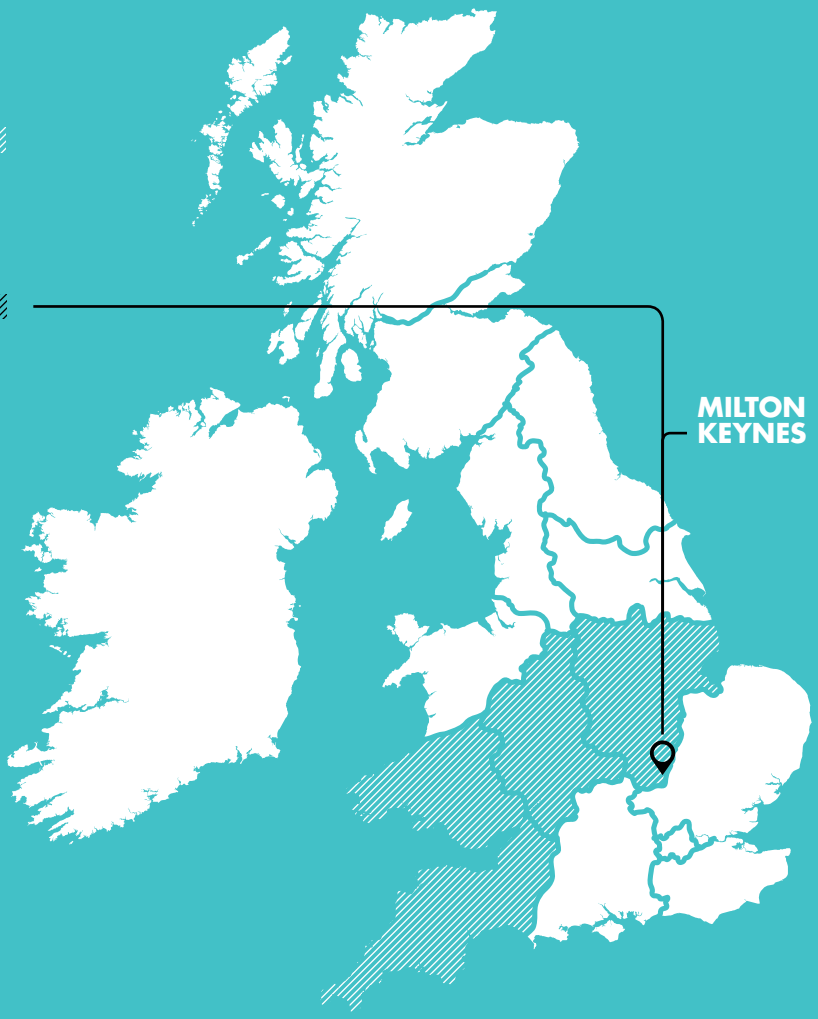
WESTERN POWER DISTRIBUTION

FALCON

DEVELOPING FUTURE POWER NETWORKS

PROJECT PROGRESS REPORT
REPORTING PERIOD: DECEMBER 2012 TO MAY 2013



LCN Fund Low Carbon Networks

ALSTOM

Aston University Birmingham

University of Bath

CGI

Cisco

Cranfield University

DOCUMENT CONTROL

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REVISION HISTORY

Date	Issue	Status	Author
13 May 2013	1.0	Initial Draft for Review	Sanna Atherton
10 June 2013	1.1	Incorporating comments from internal review	Sanna Atherton

CONTENTS

1. EXECUTIVE SUMMARY

In FALCON, we are trialling six alternative techniques to conventional reinforcement; four engineering and two commercial.

The purpose of all the intervention techniques is to increase capacity on the Milton Keynes network without resorting to traditional reinforcement. The underpinning principle of FALCON is about leveraging technology and innovation to see if there are benefits that can be accrued to customers through making efficiency savings or business policy changes. The way that this will happen is through an extensive Trials Phase that will drive learning that we can share with the wider stakeholder groups. We are in the middle of a large installation programme- as ever these things always throw up challenges but we remain on target and focussed on meeting our objectives.

We are also now mapping out our tests that will form the basis of the Trials Phase. We will use the results of those trials to then compare them to the results from the Scenario Investment Model, SIM. This will further enhance the SIM to improve on its results- we see the whole SIM workstream as an iterative process to continually improve the results and give something back to our stakeholders with an interest in FALCON. With this in mind the last few months of the Build Phase have been focussed on wider engagement with the potential users of the SIM (including other DNO's) and we are committed to that engagement process to get as much from FALCON as we can- this will give us valuable insights and learning to share with other DNO's.

As described in the previous reporting period, the Commercial trials workstream started work in earnest slightly later than anticipated but has now caught up. The back office system procurement has been completed and is currently awaiting sign off of the design. The system build will complete in late August and there will be a short testing period. This will mean that the system will be ready well in time for the trials later on in the year.

Load Estimation has presented some challenges, but we have stayed on track. The underlying principles of this workstream have been to create future energy scenarios for SIM and assess the effectiveness of using estimates as an alternative to physical substation monitoring. As detailed in the previous report the scope has expanded to develop a comprehensive energy model. More detail of progress to date is contained with this report but in brief we have delivered the following:

1. A comparison of estimates to actuals
2. The first iteration of the energy model, which is currently undergoing user testing.

We have used data from our LV Network templates project and continue to engage with wider groups and stakeholders to compare and contrast the work we're doing. The Telecommunications and the Engineering workstream continues to progress well with the installation work currently being undertaken. We have a test lab at the Milton Keynes depot that enables visitors to see the basis of the FALCON solution and we have received good feedback.

The results obtained from the trials are to be gathered and processed centrally to gather information on how effective the trials are and where possible to compare to the predictions made by the SIM).

1.1 Key Risks

1.1.1 Recruitment risks

In order to keep a tight control of costs we have engaged in a continual exercise of review and refinement to ensure that wherever possible we deliver the project using WPD resource, but also make use of the expertise in the contract market, but not increase any risk to the project and its successful delivery. This has proven to be a challenging exercise and one where we feel we have learnt a few valuable lessons. There are also a number of key risks with doing this though:

1. A lot of time can be spent interviewing and assessing for little or no benefit
2. That time spent can be to the detriment of other tasks if not kept in check
3. Whilst the potential to save money is there, the benefit could be marginal especially when you take into account handover, training and the potential for things to be missed

Currently we do not envisage any further recruitment activity. The team is settled and running well, but we continue to be vigilant on our resourcing but mindful of the impact of undertaking anything too radical.

1.1.2 Procurement risks

Currently there are no procurement risks as all equipment has been purchased and is either delivered or awaiting delivery.

