Low Carbon Network Fund Project Progress Report December 2014

Flexible Networks for a Low Carbon Future

Version:	1.0
Produced by:	Martin Hill – Future Networks Manager
Approved by:	Jim Sutherland – Engineering Director

1. Executive summary

1.1. Project Background

This project will trial a combination of smart network interventions and customer energy efficiency measures at three network locations. The objective is to demonstrate how they can release capacity on the HV network, allowing greater take up of low carbon technologies such as solar PV, heat pumps and electric vehicles without the need for traditional network reinforcement. The project will also encourage specific industrial and commercial (I&C) customers to improve the energy efficiency of their buildings to reduce their electricity demand in order to alleviate the need for reinforcement.

The results from these trials have the potential to inform future network planning and operational practices. This project will help DNOs more accurately assess operational plant ratings using dynamic techniques and how best to actively control the network at the EHV/HV level. It aims to provide evidence of the capacity headroom available in existing networks that can be used before traditional network reinforcement needs to take place. This will enable networks to connect more customers and plan network reinforcement activities to be timed optimally.

The overall project is divided in to 12 distinct work packages which complement each other and provide multiple methods which work together to achieve the overall aim of a 20% increase in network capability.

1.2. Project Progress Highlights

During this sixth reporting period of the project (June 2014 – December 2014) the project has made progress in a number of key areas.

Earlier in 2014 we made an application to Ofgem for a change in the 'project direction document' to extend the project completion date to reflect the extended timescales of a number of work packages, and a revision to the project budget to reflect some savings that had been made so far. The details of the changes are published on the Ofgem website in the revised project direction document. The main effect of the changes is to extend the project completion date to September 2015. It was also appropriate to set out the revised budget changes to reflect the fact that the deployment of Voltage Regulator trials in the Whitchurch and Wrexham networks were deemed of no benefit once the enhanced network monitoring data had been analysed and that a number of other costs had been less than originally budgeted.

The project team are currently working on preparation of the closedown report for the areas of the project that are complete and commencing dissemination. This includes the cost benefit analysis of the various project interventions.

Several technical papers have preliminary acceptance for the CIRED Conference in 2015. These include:

- LV phase imbalance assessment methodology
- Low voltage PV characterisation for power system applications

- Graceful degradation methodology for the RTTR of Overhead lines
- Dynamic rating to support safe loading of distribution transformers

We have achieved our objective of releasing 20% headroom capacity in the St Andrews area thus deferring the requirement for conventional reinforcement.

Our trial of 33kV OHL real time thermal rating on 2 lines has demonstrated an average capacity uplift of 17% and 20% over summer static ratings in the early summer period of 2014.

1.3. Key Risks

At this stage many of the risks have either arisen and been dealt with, or not materialised. The team continue to consider areas which may impede the progress of the remaining elements of the project. The risk table has been updated to reflect the current perception.

Other Risks – An ongoing risk is that a substantial change to the load in the area (such as a new customer) may change the need for the project by automatically triggering necessary reinforcement as it cannot be accommodated even with a successful outcome from the Flexible Networks project. At this time no major changes are known within the time period of the project and therefore this is no longer considered to be a material risk.

1.4. Learning Outcomes

Learning points are reviewed by the Flexible Networks project team at regular meetings to establish what was learned from the activities undertaken.

The data analysis activities are providing real insights into network performance, highlighting the benefits of network monitoring. The analysis is showing:

- Enhanced transformer rating is possible, based on actual measured annual load profiles and local measured ambient temperatures
- Potential LV network capacity release by re-balancing poorly balanced feeders facilitated by the monitoring we have installed on the feeders
- Improved assumptions for modelling of HV and LV loads in power systems models (e.g. voltage dependency and typical power factor)

Due to the need to monitor the voltages along the LV feeders for a period of time to understand the impact of small scale embedded generation (SSEG) on the voltage profile at points other than at the secondary substation busbars, it was decided that

the most cost effective way to undertake this was to obtain measurements at the service positions of customers. This has been much more difficult than envisaged, several of the customers we encountered have been wary of what the 'electricity company' is up to. As part of customer engagement we went to great lengths to explain to customers what the project was about and how we are trying to support the uptake of renewable energy apparatus, but despite all this it appears that some segments the public have little understanding of what the network operators do in terms of maintaining their quality of supply and the fact that neighbours installing PV on their roofs may have some adverse effect on them. It was also apparent that leaving them information or telling them that information was available on a website was not something they wanted to be burdened with. Overall we learnt that to interact with customers in this way requires more time than initially thought; reassuring customers and explaining that we are trying to help maintain their quality of supply, and that we would be doing something which will not cost them any money. Their caution was exacerbated because we were asking them to sign a letter/form to confirm their consent for us to install a supply monitor, as some thought it was possibly a ploy to sign them up to another energy supplier. In future we believe that we may achieve better results by approaching customers through community groups or social housing landlords.

Through our engagement with large customers on energy efficiency initiatives we have noted that the energy efficiency reports we have funded for their premises may be an extremely beneficial way of instigating future energy efficiency improvements funded by the customer. The reports give payback periods, providing financial justification for the expenditure on interventions and are of assistance to the customer in justifying investment. Therefore our contribution in funding the initial report may result in a disproportionately high return in terms of reduced demand.

2. Project manager's report

The last six months period has seen progress in a number of areas and the project is close to the amended plan in our approved Change Request. The progress and details of each of the work packages is set out below

Work Packages 1.1 - Improved use of primary substation data

This work package is complete The technical report (Improved Use of Primary substation Data) has been peer reviewed and is now ready for wider dissemination. Key learning points include:

- Capacity headroom can be released through a combination of:

- better data error detection and correction techniques being applied to raw measured data
- an improved understanding of network asset loading behaviour
- more sophisticated load forecasting techniques
- a more probabilistic assessment approach.

- An internal stakeholder engagement strategy has been formulated in order to achieve user buy-in and adoption into the main business as business-as-usual.

