IPSA network model developed as part of the APT work, would be used to import the electrical model of the network into the FPL CM. Therefore, a very important part of the work was to ensure that the model represented the required area and included all the necessary information.

The creation of the IPSA model started with the definition of the area that would need to be modelled which included:

- Barnstaple BSP.
- Taunton BSP.

- Full Barnstaple feeder on which the FPL will be connected.
- Full Taunton feeder on which the FPL will be connected.
- All remaining Barnstaple feeders simulated as loads.
- All remaining Taunton feeders simulated as loads.
- The 132kV infeed to Barnstaple BSP.
- The 132kV infeed to Taunton BSP.

The FPL CM IPSA model is shown in Figure 2-24.

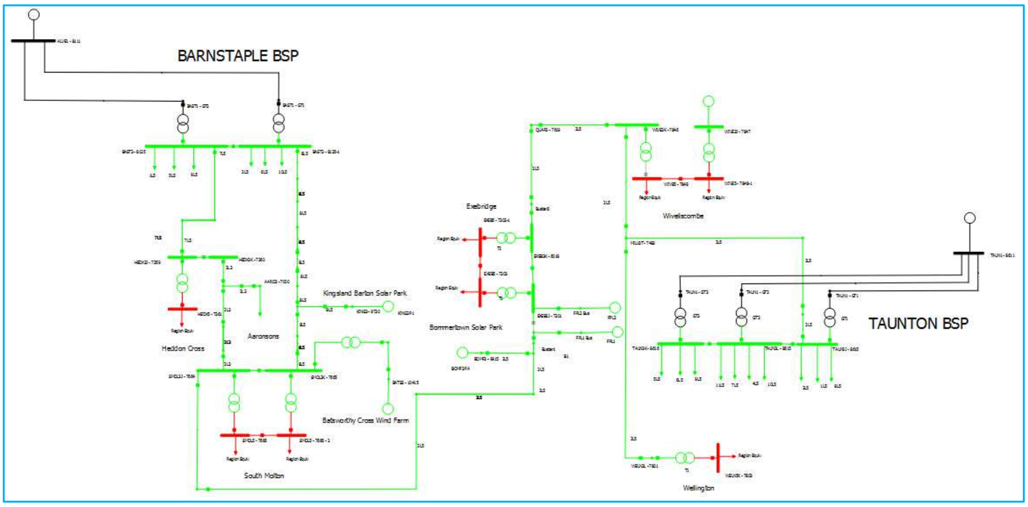


Figure 2-24 FPL CM IPSA Model

To ensure that the FPL CM will be interpreting the real-time SCADA data it receives from the NMS correctly, emphasis was given on checking the mapping of the ALIAS to the network model. Due to the small size of the model, these checks were done manually by inspecting the ALIAS in the extended data of the network components as shown in Figure 2-25.

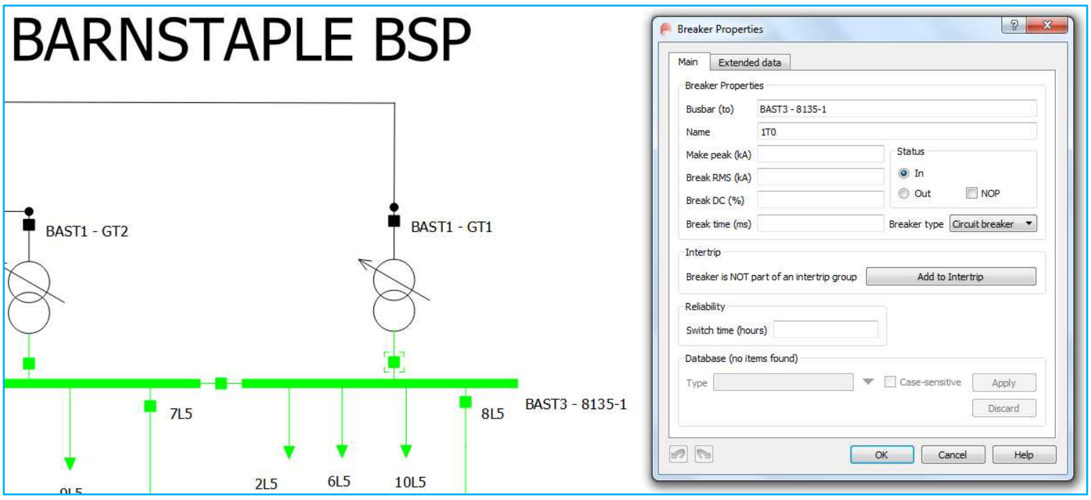


Figure 2-25 Mapping of ALIAS in extended data of network model components

IT Preparations

WPD's IR team have prepared all three servers required for the FPL CM. Two of these are the Primary (normally used to run the FPL CM) and Standby (used to run the FPL CM when the Primary server fails) iHost servers and the third server is the development server (connected to the offline NMS system when required to test updates to the FPL CM).