1.1.3 Installation risks

Installation work is always risky as there are operational matters that can take priority. There is a risk that installation timescales could slip due to suppliers misrepresenting the specification of their equipment and/ or not delivering on time, however we have the appropriate contractual frameworks in place and have ensured all suppliers are fully aware of the deadlines for delivery and installation. Overall, we have taken a measured and considered approach to the installation work.

1.1.4 Other risks

There is a risk that the technology used in the project doesn't work. As the equipment is installed it may not deliver what we expect or it fails during testing. We have ensured that detailed designs, descriptions and testing plans are or have already been created. The Technical Design Architect owns the whole design and it's 'deliverability'. The test lab functionality ensures that we are able to test the equipment to be deployed on the network before field testing commences. We have ensured that there has been and will continue to be close liaison between suppliers, partners and WPD to develop a deliverable solution.

1.2 Learning

We have identified seven common themes, with project specific challenges, learning's and benefits across all WPD LCN funded Projects. Each of the learning outcomes we obtain in the project will be categorised into these themes.

This reporting period spans the Build Phase of the project; therefore the type of learning we are expecting to obtain is associated with procurement, installation and testing activities of the trials equipment, impact of installation activities on customers within the trials area, recruiting customers for the commercial trials, impact of the commercial trials on current regulatory boundaries and learning from our experiences of Elexon profiles

An example of the learning points in each category are below:

CATEGORY	LEARNING POINT
Customer Engagement	Integrating standard business processes, such as the customer enquiries and complaints process saved time in developing the communications plan, but also ensured that any enquiries were dealt with in a professional, timely manner.
Project Management, procurement, legal	The Design Phase has proved critical, especially for non-standard DNO activities, such as software development.
Construction Process	We found that the land topology in Milton Keynes affected the radios 'lines of sight' more than we anticipated. Whilst standard planning techniques were used to plan the original radio locations, we downloaded a free 'line of sight' iPad app which used google maps. The radio signal line could be drawn across the map and the position altered depending on the outcome. This was easily and quickly used to assess the topology of the remaining sites to ensure time wasn't wasted in deploying radios, where land topology could have been an issue.
Technology and Equipment	Using knowledge gained from other WPD and DNO projects saves duplication of activity. We obtained learning from WPD's Tier 2 LV Templates project and its Tier 1 LV comparison project which provided excellent learning for assessing different monitoring equipment
People and Culture	There is a distinct difference in cultures between academic and commercial organisations.

Industry Processes and Regulations	With the commercial trials, there is a potential that a customer may not wish to participate with DNOs if engaged with STOR due to the restrictions placed within the National Grid Contract
IT & Telecommunications	The 1.4Ghz MoD frequency has provided unexpectedly good results and the quality of data being transferred is excellent. Due to this, we are looking at the potential to use the WiMAX technology across other parts of the WPD network.

We have undertaken a review of the learning parts of FALCON. We have developed a revised approach and brought the project lead role in house. The immediate focus of the Knowledge Capture and Dissemination project area will be to ensure that we have a revised plan to maximise on the learning that we have and ensure that we can proactively engage with stakeholders in the most effective and appropriate way.

We have continued to update our websites, www.westerpowerinnovation.co.uk, www.lowcarbonuk.com and the ENA's www.smarternetworks.org. Working with the Open University, we've developed a podcast explaining the commercial trials and also presented our load estimation findings at an event on 14th May. The slides are available on our website: http://lowcarbonuk.com/lcuk/articles/60-lv-network-templates-knowledge-sharing-event.

2. PROJECT MANAGER'S REPORT

The FALCON project is 18 months into its lifecycle. The seven month design phase was successfully completed and this report focuses on progress during month's three to nine of the Build Phase. The Build Phase is scheduled to last 12 months and we are currently on track.

The purpose of the Build Phase is to consolidate the individual design elements of each area of the project, combine it with the learning gained through the Design Phase and 'build' the FALCON solution. As discussed in the previous report, the only major area of the project in detailed design is the Scenario Investment Model.

The four engineering techniques, Dynamic Asset Rating, Automated Load Transfer, Meshed Network and Energy Storage and the Telecommunications solution all require equipment from our partners or require suppliers to be chosen via a tender process.

Procurement activities, equipment testing and installation across both workstreams occur in parallel, so for ease of reading, I have combined the two workstreams. Whilst the report is structured to show these activities occurring sequentially, some occurred concurrently.

The remaining sections of the report revert back to reflecting on the progress of each project area.

Procurement – Engineering Techniques and Telecommunications

Procurement activities were initiated in the Design and early stages of the Build Phase; all tendering activity is complete and contracts awarded:

- GE were chosen to supply five Energy Storage devices, sized at 100kWh, 50kW: http://geenergystorage.com/todays-news/96-first-european-sale-of-dms-integrated-energy-storage-systems.
- As stated in the previous report, Selex were chosen to supply LV monitoring equipment. They recently won an award at the Energy Innovation Centre Awards for the GridKey equipment we are using in the project: http://www.gridkey.co.uk/news/item/gridkey-wins-uk-energy-innovation-award.html
- Sensors, DAR relays and PMUs for the Automated Load Transfer technique and protection relays for the Meshed networks have been purchased via Alstom
- Tollgrade were chosen to supply overhead line monitoring on the 11kV system http://www.tollgrade.com/news-events/press-releases/130403-western-power-distribution-press-release/. These devices directly measure the overhead line current and temperature in order to corroborate the inferred dynamic line ratings from Alstom's system.
- Schnieder equipment has been sourced from our standard framework agreement; however the switchgear has been adapted for the project's purposes.
- Cisco are providing IP routing technology, specifically WIMAX enabled CGR1240 ruggedized router (CGR – Connected Grid Router) at the distribution substation locations where a mixture of trials and LV monitoring is taking place. In addition, Cisco CGR 2010 routers and CGS2520 switches are being used at nine primaries substations.

- Airspan were chosen to supply AirSynergy WiMAX base units which act as the main radio relays located at the nine primary sites. These units provide WIMAX relay capability for communicating with a number of local substations in the 1.4GHz band, as well as backhaul 3.5GHz links to the main WPD communications network routing (mainly) via the Bradwell Abbey primary site to Horwood via a dedicated microwave link. It's the first time this Airspan technology is to be deployed in this two-tier configuration in the UK: http://www.airspan.com/2013/02/27/airspan-selected-for-uk-smart-grid-pilot-with-western-power-distribution/ Surf Telecoms are overseeing the design, installation and operation of the FALCON Telecoms solution and are working with Cisco Systems and Airspan to ensure the Telecoms solution is successfully developed.