Work Package 1.2 - Improved secondary substation data monitoring

The substation monitoring continues to record network data for the other work packages. However due to the change of the completion date of several elements of the project to September 2015, it has been necessary to extend the GPRS data communications and data hosting contracts.

The monitors continue to experience intermittency in communications through the GPRS network and it is fair to say this has been more problematic than we considered it would be. The reporting system developed by the University of Strathclyde is now incorporated into the Nortech iHost system, thereby allowing users to call up a heat-map of the monitor data quality performance. This has assisted project staff in targeting problem sites and visiting these sites to rectify issues.

After several setup/teething issues, the Landis & Gyr device being used as a LV voltage monitor was installed in several customer premises. This has enabled additional information to be obtained to supplement the substation voltage data. This enables voltage profiling along selected feeders of where there is a density of solar PV versus where there is none. Also further network voltage reduction tests will continue to determine the opportunity for additional SSEG whilst maintaining sufficient voltage to remote load customers.

The installation of the LV voltage monitors encountered some difficulty in gaining customers consent for the installation of these devices at their meter position. Some customers were amenable to assisting in the trials and some were wary of what it was for. We tried to reassure customers that it did not have any effect on their chosen energy supplier, that it did not record their energy usage and that there was no cost to them. However the fact that we needed to gain confirmation of their consent on a form that they had to sign, did make some of them very guarded and decide not to grant permission for a monitor to be installed. This had the effect of restricting the places for which we could obtain voltage data along the LV feeders. We could of course have made a service connection to the LV mains cables and installed a footpath pillar, but the excavation, reinstatement and feeder pillar costs would have been around £2000+ per voltage point monitored. This route was dismissed given the likelihood is that after 6-9months of data, any further data at the same point would reduce its usefulness and then the mains cable connection and footpath pillar would need removing at a similar cost again.

As part of work package 2.1 a Transformer temperature monitor has been installed on the Liverpool Road primary transformer in Whitchurch. This monitor has been installed in place of the existing Winding Temperature Indicator (WTI) device, with the key difference being that the new unit incorporates a transducer to output the temperature data to initially iHost and eventually into our SCADA system. This allows analysis of the relationship between the transformer load, the environmental

conditions and the cooling effect. The plan is for the transformers to be operated to a determined load capacity rather than a nameplate rating.

Work Planned during the next 6 months:-

- Continue monitoring of the operation and reliability of the devices, data communication and storage.

- Continue harvesting of data that is essential for the other work packages and interventions.

Work Packages 1.3 and 1.4 - Improved operational and planning tools

The University of Strathclyde (UoS) and TNEI are developing the operational and planning/design tools. A key feature of this work is to bring together the different tools which are currently being used for design and operations and provide a common framework.

The learning outcomes are currently being documented in a series of technical reports and technical notes, covering:

- PV Generation headroom
- LV Phase imbalance assessment
- Transformer enhanced rating assessment tool (prototype)
- Improvements in HV and LV network modelling

Learning outcomes include:

- improved assumptions for modelling of HV and LV loads in power systems models (e.g. voltage dependency of load and typical load power factor)

- potential for LV network capacity release by re-balancing poorly balanced feeders

- Transformer ratings can be enhanced, based on actual measured annual load profiles and local measured ambient temperatures

Two abstract papers, one on the LV phase imbalance assessment methodology and one on low-voltage PV characterisation for power system applications, have been prepared and submitted to CIRED 2015 conference. Both papers were reviewed and accepted by CIRED technical committee. Preparation of the full papers are now in progress.

The work planned during the next reporting period is to

- finalise the draft reports and technical notes referred to above for the closedown report,

- finalise and submit the full papers on LV phase imbalance assessment methodology and LV PV characterisation for power system applications to CIRED conference,

- run a workshop with project partners and internal users to develop a methodology for deploying the design/operational tools into business as usual,

- update the the current SPEN draft PV generation policy document based on the learning outcomes from the PV Generation headroom report.

Work Package 2.1 - Dynamic thermal ratings (DTR)

Progress on the implementation of real time thermal rating (RTTR) of the Cupar to St Andrews 33kV overhead lines is summarised below;

- RTTR has been operational since early summer 2014 on the two 33kV circuits from Cupar grid supply point to St Andrews primary. The system comprises GE line monitoring equipment at four selected sites along the circuits, weather stations at 4 primary substations, and communications between monitoring equipment and the PowerOn Fusion server hosting the RTTR calculation engine The RTTR system results are now available through a live web link to a PowerOn dashboard designed specifically for reporting the RTTR of Cupar-St Andrews circuits. All the monitored data and calculated RTTR are also stored in SP Energy Networks' PI historian.

- As one the lessons learnt from the North Wales RTTR system developed under a previous LCNF Tier 1 project, a graceful degradation algorithm is required to gracefully degrade the RTTR to the seasonal rating as an increasing number of monitored weather parameters are lost. In order to meet this requirement, a graceful degradation algorithm was developed and the algorithm specifications document was submitted to GE Energy for implementation in RTTR calculation process. User acceptance test of the graceful degradation implementation has now been carried out and this algorithm is now ready to be added to the RTTR system.

- An algorithm specifications document for conductor temperature estimation was developed based on IEC61597 and Cigre W22.12. This document provides guidance for calculating the transient behaviour of the conductor temperature. This algorithm was used for model validation against the monitored conductor temperature values in Cupar-St Andrews circuits.

- Data analysis was carried out on the monitored data and calculated RTTRs to calculate the seasonal network capacity uplifts and the potential energy yield that can be gained by deploying RTTR system. In the early summer period, average uplifts of 17% and 20% over static summer rating were calculated. Lower levels of uplift were achieved in the mid-summer period.

- Additional GE line monitoring sensors were installed at a span near the Cupar grid supply point. Data analysis showed that this span is one of the critical spans that due to its orientation the prevailing wind direction has a low cooling effect on it.