FPL CM technology integration and NMS Interaction

The FPL technology consists of a number of different systems, making it crucial to ensure that the interaction between the different systems is clearly defined and commonly understood by all systems. The various parts of the FPL technology are:

1. The FPL Device.
2. NMS.
3. The FPL Control Module.

For this reason, the same design approach was followed as with SVO where the Operational Scenarios Specification was created. As shown in Figure 2-26, this involved initially identifying the different operating scenarios, then specifying the actions that each of the 3 systems needs to take and finally using the produced Specification to determine and plan the work required to configure the NMS such that it supports the functionalities it needs to have as per the Operational Scenarios Specification.

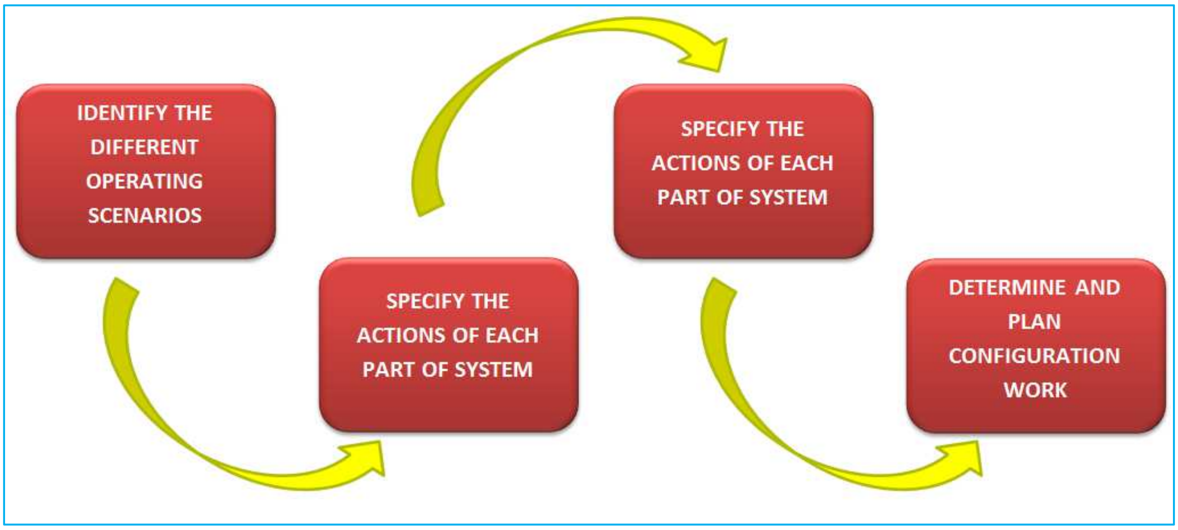


Figure 2-26 Operating Scenarios Specification Procedure

Design Documentation

In this reporting period, Nortech have submitted the FPL CM Design documentation which consists of the Logic Design and the Functional Specification. This Design documentation is currently under review.

Next steps

In June 2017 the design of the FPL CM will be completed and the build phase will commence. Work will then focus on producing the test plans for the Factory Acceptance Testing (FAT), the System Integration Testing (SIT) and the System Acceptance Testing (SAT). FAT will take place in August 2017, while the SIT will commence at the end of September 2017. The final phase of testing, SAT, will start in October 2017 and finish in March 2018 with the completion of the SAT of the FPL device.

3 Business Case Update

There is no change to the business case. The business case to further facilitate the connection of low carbon loads and generation in the project area, on both the 11kV and 33kV are still applicable.