Test lab

The test lab at our Milton Keynes depot has been constructed and is now in use. This is a crucial milestone as it gives an overall view of the FALCON solution in isolation and is a key demonstration vehicle for Western Power Distribution of what the whole project is about. It has also been used to bench test equipment prior to site deployment and to integration test plant equipment with the comms units.

The red square sections shown on the following diagram shows what has been replicated in our lab:

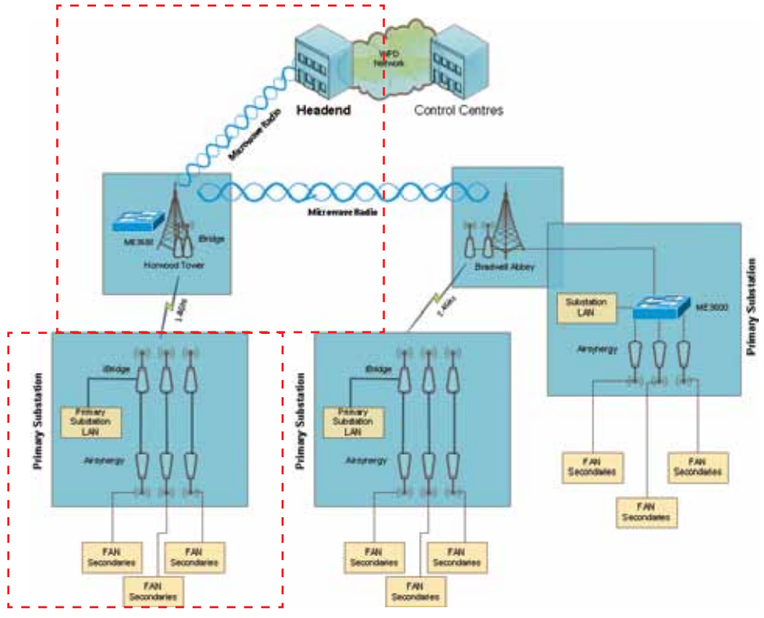

Fig1: FALCON's Telecoms solution

The lab models one primary substation, two secondary substations and the head end unit. It models all the site types we have, so we can test any of the intervention techniques.

It allows WPD Surf Telecoms, Cisco and Airspan engineers to test the connection and two way communications with the wide range of monitored equipment being deployed. The lab is enabled with remote access for specialist engineers from WPD Surf Telecoms, Cisco, Airspan and Tollgrade to be able to access the test kit remotely (without having to visit the sites or even the lab). It provides an equipment staging area where the large number of equipment are individually configured and checked prior to being taken to site for installation.

As an example, Tollgrade's 11kV Over Head Line sensors and GridKey's LV load monitoring equipment, which will gather data from the trials, were successfully tested in the lab in January. These devices will be used to gather more information on network load flows.

The lab not only provides a basis for testing equipment, but also provides WPD's engineers responsible for installing the equipment with a practical representation of the network.

Fig2: Cisco Systems testing the CGR1240 routers

Fig2: Surf Telecoms staff receiving training from Cisco Systems

The development of the test lab also provides interested industry groups, such as the Joint Radio Company, whose quarterly meeting we recently hosted at the depot, a visual representation of the FALCON telecoms solution.

Knowledge transfer
To support the transition from Design to Build, Cisco conducted a number of knowledge transfer/training workshops with the Surf Telecoms installation team. In these workshops, Surf Telecoms staff could familiarise themselves with the design and how the routers are to be installed, well in advance of the installation activities.

They are the first telecoms engineers in the UK to receive this training.

Spectrum Licence
Ofcom have approved the Airspan 1.4GHz backhaul licence for connectivity between the primary substations and collection sites and a temporary Test and Development licence has been granted for the project. The Joint Radio Company (JRC) are utilising FALCON as a case study to secure the 1.4GHz licence for all utilities for the future.

Installation activities
The Cisco and Airspan network monitoring servers were installed at the Surf Telecoms Network Management Centre in Tipton. These servers provide network management, security authentication, network timing and the ability to graph the port capacities and usage around the network. This will prove invaluable in identifying the bandwidth requirements for future networks and also demonstrates usage of the FALCON network.

Delivery of the equipment to the lab has been deliberately phased to ensure installation resource is managed effectively. Phasing the resource also ensures that installation activities are effectively coordinated. Before installation activities took place, letters were sent to all customers in the local vicinity.

At one site, a customer raised a query when the wood pole was being installed. The customer's house shared a drive with the substation. When the substation was being installed WPD planted a hedge to shield the view of the substation. The customer asked if the pole could be moved further away. We reviewed our telecoms design and agreed to move the pole. The customer was given a direct dial to the Project Engineer to ensure the revised location was acceptable. After the wood pole was moved, the customer contacted the engineer and agreed that the new location was acceptable. Some of the trials equipment requires additional land space next to our substations. Gaining access to the land via our wayleaves and legals process has, for the most part, run smoothly. We initiated the process early on in the Build phase, liaising with Milton Keynes Council and issuing press releases to raise awareness of the upcoming installation activities.

Installation activity is now well underway and whilst there are always challenges with activities of this type, they are being managed and we are confident of hitting our deadlines.

The project has gained interest from local businesses in the trials area and we are working closely with them to ensure we can maximise benefits and accommodate future load growth.

Particular interest has been shown in how the techniques can provide a greater security of supply for those connected to the feeders undergoing meshing and by engaging with these customers, we have been able to take their future plans into account and better inform our long term growth forecasts

Further work is being done to ensure awareness of the project is raised within the Milton Keynes area.

Key engineering and telecommunication risks

RISK	MITIGATION
Installations will not be complete by the end of the Build Phase	A detailed installation plan has been developed and has been shared with all parties involved in the installation. The team have closely liaised with the team managers and Surf Telecoms team managers to ensure resources are available when needed. A small contingency is built into the Trials Implementation Phase timescales.
The technology used in the Project doesn't work - it may fail during testing	Detailed designs, descriptions and testing plans are being created or have already been created. The equipment has been tested in the test lab before it has been deployed on the network. We have ensured that there has been and will continue to be close liaison between suppliers, partners and WPD to develop a deliverable solution.

Commercial Techniques

With Technique 5, we will be contracting with Distributed Generation that can be called upon to support the load on the Distribution Network in times of high stress. For Technique 6, we will be contracting with Industrial and Commercial customers who have a flexible demand to reduce the overall load on the Distribution Network in times of high stress.