- Different methods of attachment for the line sensors' temperature probe were trialled in order to identify the appropriate method that would represent the conductor temperature accurately.
- An abstract paper on graceful degradation methodology was prepared and submitted to CIRED 2015 conference. This paper was reviewed and accepted by CIRED technical committee. Preparation of the full paper is now in progress.

The work planned for the next 6 months is as follows:

- Finalise and submit the full paper on graceful degradation methodology to CIRED conference;
- Finalise the close-down report and include the data analysis for the winter period;
- A workshop with project partners and internal users to develop a methodology for deploying the RTTR in business as usual process;
- Install an ultrasonic wind sensor at a pole-mounted installation and compare the accuracy of the ultrasonic wind sensor with cup anemometer technology. This trial aims to demonstrate the effect of accuracy of a wind sensor on RTTR values.

Progress on the enhanced thermal rating of primary transformers is summarised below;

Having previously concluded from surveys that the transformers in the trial are suitable for an enhanced rating, DNV KEMA have gone on to model the enhanced loading capability of the transformers and the effect this has on the transformer aging and the winding hot spot temperature. The results of the modelling confirm that the transformers are able to supply increased peak loads without resulting in adverse aging of the transformer active part. As an example, for St Andrews primary transformers increased loading has been modelled to the point where the capability of associated cables and switchgear become the limiting factor. The level of peak load increase of 14% can be achieved with negligible impact on the remaining expected lifespan of the transformers and an acceptable winding hot spot temperature.

The firm capacity of St Andrews primary substation will be increased in the long term development statement (LTDS) line with the enhanced transformer rating.

Instrumentation with remote monitoring has been installed on a primary transformer at Liverpool Road substation to replace the conventional winding temperature instrumentation. Over the winter period when the transformer loads are at their

highest, an experiment will be conducted to compare the winding temperature predicted by the DNV KEMA and TNEI models against that actually measured.

Work Planned during the next 6 months:-

- Completion of the Methodolgy and Learning report on the enhanced rating of primary transformers.
- Experiment at Liverpool Road to verify the modelled outputs.
- Continued development of the process for adopting primary transformer enhanced rating into business as usual.

Work Package 2.2 - Flexible network control

During the period good progress has been made on the 2 aspects of this work package towards the end objective of redistributing peak load on the 11kV network at appropriate times. These aspects comprise; modelling of switching algorithms; and implementation of field devices.

University of Strathclyde (UoS) assisted by TNEI have undertaken a modelling exercise to evaluate the available thermal headroom at St Andrews primary substation, and at adjacent primary substations. Data from the secondary substation monitoring installed as part of the project was used in the modelling together with primary substation data from the PI historian, meter data for HV customers, and NOJA data from manual downloads. Opportunities to increase the headroom at St Andrews by permanent, seasonal or dynamic network reconfiguration to transfer load onto adjacent primary substations were identified and analysed.

The analysis considered the effect of load transfer on the maximum demands at the adjacent primary substations to ensure that these would not be moved into LI 4 or LI 5 load index positions.

The report identified a number of options for progressively shifting load from St Andrews to adjacent primary substations by moving normally open points (NOP's) These options were considered at a workshop comprising operational and design personnel from within the business to arrive at a preferred solution comprising a seasonal switching regime to redistribute approximately 6% of St Andrews peak load. This approach to managing the network is facilitated by the additional monitoring that we have installed on the secondary network, providing greater visibility of load flows for the first time.

In order to implement switching algorithms required for flexible networks, new generation automation equipment has been installed at a number of sites in St Andrews earlier in the project. Central Communications Units (CCU), with enhanced radio bandwidth to serve the purposes of the project have been installed at 3 primary substations, and new-generation outstations for monitoring and control

have been installed at a number of secondary substations to supplement legacy automation equipment on the network.

During this period development work has been completed to map the new CCU equipment to the secondary substation devices.

The switching logic for flexible network control will be implemented in our PowerOn Fusion SCADA system. Delivery relies upon the support from the specialised PowerOn SCADA team to integrate the new automation equipment into the PowerOn system. As we explained in our June 2014 progress report, the SCADA teams focus has been on business as usual work to complete the implementation of the new company PowerOn SCADA system and solving operational issues. This has caused an issue for the project as the non-availability of specialist resource means that implementation of flexible network control has been delayed. OFGEM have agreed to our Change Request for an extension to the completion date to September 2015 which will allow the maximum learning to be obtained from this work package.

Work Planned during the next 6 months:-

- Complete the commissioning of the additional automation points across the Network.
- Development of mapping processes to integrate the primary substation CCU to the PowerOn fusion system.
- Testing of switching algorithms on the PowerOn SCADA system at the PNDC.

Work Package 2.3 - Energy efficiency

BRE have continued their engagement with a number of large customers in the trial areas and have discussed detailed option assessment reports with these stakeholders.

In conjunction with energy suppliers we have subsequently prepared fully costed proposals for the interventions agreed with stakeholders. The agreed interventions are now at delivery stage.

The relationship developed with St Andrews University has been particularly successful. The university have access to Scottish Government funding to implement energy efficiency measures. The reports supplied by our project have been beneficial in enabling them to target this spend. In addition we have been able to identify an opportunity to reduce the supply voltage at certain university sites where they are the sole customer from a SPEN secondary substation. This is at no cost to the university and therefore compares favourably with their alternative option of installing a voltage optimiser.

We are working with Wrexham Council to implement a small scale trial of PV to domestic hot water technology in the social housing stock in Ruabon. This involves installation of a controller unit which will turn on electric hot water heating when surplus energy to that being used by the property is being produced by the solar PV.

We will assess the potential of this technology to facilitate increased connection of PV onto the network.

Following on from the previous voltage reduction to the network at Ruabon we are undertaking a further voltage intervention with the added benefit of having some voltage monitors recording data at customer supply points. This will allow extra clarity of the voltage impact and changes to ensure that we maintain within the statutory limits. At the location were a customer notified us about their supply voltage during the previous test, we have resolved a previously undetected fault condition on the LV network and installed a voltage monitor at their premises.

