Low Carbon Network Fund Project Progress Report June 2014

Flexible Networks for a Low Carbon Future

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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 and heat pumps 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 fifth reporting period of the project (December 2013 – June 2014) the project has completed a number of key milestones and continued to progress on many others.

A number of the elements of the project have already been included in the ED1 proposals. 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. These include secondary substation monitoring, the deployment of voltage regulators and the dynamic rating of some primary transformers.

Analysis of the primary network data has shown that simple methods for the calculation of network capacity, whilst easy to understand, lead to conservative estimates. This work has significant implications in respect of the upcoming review of Engineering Recommendation P2/6 – Security of Supply.

Analysis of the new (secondary) network monitoring data has shown that variations in network power flows are much greater than previously assumed. In particular, the level of LV phase imbalance is much greater than expected.

Real time Thermal Rating (RTTR) work on 33kV overhead lines and primary transformers has made significant progress on site implementation. Initial results on the RTTR capability of the primary transformers are positive indicating that they are capable of handling increased peak loads.

1.3. Key Risks

As the project has developed, risks reported previously in relation to procurement delays and system development delays have materialised. We have mitigated delays where possible however it has been necessary to submit a change request for an extension to the completion date for the project. The rationale behind this is further discussed in Section 3. - Key Issues.

Stakeholder Engagement Risk – Engagement with I&C customers within the trial area to examine the scope for energy efficiency to reduce electricity consumption has proven to be challenging. A smaller number of customers than anticipated have been identified to participate in trialling energy reduction measures. There is a risk that insufficient participation may not realise the target reduction of 2%. We do however believe that the shortfall in any capacity gains through energy efficiency will be achieved by other elements of the project.

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.

Our experience in the deployment of a large number of substation monitors has highlighted the importance of keeping track of the operational status of this large number of field devices to detect issues such as communications problems. Therefore a system of monitoring their operational status and data capture success has been developed to summarise the performance of the population and highlight issue areas.

It has become apparent that the detailed level of secondary substation monitoring is giving much more useful data for network modelling than the Maximum Demand Indicator (MDI) data that DNO's are normally able to utilise.

Initial modelling undertaken using the DNV KEMA dynamic rating system (DRS) confirm that the level of dynamic rating envisaged under this project can be achieved with negligible impact on the remaining expected lifespan of the transformers.

Many aspects of the project learning are now filtering their way into our business plans for RIIO-ED1, such as:

- Secondary substation monitoring

- Smarter MDI – 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) has been proposed for three primary transformers in SP Manweb, which will draw directly from the learning on this project.
- An Internal Working Group has been established to get 11kV in-line voltage regulators into business as usual

2. Project manager's report

The last six months period has seen progress in a number of areas and the project is close to plan apart from a few specific areas. 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 now complete. It has shown that current methods for the calculation of network capacity headroom, which are based on a direct interpretation of P2/6, whilst easy to understand, can lead to potentially conservative estimates. This is because current methods do not assess the risks to supply security directly, but rather apply the discrete P2/6 security levels according to deterministic rules. In order to calculate supply security more in line with actual network risk, it is necessary to carry out the security assessment more fully in the statistical, probabilistic domain. Modern analysis techniques, combined with the increased availability of data, enable us to do this.

For example, the annual maximum group demand is generally taken as the single highest half-hourly reading attained during the previous 12 month period. This figure, when combined with forecast load growth information, is taken as the minimum acceptable capacity of the network. This is in effect a "zero risk" assessment for the given network contingency. In practice, there is no "zero risk" option, as the next level of network outage would invariably cause loss of supplies. It should therefore be possible to extend the threshold duration from half an hour to one (or even two) hours, without introducing significant additional risk overall. Similarly, it should be possible to extend the frequency of events from a single event to multiple events, without significantly increasing overall risk, either. Finally, the risks associated with the uncertainty of load growth forecasts, which are currently unaccounted for in traditional assessments, can be included in a probabilistic risk-based statistical assessment of network capacity headroom. Provisional assessments so far are indicating that additional capacity headroom can be achieved if more of a probabilistic approach is adopted for assessing network risk. This work has significant implications in respect of the upcoming review of Engineering Recommendation P2/6 – Security of Supply. P2/6 does not actually define "maximum demand", but our methodology goes some way towards providing new insights into what this might be. It is our intention to feed our results into the upcoming review of P2/6.