The FALCON communications plan was approved by Ofgem and we quickly moved to engage with aggregators and Industrial and Commercial customers in the Milton Keynes area to take part in the trials.

To raise awareness of the trials, as well as the local press release mentioned in the previous report, we provide

- regular updates at Milton Keynes Council's Low Carbon Living Steering Group and Low Carbon Advisory Group
- representation at the MK Energy Club; high energy users in the Milton Keynes area accountable for energy reduction and sustainability goals
- occasional representation at the 'Milton Keynes Breakfast Club' – a weekly meeting of Small and Medium businesses, who discuss local issues facing them, including energy challenges.

We are exploring two different approaches to contracting with customers. One approach is to contract via aggregators and the other is to contract with a customer directly. We've already recognised that WPD doesn't yet have the skills available perform this type of service directly, so, as part of the trials evaluation we will be producing a recommendations report which provide an assessment of how we could deliver this service in the future.

We've already conducted a process to recruit aggregators to take part in the trials.

Support materials and contract templates have been created. We'll be working with the following aggregators over the remainder of the Build Phase and the next phase of the project:

- Npower
- Energy Pool (Schneider electric)
- Flexitricity
- Kiwi Power
- Energy Services Partnership
- Negawatt

We'll be assessing the proposals of each aggregator, benchmarking their approaches and disseminating our findings.

As we continue to engage with Industrial and Commercial customers to contract with directly, the aggregators will now begin their own process.

In parallel to this activity, a billing system is being developed by CGI. We learnt from the experiences of other DNOs that using a spreadsheet to reconcile meter data and pay customers accordingly is onerous, resource intensive and not replicable in WPD or other DNOs.

The system we're developing will provide a mechanism to manage and monitor third party participants and ensure they get paid. As there is no standard 'off the shelf' option for this, we have developed a detailed specification. We've shared the specification with Northern Power Grid, UK Power Networks and Electricity North West. We're building it to ensure it's suitable for migration to WPD and is replicable to other DNOs.

The billing system is on track for completion in August 2013.

Key risks

RISK	MITIGATION
Back office system isn't delivered for the start of the Trials Implementation Phase, or to the required specification	Regular close liaison and management of CGI to ensure delivery. If the system isn't delivered, a manual approach will be implemented to ensure the trials continue.

Scenario Investment Model

Following review of the SIM Blueprint by other DNOs and Ofgem, the Architectural Design Document, (the high level design of the SIM), was developed and is now complete. The SIM Blueprint can be found on the lowcarbonuk.com website:http://lowcarbonuk.com/lcuk/project-teams/project-FALCON/48-the-sim-blueprint and the Architectural Design Document is available upon request.

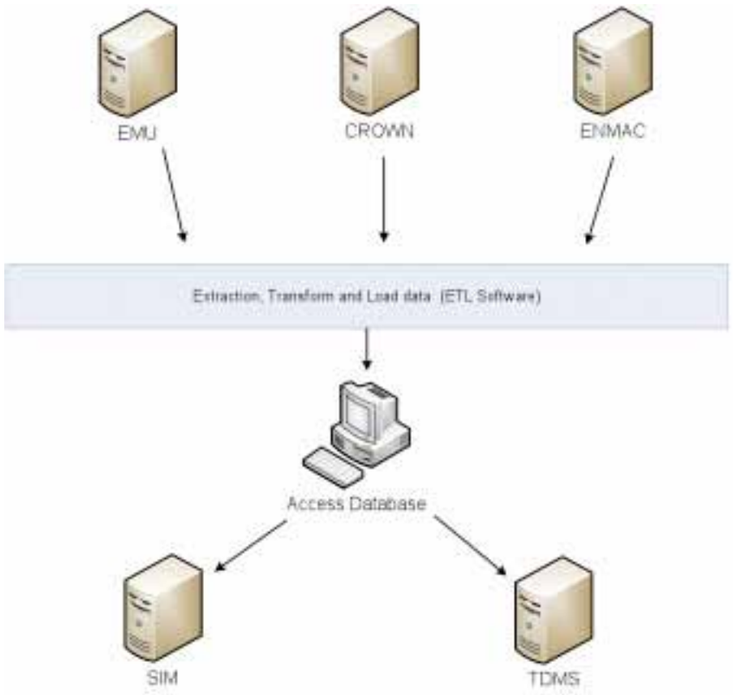

Fig 3: ETL Data Management Model'

The detailed design of the SIM and documents defining the interface between the SIM harness and the network modelling tool, IPSA, which sits at the heart of the SIM are currently being developed.

Data from WPD's existing systems is needed to populate the SIM. Work has already started on importing this network data into IPSA to create the full 11kV model of the Trials area. Figure 3 above shows which systems the data is being extracted from.

For this project we'll be developing a database and combining the information for the purposes of the SIM. The data from each system will need to be refined to ensure the separate systems can be cross referenced effectively.

Data population, cleansing and release strategies have been developed and the authoritative source network database, needed by the SIM, is available in an initial form (the data schema is complete, the data model is almost finalised, and the contents are being refined based on initial loads obtained from the identified data sources. The process is following the usual Extract, Transform and Load (ETL) data management model. We are currently establishing data owners, or 'stewards' for each WPD system to ensure that once the data has been refined and cleansed it may be uploaded back into each source system.

After establishing a SIM User Group, consisting of experienced WPD 11kV and strategic planners, we have subsequently held two SIM user group meetings. The first was to provide an introduction to the project and an overview of the purpose of the SIM. The second was to discuss progress on the SIM's development. The meetings have so far been held quarterly, however by request of the planners after the first meeting; we have developed a monthly SIM newsletter detailing development progress. TNEI, the providers of IPSA, the network modelling tool, which sits at the centre of the SIM have incorporated the newsletter in their monthly R&D update.

Key risks

RISK	MITIGATION
TNEI and IVHM Centre can't make the SIM work as a whole	Cranfield University, TNEI and WPD are working closely together to ensure requirements, roles and responsibilities are clear (and reflected contractually, where appropriate) as well as ensuring a common understanding. Interface documents between IPSA and the SIM Harness are being developed as part of the detailed design to ensure the two elements can work.

Load Estimation

To support the SIM we are developing a set of predicted customer load data based on a number of different Demand Scenarios. These Demand Scenarios will allow us to see the impact of different rates of uptake of low carbon technologies.

Two methods of estimating load have been assessed:

- industry data used for electricity market settlement and
- the development of an Energy Model.

Logica are working with us to assess the first method which makes use of the existing customer profiles developed by Elexon. This method has the advantage that it would be relatively simple to replicate across the UK but does not lend itself to long term forecasting. In contrast the Energy Model being developed by Energy Savings Trust in conjunction with UCL requires a wider range of input data, but will be well suited to long term forecasts for different scenarios.