.

Work Planned during the next 6 months:-

- Continued refinement of load modelling and comparison with actual substation monitoring data
- Completion of the interventions partially funded from the financial contribution from the sum allowed within the project.
- Collaboration with St Andrews University to trial voltage reduction where there are sole use supplies
- Further voltage optimising and evaluation during the winter loading period

Work Package 2.4 - Voltage regulation

The Voltage Regulator has been installed and energised on the St Andrews network. A model of the St Andrews – Anstruther circuit was developed by TNEI using data from the recently commissioned secondary system monitoring and West New Hall was chosen as most suitable location. A radio survey was carried out, wayleaves obtained and the location was approved. The three tank voltage regulator was installed on a new four pole gantry design which was developed as part of this project; this has now been adopted as the standard design for voltage regulator installations. The initial delay in the installation resulted in the Voltage regulator units being stored in the Glenrothes Depot. The opportunity was taken to carry out tests on these units under workshop conditions. This allowed Scottish Power engineers to develop the design for a telecontrol interface. It also enabled a single temporary GPS data logger to be configured for collection of data for all three units.

The installation process provided a number of important learning outcomes which will inform future installations. The construction engineers provided feedback on changes to the four pole design and the installation techniques. The Scottish Power telecontrol engineers were able to develop and test a telecontrol interface based on an existing gas vacuum reclose cabinet. A GPS data logging unit has been installed in the West New Hall voltage regulator and a similar device will be installed at Tegfa.

Work involved in moving voltage regulators into business as usual is progressing from the planning to the implementation phase. The following eleven activities that will be impacted by moving into business as usual were identified.

- Voltage Regulator Policy
- Design Guidance
- Procurement
- Construction Documentation
- Commissioning Guide
- Telecontrol Guidelines
- Linesman's Manual
- Maintenance Policy
- Asset Data Model
- Field Operation Procedures
- Control Room Procedures

A senior member of staff with responsibility for each topic subject was identified from SPEN and a process of internal stakeholder engagement was undertaken by TNEI. This has allowed for a clear picture of how each part of the business currently manages voltage regulators. The next step will be to get these processes documented in a standard SP format and stored on the document management system. The stakeholder engagement identified some scope for improvement in the areas of operational training, controller parameterisation and unified design processes for generation and network connections. Changes in these areas will be implemented as part of the business as usual program

Regular fortnightly meetings involving a number of the voltage regulator stakeholders have been held and this forum has been used in the development of voltage regulator policy in the areas of standard configuration, procurement, operation and maintenance.

Work planned to be undertaken during the next 6 months is as follows:-

- Compare network capacity gains expected from the St Andrews deployment against actual performance in service.
- The monitoring equipment will be installed at a 3 tanks generation site in Tegfa North Wales. This along with the monitoring equipment installed at West New Hall will be used to provide learning from AVR deployments for both generator and network connections.

- Investigate a telecontrol solution to allow the automatic, sequenced control of an AVR thereby allowing them to be used as an enabling technology for Flexible Network Control.
- Analyse results of AVR performance characterisation and model validation tests at the PNDC.
- Documentation on all the 11 processes identified above to be produced in standard format and made available on the SP Document management system.

Work Package 3.1 - Internal stakeholder engagement

The project has helped shape our plans for the next price review period and elements of the project have been built into our ED1 business plan. Meetings have taken place between members of the project team, and our Design section to review individual project plans for adoption of flexible networks techniques. It is intended that members of the Future Networks team will contribute to the 'scheme team' approach in developing these projects.

As part of an internal stakeholder engagement strategy, workshops have been arranged for design staff in both licence areas covering the new tools and techniques available to them as outputs from the project.

A workshop was undertaken in December with participants from the project and our separate ANM project to develop plans for bringing OHL RTTR into business as usual.

A tracking regime is being put in place to measure and record the benefits that the flexible networks techniques deliver for customers during the ED1 period through the reduction in conventional reinforcement.

Within SP Energy Networks there are a number of groups which provide rigour and stewardship to asset management. The project has become a normal inclusion in the activities of these groups.

Each of the members of the Future Networks team is allocated an area of the business to liaise and share innovation and learning.

SP Energy Networks staff out with the project continue to be involved and support the project operational delivery aspects. This expands and develops internal staff engagement and provides a platform to build on when taking the project findings into business as usual.

Work Package 3.2 - External stakeholder engagement

Key project learning outcomes were presented at the 2014 LCNI Conference in Aberdeen, both through formal presentation in the "Data Analytics" session and via one-to-one discussions at the SPEN exhibition stand.

A series of 'one pager' documents are being produced covering the new tools for designers developed under the project.

A stakeholder mapping exercise is being conducted to understand who will benefit from the learning and therefore target communications in an appropriate manner.

We see the 2015 LCNI conference being hosted by SPEN in Liverpool as the ideal opportunity to disseminate the findings from the project. This is planned to include presentations within appropriate breakout sessions together with workshops at the stand where a more technical focus can be achieved.

DNO's will be invited to participate in follow up one to one sessions post LCNI 2015.

Several technical papers have preliminary acceptance for the CIRED Conference in 2015. These include:

- LV phase imbalance assessment methodology
- Low voltage PV characterisation for power system applications
- Graceful degradation methodology for the RTTR of Overhead lines
- Dynamic rating to support safe loading of distribution transformers

Through our collaboration with BRE we have arranged for BRE Trust (http://www.bretrust.org.uk/) to produce a publication on flexible networks techniques that will make this information available to a wider audience within the building and construction sector.

Work Package 3.3 - Verification of experimental design

UoS are in the process of reviewing the methodologies of the work packages.

UoS have prepared a final report on the experimental design and results of the Ruabon voltage reduction experiment.

UoS have also reviewed our proposals for further experiments comprising; voltage reduction; N-1 operation of the network (to verify dynamic rating models); and flexible network control. A formal report will be issued covering these activities which will also include a review of the statistical work that TNEI and UoS have been undertaking as part of work package 1.