Work Package 1.2 - Improved secondary substation data monitoring

The substation monitoring continues to record network data for the other work packages. At this stage in the project we are now considering the future use of the monitoring in the trial areas and the maintenance of the GPRS network contracts which will expire in 2015.

In general the monitors are working well, but we continue to experience intermittency in communications through the GPRS network. It is considered that this may always be the case and is symptomatic of using the mobile network for permanently open data transmission channels. We have undertaken some steps to improve communications with revised reception aerials and positioning through detailed site signal testing.

After the population of monitors had been installed for some months it became apparent that the data capture also needs to be monitored to identify emerging patterns of data issues resulting for example from faults in the monitors or data communication issues. As an initial step the University of Strathclyde developed an offline system of summarising the data integrity in a heat map which has assisted project staff in targeting problem sites. It is planned to further develop this system and incorporate as a process in the online iHost database server.

The analysis of the secondary substation data is showing that valuable data can be obtained for network modelling. By using the demand profiles from the new data, a much better assessment of network load can be developed than is possible using the MDI data that is traditionally available.

The new network data retrieved from the secondary and primary substations has been essential in developing the WP 2.2 network automation work package control algorithms.

Work Planned during the next 6 months:-

- Continue monitoring of the operation and reliability of the devices, data communication and storage.
- Extend the use of LV network voltage monitors.
- Continue harvesting of data for other work packages and interventions.
- Adoption of the data monitoring tool into iHost.

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.

Analysis of the new (secondary) network monitoring data has shown that variations in network power flows are much greater than previously assumed. This is in line

with the findings of other LCNF monitoring projects. In particular, the level of LV phase imbalance is much greater than expected. This appears to be particularly associated with overhead networks and may be due to the use of single phase transformers on these networks. A method for assessing LV imbalance, focussing on where this may have a material bearing on network performance, is currently being developed.

A software tool is being developed to enable the dynamic rating of transformers to be calculated. This tool is based on the IEC transformer model (IEC-60076-7) and calculates an "enhanced" seasonal rating, based on actual load profile, ambient temperature and an acceptable rate of transformer aging. This enhanced rating will be used for network design planning as well the planning of operational outages. The transformer model within the tool will also allow the dynamic thermal behaviour of transformers to be modelled during unplanned outages in order to balance asset risk with security of supply.

Work planned during the next 6 months:-

- Continued evaluation of the secondary substation data by the UoS.
- Development by TNEI of the dynamic transformer rating tool
- Development by TNEI of the LV unbalance assessment tool

Develop visualisation requirements for Nortech's iHost system, based on the initial findings from the UoS and TNEI analysis.**Work Package 2.1 - Dynamic thermal ratings (DTR)**

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

A contract has been awarded to GE to supply line monitoring equipment and to implement the Cupar - St Andrews RTTR system algorithms in a stand-alone PowerOn Fusion server. Parsons Brinckerhoff have also been awarded a contract for technical support and developing RTTR system algorithms.

Site survey was carried out along the Cupar-St Andrews 33 kV circuits to specify the locations of the line monitoring equipment. Four 33 kV poles were selected based on identified microclimate regions, GPRS signal strength and road access.

GE line monitoring equipment have been installed in four selected sites along Cupar-St Andrews 33 kV circuits. GE line monitoring system includes pole mounted weather stations, solar panels, RTUs and line current / temperature sensors.

The communications between monitoring equipment (both pole-mounted and those in the primary substations) and the PowerOn server hosting the RTTR calculation engine were established. The geographical and electrical characteristics of the Cupar-St Andrews lines were modelled in GE PowerOn. 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.

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. The algorithm specifications were prepared and submitted to GE. GE is now in the process of implementing the graceful degradation algorithm which will be included in the July PowerOn service pack release.

Progress on the dynamic thermal rating (DTR) of primary transformers is summarised below;

Under the contract with DNV KEMA initial assessment of the transformers capability for DTR was completed using historical and supporting documentation.

Site surveys of 8 transformers were undertaken, which included the use of specialist sensors to measure partial discharge within the transformer tanks, visual and thermal imaging surveys, and subsequent analysis of transformer oil samples collected during the surveys.

The survey results have been analysed and a report prepared. Results confirm the transformers capability for DTR over the longer term, subject to specified refurbishment works being undertaken on the St Andrews primary transformers.