The accuracy of each estimate will be compared to measured data from substation monitoring installed as part of the FALCON Trials. This will allow an assessment of the effectiveness of using these estimates as an alternative to physical substation monitoring.

For consistency we will use the same analysis tools and metrics to evaluate how well the estimates derived from the LV Network Templates compare to measured data. We hope to extend this comparison to other estimation methods developed outside WPD. We hope that we can identify the relative performance of several different estimating methods with a view of understanding their individual strengths and weaknesses.

We expect that this will result in additional shared learning and feedback that can improve each estimation method. It will also help identify the best method for different applications and to identify when it is or is not appropriate to substitute estimation for monitoring.

We expect that LV Network templates and the Energy Model will complement each other with LV Network templates providing a quick and simple solution for short term planning and the Energy Model being used for long term planning and for situations where LV Network templates is not appropriate.
Monitoring equipment will be installed in the Milton Keynes area by the end of the Build Phase. In the interim, we have produced an initial report using data from substations in the South Wales area, which form part of the LV Network Templates project.

This report focuses on providing:
- an analysis of load estimates created using the process used for settlement
- a comparison of estimates created using an early version of the energy model
- an initial assessment of monitoring optimisation

As part of the analysis of load estimates we replicated the Elexon process in two ways:
1. altered the SVAA code,
2. created our own database,

We found that altering the SVAA code was difficult to do due to the need for specialist resources to configure the software. Creating our own database was easier and cheaper to do, and the process is replicable for other DNOs.

We ran both models (the altered SVAA code and our own database) and compared the results to each other. We found that:

- Substations with fewer customers and smaller loads were harder to model accurately
- Substations with more customers benefitted from an averaging effect, making the actual output closer to that predicted using the Elexon profiles.
- Other substation characteristics were not found to have a significant effect and results were consistent over different day types

Further information on our analysis can be found in the report on our website: http://lowcarbonuk.com/lcuk/articles/58-sdrc-load-estimation

An early version of the energy model was used to compare estimates, however an improved version will shortly available for testing by WPD.

Knowledge Capture & Dissemination
As stated in the previous report, a key objective for FALCON is to explore and trial innovative knowledge capture tools and techniques and assess which is the most effective. In addition, FALCON is due to trial a number of social media avenues to ascertain which is the most appropriate to use in the industry.

At the end of the Design Phase, University of Bath started their analysis of knowledge captured. Part way through the Build Phase it was recognised that this work was not being carried out effectively. WPD took a view at that point to measure performance against expectations. A number of meetings occurred and it has been agreed that the University of Bath will continue to support Knowledge Capture and Dissemination activities; however their role will be reduced and other parties brought in to lead the workstream, conduct the analysis and develop social media avenues for dissemination.

A revised approach to capturing knowledge has been developed by the project team and a new Knowledge Lead will be brought in at the beginning of July to develop and deliver the revised approach.

We have, however, continued to develop and deliver the podcasts as scheduled. The second podcast, focussed on the commercial trials, was filmed in mid-May and will shortly be available for viewing.

In the telecoms workstream the key learning points have been assembled led and collected together to formulate a series of contents pages for a set of target knowledge dissemination “White Papers”. The currently identified documents are:

- Telecommunications Infrastructure Installation Considerations for DNOs - Site Work
- Telecommunications Infrastructure for the future Smart Electricity Grid - Novel Supporting Technologies
- Designing Telecommunications Infrastructure for the future Smart Electricity Grid - Security Considerations
- Designing Telecommunications Infrastructure for the future Smart Electricity Grid - Assessing Existing Infrastructure
- Designing Telecommunications Infrastructure for the future Smart Electricity Grid - Telecommunications Network Monitoring and Management
- Designing Telecommunications Infrastructure for the future Smart Electricity Grid - Radio elements
- Designing Telecommunications Infrastructure for the future Smart Electricity Grid – Preparation and Testing
- Designing Telecommunications Infrastructure for the future Smart Electricity Grid - Teleprotection
- Designing Telecommunications Infrastructure for the future Smart Electricity Grid - Plant to Network Integration
- Balancing Innovation with tried and tested methods, trade off between coverage, latency and cost using the 1.4GHz WIMAX Frequency.

Tools and techniques used in radio connectivity planning for a new utilities trials area network for Project FALCON in Milton Keynes.

Of these, the paper “Balancing Innovation with tried and tested methods, trade off between coverage, latency and cost using the 1.4GHz WIMAX Frequency” is in final review. The Security paper and the site work papers are also in preparation.

We've also shared our findings from the Load Estimation project area at the LV Network Templates event, which was held at University of Bath on 14th May. The slides are available here: http://lowcarbonuk.com/lcuk/articles/60-lv-network-templates-knowledge-sharing-event

Key risks

RISK	MITIGATION
Knowledge gained so far and not captured via existing tools and techniques has been lost	Each element of the design is documented and meetings/ decisions captured; therefore there is material available to draw lessons learnt from. In addition to the documentation we already have produced, each project team member has been involved in the project since Mobilisation or Design Phase, therefore tacit knowledge is retained within the team. This will be able to be drawn from when the new Knowledge Lead starts

Key Build Phase Achievements

- Completion of Successful Delivery Reward Criteria to produce an initial report detailing our actuals vs estimates
- Initial Energy Model developed
- Main FALCON network logical data schema defined
- Main FALCON network sources identified and initial data exports taken and imported into the initial data environment – cleansing and analysis underway
- SIM blueprint reviewed by other DNOs and Ofgem
- Architectural Design Document for the SIM approved
- SIM development platform procured, installed, commissioned and now in regular use
- SIM development environment (tools, software systems) specified and installed
- First project customised release of the Network Modelling Tool issued and integrated into the wider SIM tool in preparation
- Aggregators to take part in the commercial trials recruited
- All procurement activity concluded
- Telecoms Knowledge Transfer workshops complete
- Majority of test lab activity concluded
- Telecommunications network rollout underway. Main microwave link in place, telecommunications equipment being configured in lab and commenced site rollouts
- All trials equipment delivered
- 40% of LV monitoring installed
- 30% of trials equipment installed

Outlook for next reporting period

FALCON is progressing well. There are some very valuable lessons that WPD and partners are learning that will be of significant value to the industry.

In the next reporting period we are focussed on ensuring the lessons we learn are shared more effectively with other DNOs and the rest of the industry.

The next reporting period will take the project three months into the Trials Implementation Phase. In this phase, the trials will 'go live' and we'll gather and analyse the results.