Work Package 3.4 - DNO policy changes

The activities and learning from the project are already being transferred in to BaU proposals for ED1 and to become future standard policy. These include secondary substation monitoring and smart MDIs, enhanced rating of primary transformers and automatic voltage regulators. From the early learning of the project, the above three technologies are considered sufficiently beneficial to justify firm plans to implement.

A workshop has been arranged in December to discuss the application of overhead line RTTR in conjunction with ANM to facilitate renewable generation connections. Finally, information from the PV Generation headroom report will be used to update the current SPEN draft PV generation policy document.

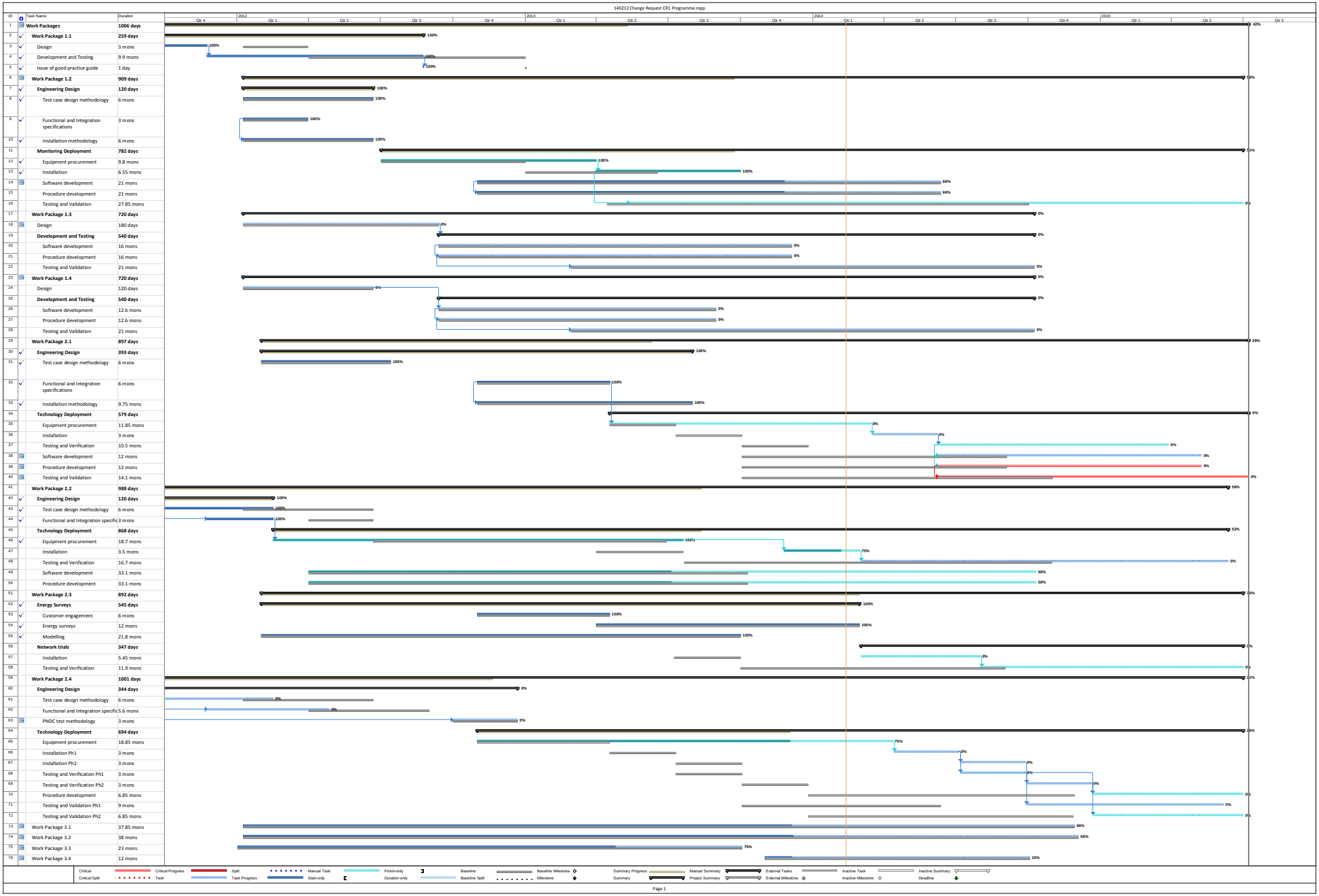
3. Key Issues

As many elements of the project are approaching their conclusion, the team is compiling the considerable amount of information into a closedown report for future dissemination.

The team are working closely with other parts of SPEN for the adoption of the project concepts into business as usual as we prepare for ED1 commencement.

Ongoing development of the knowledge dissemination plan is underway to ensure that learning is transferred both internally within SPEN and to external stakeholders.