Initial modelling has been undertaken using the DNV KEMA dynamic rating system (DRS). The results of the modelling confirm that the transformers are able to supply increased peak loads to the point where the capability of associated cables and switchgear become the limiting factor. Therefore the level of peak load increase of 7% envisaged under this project and potentially up to 10% can be achieved with negligible impact on the remaining expected lifespan of the transformers.

An initial workshop has been held to develop proposals for bringing primary transformer DTR into business as usual.

Work Planned during the next 6 months:-

- Implementation of graceful degradation algorithm in PowerOn Fusion
- Carry out data analysis on RTTR data and monitored parameters to evaluate the performance of the monitoring equipment and also identify the thermal pinch points in the St Cupar-St Andrews network.
- Installation of the further line monitoring equipment at the critical spans identified through RTTR modelling
- Develop the conductor temperature estimation algorithm and validate it through comparison with measured temperatures by the line sensors.
- Further application of the KEMA DRS (dynamic rating system) to model the determined dynamic rating of Primary transformers at selected primary substations.

- Completion of the DNV KEMA final report on the DTR of primary transformers.
- Instrumentation will be installed to verify the modelled outputs.
- Continued development of the process for adopting primary transformer DTR into business as usual.

Work Package 2.2 - Flexible network control

During the period good progress has been made on 2 aspects of this work package towards the end objective of redistributing 9% of peak load on the network at appropriate times. These aspects comprise; modelling of switching algorithms; and implementation of field devices.

UoS have been developing the switching algorithms for the 11kV secondary network in St Andrews that are required to redistribute load. Secondary substation load data gathered under WP 1.2 has been analysed by UoS to understand network characteristics, and develop models which enable switching algorithms to be developed. These algorithms will subsequently be implemented as logical sequence switching (LSS) logic within the PowerOn Fusion SCADA system.

The switching algorithms will result in altered network topology and it is necessary to consider all effects that this might have. The resulting network load flows have been modelled by TNEI to analyse impacts on plant, protection systems and system stability.

Results of the above modelling activities so far indicate that we will be able to achieve and exceed the target of 9% load redistribution.

In order to implement the switching algorithms being developed, 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 ongoing to map the new CCU equipment to the secondary substation devices. Training has been rolled out for technicians to carry out configuration and commissioning.

As stated above, 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. Currently the SCADA teams focus is 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 will be delayed beyond the current project completion date of December

2014. This is one of the factors highlighted in our Change Request for an extension to the completion date.

A programme has now been developed in conjunction with the SCADA team to map out a route to achieve the desired outcomes by the extended project completion date.

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.
- Finalise switching algorithms for subsequent testing on the PowerOn SCADA system at the PNDC.

Work Package 2.3 - Energy efficiency

As stated in the last biannual report, BRE have engaged with a number of large customers in the trial areas and carried out on-site surveys. BRE have now prepared detailed option assessment reports in order to provide independent and authoritative feedback to stakeholders the reports identify potential interventions and also include performance specifications and list of available grant, incentives and low interest loan schemes.

Theoretical intervention scenarios for each of the trial areas have been developed to understand the cost/benefit of introducing certain energy efficiency measures.

We have engaged with energy suppliers as we have identified that there are opportunities to work together in order to make interventions more attractive to stakeholders. It is also recognised that energy suppliers have specialist staff engaged in energy efficiency work.

In January we undertook a system voltage intervention whereby we reduced the network voltage at the Ruabon trial site. This was carried out at the primary substation transformer using the existing stage I (3%) voltage reduction system. This allowed the voltage change to be applied in a practical manner without the need to carry out a more difficult method of outages and tap-changing to the secondary transformers. However the downside to undertaking the voltage change at the primary transformer was that the whole network from that primary substation was affected.

Whilst the network voltage change was visibly noticeable the load current change that would be expected was not so apparent, which is probably due to the make-up of the type of loads connected and the many other variables which affect load. This is consistent with the learning from the WPD – LV Templates project and the National Grid / GCRP tests, which have recognised a 1% voltage reduction producing up to a 1% demand reduction and up to a 1% energy reduction.

After 3 weeks one customer queried his supply voltage as they were a dentist and had noticed the difference in the operation of their equipment. We determined that the supply voltage at the premise had remained above the statutory limit. However we immediately restored the network voltage back to its original level following the customer contact and are looking into the network in this particular location. A further voltage reduction intervention is planned during this summer period. LV monitors will be utilised at selected points on the network to capture the effects on voltage.