Installation activity is on track for completion at the end of the Build Phase and the data we need to extract from our IT systems, (CROWN, EMU and PowerOn Fusion), will have been further defined and a more complete database of 'cleansed' data will have been established. The SIM will be able to produce its first results for analysis and we'll also have recruited business customers to take part in our commercial trials.

The activity of recruiting customers to take part in the trials will continue up until the start of the Trials Implementation Phase.

3. BUSINESS CASE UPDATE

We forecast that there will be no significant benefits (either carbon or financial) during the course of the project trials, as there is no change to the existing DR5 plan. Our approach for capturing benefits for each technique has been documented and a process is in place to ensure any future benefits are captured.

4. PROGRESS AGAINST BUDGET

We have submitted a revised budget to Ofgem reflect the updated project plan. This is currently going through the Ofgem approvals process, however for the purposes of this report; progress against the previous budget is shown below. As the project plan is out of line with the cost model below, the variances are more apparent:

	Total Budget	Forecast Spend May 2013	Actual Spend May 2013	Variance £	Variance %	Comments
Labour	**2281**	**875.9**	**506.6**	**369.4**	**42%**	
Project Management Costs (WPD)	813	363.6	289	74.7	21%	Resource filled by Logica
WPD Design Team	1468	512.3	217.6	294.7	58%	
Equipment	**1679**	**686.3**	**671.7**	**14.6**	**2%**	
Solution Design - Use Cases Review and finalise use cases	8	4	3.8	0.2	6%	
Solution Design - Use Cases Detailed desktop network design	56	27.8	26.1	1.7	6%	
Solution Design -Method infrastructure scenario investment model Design	8	6.6	6.2	0.4	6%	
Deploy intervention techniques Intervention technique 1 - Dynamic Asset Management	61	132.1	131.3	0.8	1%	
Deploy intervention techniques Intervention technique 2 - Automatic Load Transfer	12	10.9	44.7	-33.8	-309%	Bespoke Switchgear cost more than originally anticipated
Deploy intervention techniques Intervention technique 3 - Meshed Networks	138	66.3	64	2.3	3%	
Deploy intervention techniques Intervention technique 4 - Storage	1388	438.7	395.7	43	10%	
Operate Scenario Investment Model Deploy learning from intervention techniques to SIM	8	0	0	0	0%	
Contractors	**6012**	**2672.5**	**2763.1**	**-90.7**	**-3%**	
Project Management Costs (Logica)	736	395.2	642.4	-247.2	-63%	As above - to fill WPD resource gap
Solution Design - Use Cases Review and finalise use cases	240	214.6	233.3	-18.7	-9%	
Solution Design - Use Cases Detailed desktop network design	287	456.5	496.4	-39.9	-9%	
Solution Design -Method infrastructure scenario investment model Design	325	277.2	277	0.2	0%	
Scenario Investment Model Build Scenario Investment Model Software Development	244	170.8	170.5	0.3	0%	
Deploy monitoring equipment infrastructure Deploy IP infrastructure	6	0	0	0	0%	

Deploy intervention techniques Intervention technique 1 - Dynamic Asset Management	3	3.1	3.1	0	0%
Deploy intervention techniques Intervention technique 2 - Automatic Load Transfer	1671	555.1	514.7	40.4	7%
Deploy intervention techniques Intervention technique 3 - Meshed Networks	73	25.1	23.4	1.8	7%
Deploy intervention techniques Intervention technique 4 - Storage	336	152.9	140.2	12.7	8%
Deploy intervention techniques Intervention technique 5 - Distributed Generation	44	34.5	35.3	-0.9	-2%
Deploy intervention techniques Intervention technique 6 - Demand Side Management	86	52.9	54.8	-1.9	-4%
Operate trials Intervention technique 2 - Automatic Load Transfer	24	0	0	0	0%
Operate trials Intervention technique 3 - Meshed Networks	7	0	0	0	0%
Operate trials Intervention technique 5 - Distributed Generation	90	0	0	0	0%
Operate trials Intervention technique 6 - Demand Side Management	90	0	0	0	0%
Operate Scenario Investment Model Gather intervention technique results	218	0	0	0	0%
Operate Scenario Investment Model Assess Results	397	0	0	0	0%
Operate Scenario Investment Model Deploy learning from intervention techniques to SIM	245	0	0	0	0%
Operate modified trials Assess Results	56	0	0	0	0%
Learning dissemination Market research with stakeholders	28	321.4	165.2	156.2	49%	Delayed stage payment for Bath Uni - revised contract being discussed
Learning dissemination Electronic media	49	0	0	0	0%

Learning dissemination Workshops / seminars	302	2.9	1.5	1.4	49%	Delayed stage payment for Bath Uni - revised contract being discussed
Learning dissemination FALCON Dissemination conferences	73	0	0	0	0%	
Learning dissemination Academic dissemination	120	2.4	1.2	1.2	49%	Delayed stage payment for Bath Uni - revised contract being discussed
Learning dissemination Other media	41	0	0	0	0%	
Learning dissemination Reports	132	4.8	2.4	2.3	49%	Delayed stage payment for Bath Uni - revised contract being discussed
Learning dissemination Training	91	3.2	1.6	1.5	49%	
IT	**2914**	**1593.3**	**1696.4**	**-103.1**	**-6%**	
WPD IT Costs - Hardware and connection	72	17.9	19.1	-1.2	-6%	

Solution Design - Use Cases Detailed desktop network design	247	195.7	208.4	-12.7	-6%
Scenario Investment Model Build Hardware/Software purchase	97	87.2	92.8	-5.6	-6%
Deploy monitoring equipment infrastructure Deploy IP infrastructure	1620	649.8	691.9	-42.1	-6%
Deploy intervention techniques Intervention technique 1 - Dynamic Asset Management	133	105.7	112.5	-6.8	-6%
Deploy intervention techniques Intervention technique 2 - Automatic Load Transfer	133	105.7	112.5	-6.8	-6%
Deploy intervention techniques Intervention technique 3 - Meshed Networks	133	105.7	112.5	-6.8	-6%
Deploy intervention techniques Intervention technique 4 - Storage	133	105.7	112.5	-6.8	-6%
Deploy intervention techniques Intervention technique 5 - Distributed Generation	135	106.8	113.8	-6.9	-6%