4. Project Plan


140212 Change Request CR1 Programme.mpp
ID
Task Name
Duration
Work Packages 1006 days
Work Package 1.1 259 days
Design 3 mons
Development and Testing 9.9 mons
Issue of good practice guide 1 day
Work Package 1.2 909 days
Engineering Design 120 days
Test case design methodology 6 mons
Functional and Integration specifications 3 mons
Installation methodology 6 mons
Monitoring Deployment 782 days
Equipment procurement 9.8 mons
Installation 6.55 mons
Software development 21 mons
Procedure development 21 mons
Testing and Validation 27.85 mons
Work Package 1.3 720 days
Design 180 days
Development and Testing 540 days
Software development 16 mons
Procedure development 16 mons
Testing and Validation 21 mons
Work Package 1.4 720 days
Design 120 days
Development and Testing 540 days
Software development 12.6 mons
Procedure development 12.6 mons
Testing and Validation 21 mons
Work Package 2.1 897 days
Engineering Design 393 days
Test case design methodology 6 mons
Functional and Integration specifications 6 mons
Installation methodology 9.75 mons
Technology Deployment 579 days
Equipment procurement 11.85 mons
Installation 3 mons
Testing and Verification 10.5 mons
Software development 12 mons
Procedure development 12 mons
Testing and Validation 14.1 mons
Work Package 2.2 988 days
Engineering Design 120 days
Test case design methodology 6 mons
Functional and Integration specifica 3 mons
Technology Deployment 868 days
Equipment procurement 18.7 mons
Installation 3.5 mons
Testing and Verification 16.7 mons
Software development 33.1 mons
Procedure development 33.1 mons
Work Package 2.3 892 days
Energy Surveys 545 days
Customer engagement 6 mons
Energy surveys 12 mons
Modelling 21.8 mons
Network trials 347 days
Installation 5.45 mons
Testing and Verification 11.9 mons
Work Package 2.4 1001 days
Engineering Design 344 days
Test case design methodology 6 mons
Functional and Integration specifica 5.6 mons
PNDC test methodology 3 mons
Technology Deployment 694 days
Equipment procurement 18.85 mons
Installation Ph1 3 mons
Installation Ph2 3 mons
Testing and Verification Ph1 3 mons
Testing and Verification Ph2 3 mons
Procedure development 6.85 mons
Testing and Validation Ph1 9 mons
Testing and Validation Ph2 6.85 mons
Work Package 3.1 37.85 mons
Work Package 3.2 38 mons
Work Package 3.3 23 mons
Work Package 3.4 12 mons
Qtr 4
2012
Qtr 1
Qtr 2
Qtr 3
Qtr 4
2013
Qtr 1
Qtr 2
Qtr 3
Qtr 4
2014
Qtr 1
Qtr 2
Qtr 3
Qtr 4
2015
Qtr 1
Qtr 2
Qtr 3
Critical
Critical Split
Critical Progress
Task
Split
Task Progress
Manual Task
Start-only
Finish-only
Duration-only
Baseline
Baseline Split
Baseline Milestone
Milestone
Summary Progress
Summary
Manual Summary
Project Summary
External Tasks
External Milestone
Inactive Task
Inactive Milestone
Inactive Summary
Deadline
Page 1

5. Consistency with full submission

The solution being developed and the methods being trialled in the project remain consistent with those set out in the full submission, subject to the changes introduced as part of our approved Change Request.

Integration of Voltage Regulators –In our Full Submission we stated that as part of Work Package 2.4 Voltage Regulation, we would install 11kV voltage regulation equipment in each of the 3 trial areas comprising St Andrews, Whitchurch, and Wrexham.

Long secondary network feeders tend to be voltage constrained under 'abnormal' network feeding arrangements which can occur under flexible network control. Voltage regulators can be used to address this constraint and therefore facilitate flexible network control.

However detailed assessment of the new data (from secondary substation monitoring) available for the Whitchurch and Wrexham networks determined that this voltage constraint issue does not arise and there is no requirement to install voltage regulators to facilitate flexible network control. This may be due in part to the highly interconnected nature of the legacy Manweb network. Therefore there is no benefit or opportunity to deploy voltage regulators at these two sites.

The deployment of a voltage regulator on the St Andrews 11kV network remains valid.

Project Budget - As part of the change request approved by Ofgem we have reduced the project budget forecast to the benefit of the LCN fund and ultimately the customer.

6. Risk management

Several original submission risk perceptions have been updated in the table below, to reflect how certain risks have not materialised in those aspects of work completed with a review and consideration for those risks that still exist. At this stage of the project generally the risks to the project are considered to be low.

No.	WP	Risk Description	Mitigation	Contingency Plan	Current Perception
1	WP 1 WP 2	The network trial sites may not be representative enough in terms of topology, and load and generation issues to provide learning for other UK DNOs.	Three network trial locations have been selected with different topology, varying levels of PV connection and different customer demographics. UoS will also provide expert review of experimental design to ensure that outcomes are technically robust, representative and verifiable.	Monitoring can be transferred to other sites relatively easily if required. It would not be necessary to repurchase monitoring equipment.	Low
2	WP 1.2	There is a risk that procurement timescales could lengthen if monitoring equipment is not readily available.	The majority of the monitoring equipment has been deployed before by SPEN so procurement timescales are well understood.	As equipment for network trials becomes available, it will be installed at each of the 3 network trial areas consecutively with sites prioritised depending on criticality of network benchmarking. This will prevent any significant slip of project timescales.	Low. Only risk remaining is large scale failure of the population of units, this is perceived as low risk, as they are performing satisfactorily to date.
3	WP 1.2	Customers may suffer supply interruptions during installation of monitoring equipment.	Installation of monitoring at substations should not require an outage in most cases and if outage is required, it should be possible to minimise customer supply interruptions by load shifting.	It has been assumed that a small percentage of secondary substations will result in supply interruptions and a detailed customer engagement strategy has been developed to deal with this.	Low
4	WP 1.2	The development of a "smart" monitor, may require additional time due to unforeseen development risk.	To mitigate this, SPEN will be engaging with a technology partner (Nortech) with expertise in developing algorithms for these devices and with a clear business plan in line with the aims and objectives of the LCNF project.	This is not on the project critical path.	Low
5	WP 1.1 WP 1.2	Significantly more data will be generated to collect, communicate, store and process. Increase in costs of communication systems.	The magnitude of annual raw data storage required has been estimated. Work Packages 1.1 and 1.2 will explore the management of large datasets.	Sampling rate can be optimised as necessary.	Low
6	WP 1.2	There could be data	The existing SPEN regulations	No contingency required.	Low