Work Planned during the next 6 months:-

- Continued refinement of load modelling and comparison with actual substation monitoring data
- Carry out specialist targeted surveys in conjunction with energy suppliers which will provide costed proposals for interventions and estimated energy savings.
- Agree with stakeholders the interventions to be carried forward to implementation and the financial contribution to be provided 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 summer loading period

Work Package 2.4 - Voltage regulation

The installation of a regulator at St Andrews under this work package has been delayed by approximately 7-months due to the late availability of secondary substation monitoring data under work package 1.2. This is required to enable modelling of the regulator location on the network to be carried out. The required data has become available during this period.

Effort during the past 6 months has mainly been focussed on advancing the St Andrews regulator deployment, addressing a number of unforeseen difficulties as they arose.

The voltage regulators have been delivered and are currently in storage at the SPEN Glenrothes depot.

Using output from the recently-commissioned secondary system monitoring, detailed IPSA modelling of the St Andrews - Anstruther circuit has been completed in order to determine the range of possible regulator locations and to calculate the extent of the backfeed capability at each location. Modelling work was complicated by a significant source of generation midway along the St Andrews - Anstruther circuit. This required additional metering data to be obtained in order to be sure that this generation was not inadvertently exporting onto the system (which, had this been the case, would have meant the circuit was not suitable for the flexible network

control trial). The modelling work was also delayed by the need to clarify with network planners, which of three possible parallel backfeed paths was to be used for the flexible network control regulator deployment trial.

The results from the power system studies have been used to inform the radio surveying process (required for the telecontrol and temporary additional monitoring), which is now complete. Deployment of the regulator to the network is now dependent on completion of the wayleaving process, which could not be started until the range of possible regulator locations had been narrowed down.

The engineering of a suitable telecontrol solution for the new regulator has also progressed. As identified in the last progress report, in order that the deployment of the regulator would not be delayed pending the development of the new high bandwidth telecontrol system, it is intended to use the same telecontrol solution that has been developed in late 2013 for the new Tegfa regulator in the SPM area. In order to implement this solution, lack of CCU capacity at both St Andrews and Anstruther primaries had to be addressed. Various alternative solutions have been investigated, and a preferred solution is being taken forward for implementation. Additional monitoring equipment will be used to capture analogue regulator status information.

Further design work has been undertaken by a specialist design consultant in order to arrive at a generic, standardised pole mounted installation design that can be used for all installation situations (including a full range of possible conductor sizes and spans), for any type and size of regulator up to 200A. This design, which maximises the use of standard steelwork components, will be suitable for use with both possible options consisting of 2 tank open delta, and 3 tank closed delta configurations.

In response to learning so far, effort has been deployed into the planning of activities required to move voltage regulators into Business As Usual within SPEN. This has been achieved through ongoing engagement of the parts of the wider SPEN business that will need to be actively involved in the BAU process. A number of changes to deployment policy have been put forward and an initial BAU Planning meeting held involving key internal BAU stakeholders. Through the active encouragement of the Flexible Networks project, a significant number of SPEN personnel recently attended a voltage regulator workshop organised by Cooper Power Systems and held at the PNDC. This workshop, which was also attended by delegates from a number of other DNOs, provided useful confirmation that the objectives and anticipated outputs from WP 2.4 will be of interest and value to the wider DNO community.

Significant effort has also been directed during the past 6 months to the development of the planned programme of regulator characteristic performance tests, which has been developed in conjunction with the PNDC. Development of this test programme has involved research into the routine test requirements of IEEE C57.15: 2009 and detailed consideration of the regulator control system and operating philosophy. Following delays, the PNDC 11kV network has also been fully

commissioned during this period and it is now expected that these test will commence in early August.

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

- Deploy the new telecontrolled AVR to the St Andrews network.
- Enhanced monitoring equipment will be fitted to the St Andrews AVR and to further AVRs currently installed on our 11kV networks. This will enable sufficient data to be obtained to capture learning from the AVR deployments as legacy telecontrol equipment does not sufficient capacity to retrieve this data.
- Develop 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.
- Carry out a series of AVR performance characterisation and model validation tests at the PNDC.
- Use the existing PNDC AVR to trial a new CL-7 type control and communication device.
- Model expected network capacity gains expected from the St Andrews deployment to provide data against which to compare performance in service.