Deploy intervention techniques Intervention technique 6 - Demand Side Management	173	112	119.2	-7.2	-6%	
Operate Scenario Investment Model Assess Results	35	0	0	0	0%	
Learning dissemination Market research with stakeholders	2	1.2	1.2	0	-1%	
IPR Costs	**0**	**0**	**0**	**0**	**0%**	
Travel & Expenses	**329**	**197.3**	**131.3**	**66**	**33%**	
Phase 1 - Solution Design	157	127.3	76.8	50.5	40%	T&E included in Contract Milestones
Phase 2 - Solution Build	124	68.5	53	15.5	23%	T&E included in Contract Milestones
Phase 3 - Trial Implementation	21	0	0	0	0%	
Learning Dissemination	28	1.5	1.5	0	0%	
Payments to users	**240**	**0**	**0**	**0**	**0%**	
Operate modified trials Gather intervention technique results	240	0	0	0	0%	
Contingency	**0**	**0**	**0**	**0**	**0%**	
Decommissioning	**0**	**0**	**0**	**0**	**0%**	
Other	**668**	**474.9**	**488.9**	**-14**	**-3%**	
Phase 1 - Solution Design	421	370.4	378.4	-8.1	-2%	
Phase 2 - Solution Build	95	20.4	22.1	-1.7	-8%	
Phase 3 - Trial Implementation	106	0	0	0	0%	
Learning dissemination	46	84.1	88.4	-4.3	-5%	
TOTAL	**14123**	**6500.2**	**6258**	**242.2**	**4%**	

5. BANK ACCOUNT

All the money for the project has been received from other DNO's.

6. SUCCESSFUL DELIVERY REWARD CRITERIA (SDRC)

The following tables show the status of the Successful Delivery Reward Criteria for the previous reporting period and this reporting period.

Previous reporting period

SDRC	DUE BY DATE	COMMENTS
SIM design blueprint complete, a prototype visualisation developed and shared with the industry.	30/09/12	Complete
An initial report written on the effectiveness of using estimates as an alternative to physical substation monitoring	30/09/12	Complete

Next reporting period

SDRC	DUE DATE	COMMENTS
SIM built and an updated run to take place to identify network 'hotspots'	30/09/2013	On track

There were a number of tasks associated with the above SDRC in the in the project direction. The tasks and progress against each of them are outlined below.

The hardware and software to develop the SIM will have been purchased

The SIM hardware and software to be used for the development is all now installed and operational at Cranfield IVHM Centre. The system is based on two (redundant) LINUX servers. The operational host systems may differ in specification if system testing / benchmarking using these development systems indicates high resource usage and long execution times. These are investigations which need to be carried

out once the SIM is more fully developed and the datasets available.

A system design specification will have been developed
The SIM Blueprint is available on our website and has been issued to Ofgem and DNOs for review but this is effectively a requirements level document.

The High Level Design phase culminated in the issuing in December of the Architectural Design Document (ADD) for the SIM which describes how the SIM is made up of a number of subsystems. Additional documents which expand on and describe the interfaces between subsystems (Interface Control Documents, ICDs) are also either ready or in production. Further documents are following from the Low Level Design (and build) phase now underway, notably the SIM Detailed Design Document (DDD) for each of the subsystems.

A system test plan will have been created
There are several test Plans in the Test Documentation set. Module Test Specifications map onto the detailed design, Integration Test Documents map onto the ADD level and System/Acceptance Test Plans map onto the Requirements Specification (As captured in the Blueprint and System Requirements Specification, SRS). These tests plans are at various stages of development. As the tests draw heavily on the availability of data which can be used to drive the tests cases, a dependency on the data preparation workstream is present.

The first outputs from the SIM will be available for viewing
The core of the SIM, the version of IPSA (the NMT engine) tailored for the FALCON project by TNEI, is already available and will shortly be integrated with the available SIM harness elements in Cranfield. It is expected that there will be sufficient components to run the hotspot analysis by the ADRC due date. There is again a dependency on the data workstream which will present the current best model of the network to be analysed for hotspots and this work is ongoing.

The wider learning gained from the Build phase of the project will be disseminated as per the communications plan
As detailed in section 2 -Project Manager's Report a revised approach to capturing knowledge has been developed by the project team and a new Knowledge Lead will be brought in at the beginning of July to develop and deliver the revised approach. Please refer to the next section in the report, Learning Outcomes, for information on dissemination activities during this reporting period.

7. LEARNING OUTCOMES

We have identified seven common themes, with project specific challenges, learning's and benefits across all WPD LCN funded Projects. Each of the learning outcomes we gain in the project will be categorised into these themes.

This reporting period spans the Build Phase of the project; therefore the type of learning we are expecting to obtain is associated with procurement, installation and testing activities of the trials equipment, impact of installation activities on customers within the trials area, recruiting customers for the commercial trials, impact of the commercial trials on current regulatory boundaries and learning from our experiences of Elexon profiles.

In line with our Successful Delivery Reward Criteria, we've continued to develop and deliver the podcasts as scheduled. The second podcast, focussed on the commercial trials, was filmed in mid-May and will shortly be available for viewing.

We're disseminating our telecoms solution not only via the JRC, and at UK based conferences, but at international conferences, such as CIRED 2013: www.cired2013.org

We've also shared our findings from the Load Estimation project area at the LV Network Templates event, which was held at University of Bath on 14th May. The slides are available on our website: http://lowcarbonuk.com/lcuk/articles/60-lv-network-templates-knowledge-sharing-event. In addition to this, we've met with Northern Power Grid to share our findings and have met with De Montford University to assess how their work complements FALCON.

The high level learning outcomes from the reporting period are outlined below.

7.1 Customer Engagement

- Integrating standard business processes, such as the customer enquiries and complaints process saved time in developing the communications plan, but also ensured that any enquiries were dealt with in a professional, timely manner.
- The customer is central to our planning processes, and whilst we have had very few enquiries or complaints, any enquiries can delay installation activities, and so time needs to be factored in to account for these.
- Engaging with Industrial and Commercial customers has taken a lot longer than we originally anticipated and whilst this has been mitigated by bringing in expert resources, it still presents a challenge given the complexity of what we are seeking to achieve.

7.2 Project Management, Purchasing, legal

- The Design Phase is critical, especially for non-standard DNO activities, such as software development.
- Ensuring that there a well thought out and planned logistics process helps to ensure that there is enough equipment in stock to keep the installation teams fully utilised.
- It is important to undertake design planning and intervention planning separately to ensure that they are executed thoroughly.
- The SDRCs associated with the Load Estimation workstream have been a challenge, due to the wording of them, as detailed in section 6 in the previous 6 monthly progress report. They were set in the bid phase before the approach to Load Estimation was designed. Analytical SDRCs should be broader to ensure that when different approaches are developed, or new information discovered, it can be factored in to ensure that more value can be easily demonstrated, without negatively impacting on the SDRCs.
- The challenges of consumer data cannot be underestimated. Obtaining the data is

hard, ensuring compliance with Data Protection Act harder still. More time must be allowed when dealing with these areas.