4 Progress against Budget

Table 4-1: Progress against budget

	Total Budget	Expected Spend to Date May 2017	Actual Spend to date	Variance £	Variance %
Labour	**1262**	**439.5**	**427.8**	**-4.1**	**-1%**
WPD Project Management & Programme office	510	245.0	238.7	-6.3	-3%
Project Kick Off & Partner / Supplier Selection	33	33.0	33.0	0.0	0%
Detailed design & modelling	101	81.0	74.1	-6.9	-9%
Installation of Equipment - 11kV & 33kV	390	10.0	9.4	-0.6	-6%
FPL Technologies - Substation Installation 33kV	141	65.0	67.4	2.4	4%
Capture, analyse & verify data for EVA, SVO & FPL	58	0.0	0.0	0.0	0%
Dissemination of lessons learnt	29	5.5	5.3	-0.2	-3%
Equipment	**6691**	**2805.2**	**2799.8**	**-23.1**	**-1%**
Project Kick Off & Partner / Supplier Selection	2	2.0	2.0	0.0	0%
Procurement of SVO Equipment	1540	390.0	388.0	-2.0	-1%
Procurement of FPL Technologies 33kV	4550	2113.2	2113.2	0.0	0%
FPL Technologies - Substation equipment 33kV	599	300.0	296.5	-3.5	-1%
Contractors	**3339**	**1155.5**	**1135.7**	**-8.7**	**-1%**
Detailed design & modelling	804	650.0	648.5	-1.5	0%
Delivery of SVO Technique - 11kV & 33kV	392	150.0	142.5	-7.5	-5%
Installation of Equipment - 11kV & 33kV	850	22.0	20.5	-1.5	-7%
Implementation of Solution	46	40.0	38.8	-1.2	-3%
Implementation of Solution	139	0.0	0.0	0.0	0%
FPL Technologies - Substation	540	265.0	257.5	-7.5	-3%

Installation 33kV					
Capture, analyse & verify data for EVA, SVO & FPL	445	7.5	6.9	-0.6	-8%
Dissemination of lessons learnt	123	21.0	21.0	0.0	0%
IT	**396**	**142**	**136**	**-6**	**-4%**
1. WPD - Advanced Network Modelling and Data Recovery	130	35	32	-3	-8%
1. WPD - Procurement of SVO Equipment	60	15	15	0	1%
Installation of Equipment - 11kV & 33kV	60	5	1	-4	-71%
6. WPD - Implementation of Solution	46	42	39	-3	-8%
FPL Technologies - Substation Installation 33kV	100	45	49	4	9%
Travel & Expenses	**159**	**75**	**71**	**-4**	**-6%**
Travel & Expenses	159	75	71	-4	-6%
Contingency	**1190**	**0**	**0**	**0**	**0%**
Contingency	1190	0	0	0	0%
Other	**53**	**10**	**10**	**0**	**-1%**
Other	53	10	10	0	-1%
TOTAL	**13091**	**4627**	**4581**	**-47**	**-1%**

5 Successful Delivery Reward Criteria (SDRC)

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
5 - Trialling and demonstrating the SVO Method	Green	20/04/2018	On track
6 - Trialling and demonstrating the FPL Method	Green	05/10/2018	On track
7 - Trialling and demonstrating the integration of the EVA, SVO and FPL Methods	Green	28/12/2018	On track
8 - Knowledge capture and dissemination	Green	12/04/2019	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

Significant learning has been generated and captured throughout this reporting period and has been robustly documented in SDRC-4. Other significant learning has been generated in respect of the construction activities associated with the delivery of the SVO and FPL systems. This learning will, in the next reporting period be transferred to WPD internal policies and shared with all other DNOs on request.

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 WPD's 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 Network Equilibrium risk register is a live document and is updated regularly. There are currently 58 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)

Details of the Risk	Risk Rating	Mitigation Action Plan	Progress
All required inputs for the final build of the SP5 system are not available	Severe	Dependencies on other elements and organisations has been removed and the production is suitably staged to enable delivery	A methodology and process is being finalised to enable the delivery to be aligned to support the SVO go-live date of December 2017
The SVO and FPL plugins will are not accurate enough to suitably benchmark the project's outputs	Severe	A focussed set of required to be delivered in PSS/E has been developed	Work is underway on the revised creation of SVO and FPL plugins in PSS/E
Delivery cost of APT increases beyond that budgeted	Major	Clearly define required output and timescales to understand any financial impact	Analysis and audit work is being performed on the outputs of the APT to determine final suitability
Insufficient WPD resource is available for project delivery	Major	Engage with senior stakeholders and the project sponsor to ensure they are aware of the resourcing requirements to deliver the project WPD has contracted with PB to support the project in the technical aspects.	Construction work in now underway on a number of sites consecutively and the availability of required staff will be closely monitored
Correct level of network data can't be gathered to benchmark SVO and FPL performance	Major	Ensure existing monitoring points are accurate and reliable and integrate new monitoring points for missing data where appropriate	Work is ongoing within a wider project to ensure that the project area's monitoring points are accurate and robust