Work Package 3.1 - Internal stakeholder engagement

Elements of the project have already been included in the ED1 proposals, which have been shared with staff. The project has shaped our plans for the next price review period.

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

The Scottish Power 'Flexible Networks' Project together with ENW's 'Smart Street' featured in a series of presentations at an IET event on Smart Grids, held in the Manchester Conference Centre in April. The event was well attended by academics, industry stakeholders and other interested parties, who took the opportunity to engage with and question the presenters on their project activities.

The Scottish Power Flexible Networks project activities were also presented to the Energy Technology Partnership (ETP) in Dundee, Scotland, where the project learning to date and future adoption plans were discussed. The event was attended by PhD students, energy industry representatives and other academic organisations. The presentation was well received and generated an interesting discussion.

An external dissemination event is planned on conclusion of the project when tangible project findings can be made available to stakeholders together with project engineers who can answer questions and engage in discussions on the details of what worked - what did not and why.

Work Package 3.3 - Verification of experimental design

Work is ongoing with UoS for them to review the methodologies of the work packages.

UoS have prepared a draft 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 prepared 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, dynamic 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.

3. Key Issues

As the project developed and the delivery issues summarised below have emerged, it has become clear that we will be unable to deliver the learning envisaged by the current project completion date of December 2014. We have submitted a change request to Ofgem for an extension to the project completion date to enable us to deliver this learning. Should the timescale extension be agreed, we are confident of delivering the learning originally envisaged by the revised completion date.

Procurement Delays – Delays have been experienced in procuring newly developed and innovative technologies, in that, to ensure best value is secured and robust

governance procedures are followed, the timescales for procurement were longer than initially programmed. This is mainly because relatively novel and complex requirements specifications take longer than normal to develop and more time is required for suppliers to respond.

We have found that the overall timescale to undertake procurement of innovative technology is of the order of 6-months and this was not fully taken into consideration in the Full Submission, with 3-months being the typical duration included in the plan. This has been one of the learning points from the project to date.

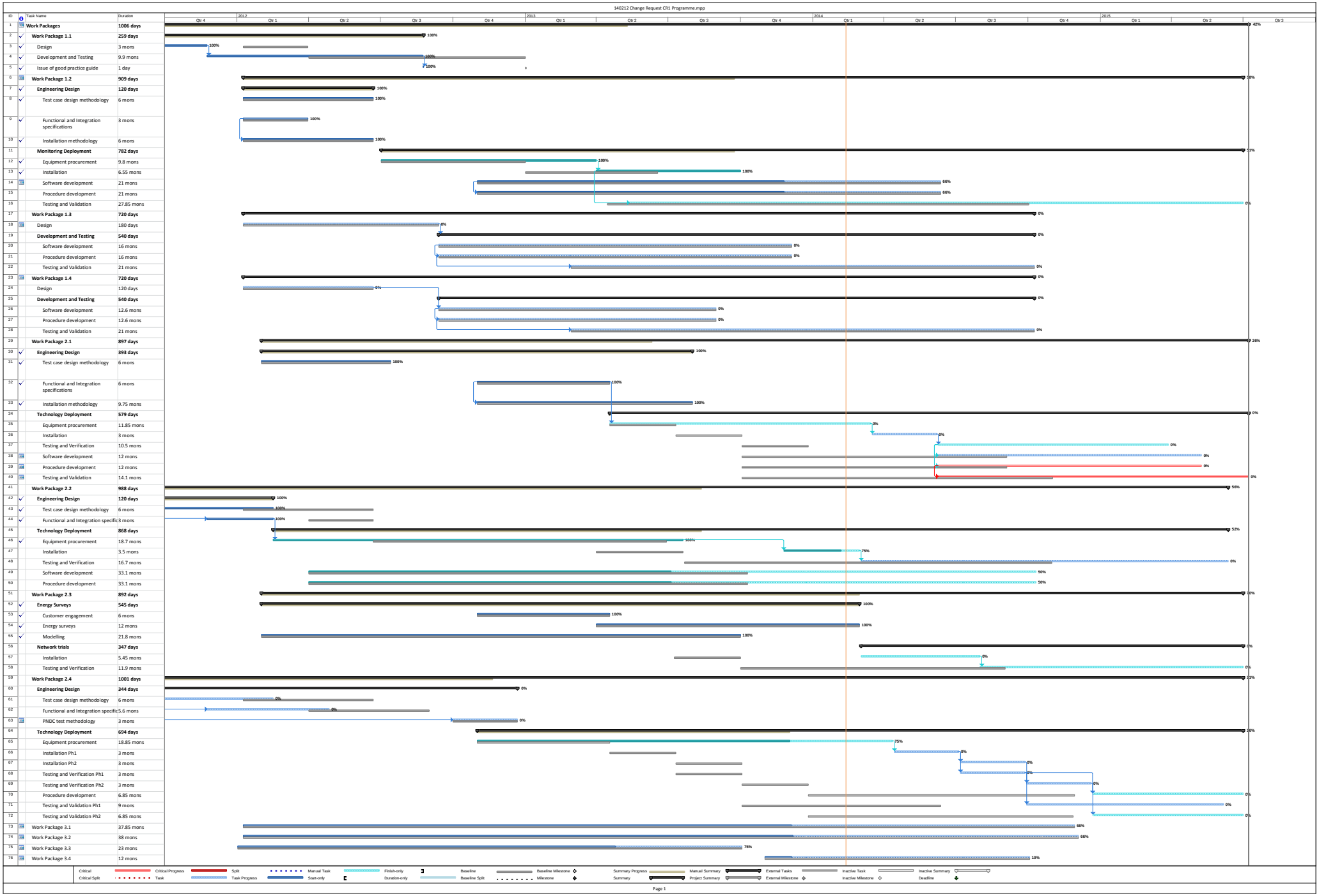
In addition further specific delays have affected a number of the procurement exercises that have impacted the critical path of the project.