		privacy issues for customers due to the extensive programme of monitoring to be deployed.	governing data privacy for customers will be used in this project.		
7	WP 1.2	Increased visibility of the network through enhanced monitoring may actually erode anticipated headroom.	Traditionally, there has been a degree of conservatism applied to network design.	Greater knowledge of headroom will improve risk management and reinforcement prioritisation for the network, protecting customers and ensuring P2/6 compliance.	Low
8	WP 1.3 WP 1.4	The development of new tools and processes for the control room and network design involves some complexity and time/cost risk.	SPEN has engaged partners with expertise in the development of tools/software for this application (UoS, TNEI).	This is not on the project critical path.	Low
9	WP 1.3 WP 1.4	Failure of internal user to adopt new tools and processes.	This project contains a detailed component of internal stakeholder engagement (WP 3.1), from the start of the project, to obtain user input and maximise likelihood of adoption. Business change techniques will also be utilised.	Executive buy-in could be utilised	Low
10	WP 1.3 WP 1.4	The 11kV network has not been modelled in entirety, only in limited network areas when it has been required. The LV network is not modelled in detail at all. There is minimal data available on legacy assets at these voltage levels. Once 11kV and LV network models are created, there needs to be a clear maintenance strategy to reflect new connections.	The impact of this on the value of data will be investigated through a detailed uncertainty analysis. In addition, tools that can be used to automate the process of model creation will be investigated. It is not the intention to model all LV networks in detail but rather to improve representation of them. Strategies for model maintenance, through engagement with key customers for example, will be developed.	UoS has developed a GIS software that could be used to accelerate input of overhead line lengths.	Low
11	WP 2.2	From investigation of flexible network control,	A range of representative network area topologies and characteristics	This will be a learning point in itself. This should provide some excellent	Low

		it may be found that the trial networks are already running efficiently or that there are diminished returns associated with the use of this network technology.	are being investigated.	insight into the capacity headroom increases possible with this technology for a range of representative topologies and characteristics.	
12	WP 2.3 WP 3.2	Engagement with external stakeholders i.e. customers, other DNOs, academia, local councils and authorities, community groups, may not be very effective.	A detailed element external stakeholder engagement is included in the project and UoS is providing support on knowledge dissemination. A customer engagement strategy has already been developed and BRE Trust will be involved in carrying out the energy surveys.	Innovative ways of engaging with stakeholders will be considered such as a 'roadshow' to visit other DNO's.	Low
13	WP 2.3	It may not be possible to achieve the expected energy efficiency savings or there may be a lack of customer uptake.	A focussed approach will be used to target customers who should be able to achieve the most energy savings through proposed energy efficiency measures. A network benchmark will be established through monitoring before energy efficiency measures are trialled to provide a technically sound appraisal of possible benefits.	A customer cash incentive of £100k in total will be made available to encourage uptake. A reasonable outcome may be that energy efficiency measures do not have an adequate cost-benefit case.	We consider that the 2% capacity gain through the energy efficiency work package may not be achieved which will be reflected in the learning from the project. However we expect to mitigate the shortfall with additional gains from other work packages.
14	There is a possibility of the unforeseen appearance of a load of up to 5-6MW at St Andrews or Whitchurch before the next price control period, that would require reinforcement. Even though this load is a marginal increase, it may cause P2/6 non-compliance.		Use early outcomes from LCNF project to delay reinforcement where possible.	Typically, the onus would be on the connecting customer to subsidise network reinforcement although regional development agencies may contribute. The network may need to be reconfigured but would still provide useful learning on network behaviour.	No significant load or generation has been seen in the trial sites to date.

15	The project may not provide the expected capacity headroom increases and St Andrews and Whitchurch may need to be reinforced using the traditional approach and/or it is not possible to connect much additional PV at Wrexham.		This project is based on a methodology of integrated, discrete work packages which have all been identified as having the potential to provide headroom increases. Risk is mitigated through the potential for some work packages to outperform in terms of capacity gain.		The project is expected to deliver varying degrees of benefit across the work packages which have more or less application on different network scenarios. We still hope to achieve the overall project goal.
Additional risks identified since original submission					
15a	WP 2.2	Resource availability for integration of new network automation technology into existing company SACDA system PowerOn.	There are no other available resources to mitigate this risk.	Request project timeframe extension.	Delivery plan in place for completion within revised timescales.
15b	WP2.4	Suitability for trial sites for the deployment of Automatic Voltage regulators (AVR).	To use a new connections AVR installation to capture learning of the design, specification and engineering for the equipment. Also use PNDC AVRs to carry out enhanced testing of functionality and performance.	To consider alternative locations for AVR use.	Low
15c	WP 1.2	Availability of new enhanced network monitoring data to inform and develop other work packages.	Increase monitor installation program to speed up delivery of new network data.	Advance preparation work for other work packages reliant on new network data. Use early data analysis to steer direction of other work packages.	Low
15d	Procurement of new technology products.		Consider the use of collaboration agreements.	Use prototype equipment in test case trials before committing to contract.	Low

7. Successful delivery reward criteria (SDRC)

Project budget (criteria 9.1) – The original project budget has been superseded with the one submitted to Ofgem as part of the Change Request and this amounted to a reduction of approximately £1M. This revised budget is now the one which we are reporting against. The following are the key points for any variations;

- Some equipment costs have yet to be invoiced.
- IT costs from IBM are not quite complete and therefore are outstanding.
- Some elements of the budget have used their contingency and others have not to date. Also the PNDC testing costs have not been incurred yet.
- The payments to users have been allocated, but none have been made to date until the customer's contractor invoice for their completed work.

Project Milestone Delivery (criteria 9.2) – At this stage in the project many of the work packages are being concluded in line with the dates in the Full Submission. As a result, a considerable amount of learning will be available at the end of 2014.In accordance with our approved Change Request, work package 2.2. and work package 2.4 will run into 2015.

Creation of a Flexible Network (criteria 9.3-9.5) – As we approach the end of the project we remain confident that a 20% headroom can be created, although the make-up of the 20% may be different across the trial sites due to the applicable benefit variations that each site is able to offer. In the St Andrews trial area we have been able to achieve the increase in headroom for peak load by 20% and thereby achieve the DPCR5 reinforcement target set in this area.

Engagement, dissemination and adoption (criteria 9.6) –

A number of the elements of the project have been built into the ED1 business plan. It is envisaged that the during the period 2015-2023 most of the Flexible Networks key tools will be available to use as an alternative to existing practices for suitable network situations. These include secondary substation monitoring, the deployment of voltage regulators and the enhanced rating of some primary transformers.