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

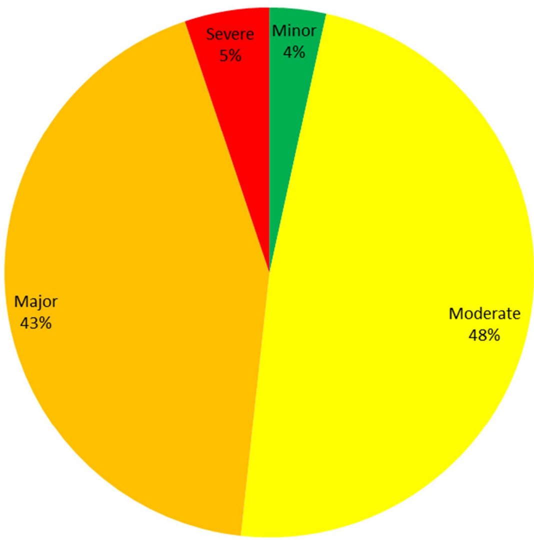
Table 8-2 - Graphical view of Risk Register

Likelihood = Probability x Proximity						
	Certain/Imminent (21-25)	0	0	0	1	0
	More likely to occur than not/Likely to be near future (16-20)	0	0	2	2	0
	50/50 chance of occuring/ Mid to short term (11-15)	0	0	3	3	0
	Less likely to occur/Mid to long term (6-10)	0	0	9	10	7
	Very unlikely to occur/Far in the future (1-5)	0	0	2	10	9
		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	2	28	25	3	No of instances
Total	58				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 the project.

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 - Risks identified in the previous progress report

Details of the Risk	Previous Risk Rating	Current Risk Rating	Mitigation Action Plan	Progress
The full and final APT will not be available to support the delivery of SDRC-4	Major	Closed	Ensuring appropriate plan is in place and resource.	SDRC-4 was successfully delivered whilst also highlighted areas of the APT and wider that would benefit from additional development
Key personnel leave the project	Major	Moderate	Rigorous and robust documentation of work. Induction Package to aid new starters	This risk has reduced now the design phase is complete and approved
Correct level of network data can't be gathered to benchmark SVO and FPL performance	Major	Major	Installation of additional network monitoring points to ensure data can be appropriately gathered	Work is ongoing within a wider project to ensure that the project area's monitoring points are accurate and robust
Required data from several WPD systems in to the Siemens SVO system to enable it to function is unmanageable and non-updatable	Major	Moderate	Develop a team structure and a process to enable the required timely updates to be carried out	Training has now taken place on how to appropriately update the system and guidelines are being produced
SVO method is delivered behind schedule	Moderate	Moderate	Ensure all elements of the method and communications interface are understood	Following the design freeze of the SP5 system this has reduced

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 - Risks identified at the Bid Phase

Risk	Previous Risk Rating	Current Risk Rating	Comments
Project team does not have the knowledge required to deliver the project	Minor	Minor	A Technical Lead role has now been appointed for the project and a contract has been signed with WSP|PB to provide specialist engineering resource to successfully deliver the project
No SVO available from the contracted supplier	Major	Closed	The SVO system procurement activity is now complete
Project cost of high cost items are significantly higher than expected	Major	Minor	All major items are now contracted and the state of these will be robustly monitored
No FPL available from the contracted supplier	Major	Minor	An FPL supplier has been contracted (ABB)
Selected sites for technology installations become unavailable	Moderate	Minor	Works have started a significant number of project site locations and suitable reserve sites have been selected as documented in SDRCs 2 and 3

9 Consistency with Full Submission

During this reporting period a core team of both WPD and WSP|PB engineers has been formed, which has and will continue to ensure that there will be consistency and robust capturing of learning moving forwards. 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:

- **EVA** – Develop and demonstrate an Advanced Planning and Operational tool for 33kV and 11kV networks;
- **SVO** – Install and trial advanced voltage control schemes at 16 substations; and
- **FPL** – Install and trial a Flexible Power Link at a 33kV substation.

10 Accuracy Assurance Statement

This report has been prepared by the Equilibrium Project Manager (Jonathan Berry), reviewed by the Future Networks Manager (Roger Hey), recommended by the Network Strategy and Innovation Manager (Nigel Turvey) 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.