System Development Delay - We have determined that the most appropriate method of implementing Flexible Network Control in Business As Usual (BAU) is via our PowerOn SCADA system. As part of an upgrade to PowerOn taking place as part of our business systems enhancement, additional functionality will be provided which will allow the implementation of flexible network control algorithms. We believe that this is an efficient approach to implementing flexible network control – using the system that will eventually be employed in BAU.

Timescales for implementation of the PowerOn upgrade and subsequent mapping of new network control devices dictate that only towards the end of 2014 we will be able to begin commissioning flexible network control using this philosophy, and therefore it will be into 2015 before trials of flexible network control will commence, approximately 9-months later than originally planned.

We have undertaken mitigation measures to reduce the effect of these delays as much as possible. However when the series of above delays are considered against the project timescales, in order to allow sufficient time for the different solutions to be trialled, and the learning originally envisaged to be obtained, the realistic project completion date is September 2015. Achieving this date will be onerous, however we have undertaken a detailed planning exercise for each individual Work Package and believe that we can complete by September 2015 and ensure that the learning outcomes achieved will be consistent with the Full Submission. We have submitted a Change Request for the project completion date to be extended to September 2015.

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
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Qtr 3
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Task
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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. However to address the key issues set out in Section 3. – Key Issues above we have submitted a change request to Ofgem which requests an extension to the project completion date and a restructuring of the budget. If this change request is approved we believe that the project will deliver its objectives at the required level of quality within the original funding.

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 has now 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 reason or opportunity to deploy voltage regulators at these two sites.

The deployment of a voltage regulator on the St Andrews 11kV network remains valid. At St Andrews, a suitable 11kV circuit has been identified which is voltage constrained under particular feeding conditions that are envisaged as part of the flexible network control scenario.

Since voltage regulators are not required to facilitate flexible network control on the Wrexham and Whitchurch networks, omission of these has no effect on the overall project target of creating 20% capacity headroom in each of the trial networks.

The project will continue to deliver value for money to customers as there will be a cost reduction due to the omission of the 2 regulator installations.

We are mitigating any potential effect on learning in two ways. Firstly there is a voltage regulator installed in the test network at the Power Network Demonstration Centre (PNDC) which was funded as part of the establishment of the PNDC. This will be utilised to fully test the regulator through an extensive series of test scenarios that it wouldn't otherwise be possible to carry out on a DNO network. This is a significant benefit of having the PNDC test facility available to us. Secondly a non LCNF voltage regulator set has recently been installed for a new generator connection in Ruthin, Wales. Although this is a different application we are capturing learning from the design and engineering development. This learning will take the

form of engineering specifications for the procurement and installation of voltage regulators which will be made available for other DNOs to assist in rolling out this technology on their distribution networks.