Meetings have taken place between members of the project team, and our Design section to review individual project plans for adoption of flexible networks techniques.

Key project learning outcomes were presented at the LCNI Conference in Aberdeen, both through formal presentation in the "Data Analytics" session and via one-to-one discussions on the SPEN exhibition stand.

A workshop has been arranged in December to discuss the application of overhead line RTTR in conjunction with ANM to facilitate renewable generation connections.

8. Learning outcomes

Learning points are reviewed by the Flexible Networks project team at regular meetings to establish what was learned from the activities undertaken.

The data analysis activities are providing real insights into network performance, highlighting the benefits of network monitoring. The analysis is showing:

- Enhanced transformer rating is possible, based on actual measured annual load profiles and local measured ambient temperatures. Modelling undertaken using the DNV KEMA dynamic rating system (DRS) confirm that the level of enhanced rating envisaged under this project can be achieved with negligible impact on the remaining expected lifespan of the transformers.
- Potential LV network capacity release by re-balancing poorly balanced feeders
- improved assumptions for modelling of HV and LV loads in power systems models (e.g. voltage dependency and typical power factor)

The installation of LV voltage monitors at customers supply points has been much more difficult than envisaged. Overall we learnt that to interact with customers in this way requires more time than initially thought; reassuring customers and explaining that we are trying to help maintain their quality of supply, and that we would be doing something which will not cost them any money. We believe that in future it may be more successful to approach customers through community groups or social housing landlords.

Many aspects of the project are now built into our business plan for RIIO-ED1, such as:

- Secondary substation monitoring
- Smarter MDIs – a smart-meter-like device to be installed in place of the traditional maximum demand indicator in all new and replacement LV switchboards
- Real time thermal rating (RTTR) for three primary transformers in SP Manweb
- An Internal Working Group to get 11kV in-line voltage regulators into business as usual

9. Business case update

A formal change request was submitted to Ofgem which made a request for an extension to the project timescales for certain work packages. The change request was approved by Ofgem and a revised project direction letter was issued by Ofgem on the 27th October 2014.

Progress against budget

Table 1 below is a summary of the total project budget position from commencement to December 2014. The budget plan refers to the revised budget approved in the October 2014 project direction.

Table 1.

Activity	Budget to Dec 2014 (£k)	Actual to date (£k)	Variance (£k)	Commentary
Labour	993	1,006	+13	Labour costs pretty much in line with budget. Minor variation due to extra resources used during Oct.
Equipment	1,738	1,662	-76	Some equipment costs to be invoiced from contractors.
Contractors	1,521	1,517	-4	Contractor costs are in line with revised budget.
IT	328	263	-65	Further IT costs are yet to be completed and invoiced.
Travel & Expenses	22	22	0	Project exceptional travel has been as expected to date.
Contingency & Others	283	136	-147	Certain activities have utilised some of their contingency budget to date.
Payments to users	100	0	-100	Payments will be paid on completion of the energy saving measured being completed by the customer's contractors.
Totals	**4,985**	**4,606**	**-392**	

As part of the change request approved by Ofgem, a revised budget was submitted which set out the latest expenditure forecast. The position of this budget reflected the savings made on equipment and labour and the omission of the voltage regulator installations in the SP Manweb area. The result of this was a reduction in the project budget of just over £1M.

In line with the funding arrangements, SPD have contributed to costs incurred for a proportion of the expenditure for which they receive a direct benefit, detailed in table 2 below. Costs for the LCN funded element have been transferred from the bank account and a copy of the statement is included in the Appendix.

Table 2.

Activity	SPD Contribution to date (£k)	LCNF costs (£k)	Total/Actual to date (£k)
Labour	377	629	1,006
Equipment	956	706	1,662
Contractors	554	963	1,517
IT	87	176	263
Travel & Expenses	7	15	22
Contingency & Others	90	47	137
Payments to users	0	0	0
Totals	**2,071**	**2,536**	**4,606**

10. Bank account

A copy of the bank statement detailing the transactions of the Project Bank Account since its creation is attached to this report. The figures in the statement relate to the LCN funded costs only and not the total project costs. The total debit from the LCNF bank account is lower than the LCNF element of project costs until the date of the next costs reconciliation. Minor differences in the reconciliation between costs and funding being transferred from the bank account are due to timing of transactions.

11. Intellectual Property Rights (IPR)

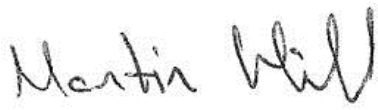
The project is not funding the development of any technology which should create foreground IPR. All partners have accepted the LCNF default IPR arrangements. This approach has not changed since the project commenced and we do not anticipate any further changes.

12. Accuracy assurance statement

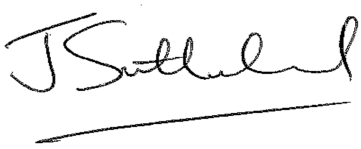
The Project Manager and Director responsible for the 'LCNF - Flexible Networks Project' confirm they are satisfied that the processes and steps in place for the preparation of this Project Progress Report are sufficiently robust and that the information provided is accurate and complete.

Steps taken to ensure this are:-

- Regular update reports from each project team member for their area of responsibility.
- Evidence of work undertaken by the project team is verified by the section manager as part of their day-to-day activities. This includes;
  - Checking and agreeing project plans.
  - Holding regular team project meetings and setting/agreeing actions.
  - Conducting frequent one-to-one meeting and setting/agreeing actions.
  - Confirming project actions are completed.
  - Approving and signing off completed project documents.
  - Approving project expenditure.
- Weekly reports are produced by each section manager of the progress of the work their department is undertaking.
- Director and Senior Management summary reports for the project progress are produced.



Signature (1): Martin Hill – Future Networks Manager



Signature (2): Jim Sutherland – Engineering Director