Project Budget - As part of the change request submitted to Ofgem we have reduced the project budget forecast to the benefit of the LCN fund and ultimately the customer. Until the change request is approved the figures provided in section 9 of this report are the budget progress against the original submission figures.

6. Risk management

The main risks currently facing the project are associated with timescales. We review project progress on a monthly basis against the revised completion date in our change request and identify mitigations where required.

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.

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.	The three trial sites are still considered suitable for the experiments of this trial, i.e. Wrexham – high penetration of PV, St Andrews – increasing load and generation in a radial type network, Whitchurch – increasing load in an interconnected type network.
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.	The monitoring equipment is now delivered and installed. 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. Remaining risk in the procurement of other equipment for Transformer Dynamic rating following the transformer assessments is considered to be low.
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.	There have been no interruptions to customers during the monitoring equipment installations.
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.	The equipment development work has been completed, with the monitor suppliers. No delaying issues arose and all equipment is working satisfactorily.
5	WP 1.1 WP 1.2	Significantly more data will be generated to collect, communicate,	The magnitude of annual raw data storage required has been estimated. Work Packages 1.1 and	Sampling rate can be optimised as necessary.	Sampling rates and data size have shown to be acceptable for the data being collected.

		store and process. Increase in costs of communication systems.	1.2 will explore the management of large datasets.		
6	WP 1.2	There could be data privacy issues for customers due to the extensive programme of monitoring to be deployed.	The existing SPEN regulations governing data privacy for customers will be used in this project.	No contingency required.	There are no data privacy issues. Ofgem have approved our 'Customer Engagement Plan' and this includes how we will ensure customer privacy.
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.	No change. However the early data analysis has shown that this risk is not an issue and headroom has actually been enhanced through the increased visibility.
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.	No change.
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	No change. Business champions at manager level are being used to ensure adoption of LCNF learning. A specific role has been identified to transfer learning into BAU. Internal staff have embraced the project developments.
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	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.	No change.

		strategy to reflect new connections.			
11	WP 2.2	From investigation of flexible network control, 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.	A range of representative network area topologies and characteristics are being investigated.	This will be a learning point in itself. This should provide some excellent insight into the capacity headroom increases possible with this technology for a range of representative topologies and characteristics.	The Whitchurch network investigation has shown a worthwhile return for the application of flexible network control.
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.	The engagement with customers has been difficult with a lower take up that expected. Generally customers have either already carried out energy efficiency or do not see the time involved worthwhile. We continue to pursue further engagement. Involving Energy Suppliers is furthering the opportunity to engage with customers on energy efficiency.
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.	It was considered that this would be achieved within the project original timescales. However due to development delays of the company SCADA system, the specialised resource cannot be made available for the Flexible network automation technology integration until into 2015
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.	The capture of the other non-LCNF AVR deployment within SPEN will give a similar level of learning for the design, specification and engineering for this equipment.
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.	Even though the monitoring installation program was reduced from 6 months to 3 months the original procurement delay has meant the late delivery of the new network data has impacted the progress of some other elements of the project, e.g. the voltage

					regulator deployment analysis.
15d	Procurement of new technology products.		Consider the use of collaboration agreements.	Use prototype equipment in test case trials before committing to contract.	The procurement of new innovation technology products for the project has encountered some delays from the anticipated 3-months to 6-months as the specification of such equipment typically needs to be developed with suppliers rather than a traditional procurement tender process.

7. Successful delivery reward criteria (SDRC)

Project budget (criteria 9.1) – At present the spend is lower than budget to date for a number of reasons;

- The Dynamic rating software integration costs are not yet incurred.
- Only one voltage regulator set required and not 3 as envisaged.
- The procurement cost of the monitoring equipment was lower following the tender process.
- The installation costs for the monitoring equipment were lower than expected.
- None of the contingency budget has been required to date.
- No payments to users have yet been made to date.
- A revised budget has been submitted as part of the change request.

Project Milestone Delivery (criteria 9.2) – At this stage in the project it has become clear that, despite mitigation efforts, delays experienced in a number of areas will result in delays to some of the milestone dates within the Full Submission. As explained further in Section 3. – Key Issues, work package 2.2. will run into 2015. Also the voltage regulation work package is approximately 7 months behind plan. Therefore we have submitted a project change request for an extension to the project timescale. We remain confident however that a considerable amount of learning will still be available by the end of 2014.

Creation of a Flexible Network (criteria 9.3-9.5) – no update can be provided until the project is complete however 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.

Engagement, dissemination and adoption (criteria 9.6) – The Scottish Power 'Flexible Networks' Project together with ENW's 'Smart Street' featured in a series of presentations at an IET event on Smart Grids, held in the Manchester Conference Centre in April. The event was well attended by academics, industry stakeholders and other interested parties, who took the opportunity to engage with and question the presenters on their project activities.

The Scottish Power Flexible Networks project activities were also presented to the Energy Technology Partnership (ETP) in Dundee, Scotland, where the project learning to date and future adoption plans were discussed. The event was attended by PhD students, energy industry representatives and other academic organisations.

A number of the elements of the project have already been adopted into the ED1 proposals. 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 dynamic rating of some primary transformers.

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.

Our experience in the deployment of a large number of substation monitors has highlighted the importance of keeping track of the operational status of this large number of field devices to detect issues such as communications problems. Therefore a system of monitoring their operational status and data capture success has been developed to summarise the performance of the population and highlight issue areas. We are planning to develop this system and incorporate within the online iHost sever which holds the data being captured under the project.

It has become apparent that the detailed level of secondary substation monitoring is giving much more useful data for network modelling than the MDI data that DNOs are normally able to utilise. We are currently considering what changes need to be made to planning and design policy to adopt this learning.

Initial modelling undertaken using the DNV KEMA dynamic rating system (DRS) confirm that the level of DTR envisaged under this project can be achieved with negligible impact on the remaining expected lifespan of the transformers.

Many aspects of the project are now filtering their way into our business plans 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) has been proposed for three primary transformers in SP Manweb
- An Internal Working Group has been set up to get 11kV in-line voltage regulators into business as usual

9. Business case update

We have no changes or update to the business case to date.

We have submitted a request for an extension to the project timescale due to the various issues described previously in this report.

Progress against budget

Table 1 below is a summary of the total project budget position from commencement to June 2014

Table 1.

Activity	Budget to June 2014 (£k)	Actual to date (£k)	Funding carried forward (£k)	Commentary
Labour	1,861	921	-940	Overall labour cost forecast reduced (however some contractor support costs increased due to outsourcing)
Equipment	1,989	1,573	-403	Reduced equipment costs and costs yet to be invoiced have made up the majority of the under spend.
Contractors	1,174	862	-312	The difference is due to some contactor work behind plan and works yet to be invoiced.
IT	345	223	-122	Further IT costs are yet to be incurred/invoiced.
Travel & Expenses	35	22	-13	Project exceptional travel has been less than expected to date.
Contingency & Others	557	7	-550	Some aspects of contingency budget will be required, but these have not yet been incurred and will be significantly less than budgeted
Payments to users	100	0	-100	No payments to users have been made to date. We are currently identifying and prioritising payments to users.
Totals	**6,061**	**3,608**	**-2440**	

The above table shows a variance between the initial budget to June 2014 and the actual expenditure to date. This is due to a number of costs to the project having not been incurred in line with the project progress and some costs have yet to show against the project.

The contingency budget for the project elements which have been completed to date has not been required.

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 & Partners Contribution to date (£k)	LCNF costs (£k)	Total/Actual to date (£k)
Labour	338	583	921
Equipment	939	634	1,573
Contractors	321	541	862
IT	74	149	223
Travel & Expenses	7	15	22
Contingency & Others	2	5	7
Payments to users	0	0	0
Totals	**1681**	**1927**	**3,608**

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)

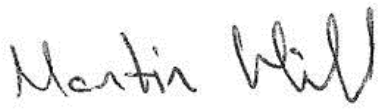
The project is not funding the development of any technology which should create foreground IPR. All partners have accepted the LCNF default IPR arrangements. This approach has not changed since the project commenced and we do not anticipate any further changes.

12. Accuracy assurance statement

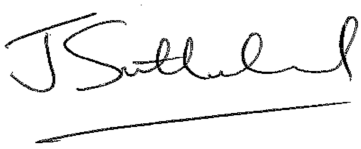
The Project Manager and Director responsible for the 'LCNF - Flexible Networks Project' confirm they are satisfied that the processes and steps in place for the preparation of this Project Progress Report are sufficiently robust and that the information provided is accurate and complete.

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