7.3 Construction Process

- Before installing equipment on the network, we found that testing it initially in the lab was essential to ensure interoperability of equipment.
- At some of the sites where we are installing battery storage we will require an additional housing next to the existing substation to house the new equipment. In the larger brick built substations there is enough spare room to house them. A Transformer, a filter and some isolation switchgear is needed to connect the batteries to the network. Due to the additional equipment required this means the size of the housing required is approximately 2.5m3. This exceeds what we initially expected and planned. If our existing substation and new housing combined exceeds 29m3 it will fall outside the remit of "Permitted Development" and we will need to obtain local planning permission, which has the associated lead in times for obtaining these permissions.
- We've found that it is worthwhile carrying out Environmental surveys up front, as we experienced delays due to Great Crested Newts nesting at one substation. Whilst it was not possible to mitigate all risks, the surveys could have highlighted this beforehand.
- Substations are generally located in areas with minimal customer impact, which isn't always consistent with getting the best location to obtain a radio signal. Milton Keynes also has a surprising and significant number of trees, which also made radio planning particularly lengthy compared to conducting the same trial in a different part of the network.
- We found that the land topology in Milton Keynes affected the radios 'lines of sight' more than we anticipated – at three of the main primaries it was not possible to "see" Bradwell Abbey, so we had to redesign the radio network. These sites were instead directed at the more distant Horwood site. New high gain antennas were fitted at these sites (and at the three primaries) allowing connection to the main Tipton backhaul without having to use the microwave link. Whilst standard planning techniques were used to plan the original radio locations, we downloaded a free 'line of sight' iPad app which used google maps. The radio signal line could be drawn across the map and the position altered depending on the outcome. This was used to assess the topology of the remaining sites to ensure time wasn't wasted in deploying radios to the remaining sites.
- We initially anticipated that Surf Telecoms were able to install some of the pole mounted equipment; however we found that specialist linesmen installation teams were needed. Scheduling our installation activities into business as usual activities are providing a challenge.

7.4 Technology & Equipment

- We've found that since FALCON's initial bid submission, the Energy Storage Market has matured, and the technology and associated costs are being continuously refined.
- Using knowledge gained from other WPD and DNO projects saves duplication of activity. We obtained learning from WPD's Tier 2 LV Templates project and its Tier 1 LV comparison project which provided excellent learning for assessing different monitoring equipment. These two projects provided information on the suitability of monitoring equipment and informed our procurement process.

7.5 People and Culture

- There is a distinct difference in cultures between academic and commercial organisations.
- The intent in engaging Universities was to make use of their core research skills to ensure that we had independent thought and analysis. However, it is our view that significant management time either has to be set aside to managing them, or alternative sources to conduct management should be utilised. In our experience estimation of effort is poor, over utilisation is common and teaching is a distraction to deliverables. A different approach to each partner is needed with appropriate contractual terms.

7.6 IT and Telecommunications

- The 1.4Ghz MoD frequency has provided unexpectedly good results and the quality of data being transferred is excellent. Due to this, we are looking at the potential to use the WiMAX technology across other parts of the WPD network.
- It is our view that the data we have today is acceptable for today's DNO. Alternative approaches and strategies will be needed for the future. Systems and their data needs will be fundamentally different and this will require a whole new approach to data.

7.7 Industry processes and Regulations

- With the commercial trials, there is a potential that a customer may not wish to participate with DNOs if engaged with STOR due to the restrictions placed within the National Grid Contract.
- Through our Load Estimation workstream, we've learnt that for future planning, we'll need to move to a more sophisticated planning model and look at different half hourly slots, day types and seasons. As detailed in the load estimation initial report (http://lowcarbonuk.com/lcuk/articles/58-sdrc-load-estimation) in running the two models we replicated the Elexon processes we found that:
  - Substations with fewer customers and smaller loads were harder to model accurately
  - Substations with more customers benefitted from an averaging effect, making the actual output closer to that predicted using the Elexon profiles.
  - Other substation characteristics were not found to have a significant effect and results were consistent over different day types

8. INTELLECTUAL PROPERTY RIGHTS (IPR)

There is no IPR generated or registered during this reporting period and it is not expected that we will register any IPR in the next period.

9. RISK MANAGEMENT

The project has a RAID log that is managed by Project Support and reviewed with the project team and key WPD senior stakeholders. Below are the key risks that were highlighted in the full submission proforma and the mitigating action taken or action that is still underway.

Risks highlighted in the full submission proforma

RISK/ISSUE	DESCRIPTION	MITIGATING ACTION TAKEN/UNDERWAY
The project team cannot be effectively resourced	Other significant or higher priority activities running in parallel might impact WPD's ability to resource FALCON which will lead to a significant delay in the project start date, milestone or deliverables	Risk closed. Obtaining the right skills for the project was a key learning point for WPD during the Mobilisation and early part of the Design Phase. Where non-standard DNO, or niche, specialised skills have been required we have sourced these from external organisations. Whilst the risk is closed, another has opened. Sourcing skills externally has placed pressure on the budget, the impact of which is being carefully monitored.
The project Delivery Team does not have the knowledge required to deliver the project	Some of the Bid Team were made redundant which could lead to a gap in project delivery knowledge leading to increase costs, delay the project schedule or poor quality dissemination outputs	Risk closed. Key members of the Bid team transferred across to the Project Delivery Team, plus external partners remained the same, therefore a vast amount of knowledge was retained. The Design phase proved critical in developing the detailed scope of the project. This risk is closed.
The overall Project scope and cost could creep	due to poor control, under estimation of costs at bid stage, changes in technical scope and partner uncertain of their scope.	Time, cost and quality parameters are carefully monitored to ensure project scope does not creep and negatively impact the budget and timescales. Any changes to the original scope are subject to approval via the change control processes.
Partner perceptions on their project scope may change as we move from MoU to signing a contract	Lack of clarity in discussions during the bid stages leading to cost increases, funding contribution decreasing, lack of partner resource availability	Risk closed. All partners moved successfully from MoU to a collaboration agreement during the Mobilisation Phase. The purpose of the Design Phase was to refine the scope of each partner and, where appropriate, contracts updated.
A partner may withdraw from the project or may have oversold their solution	Misunderstood technical requirements , misrepresentation of solution leading to a delay in the schedule, inability to achieve SDRCs	We experienced this with Aston University, as outlined in the previous report. We mitigated this by sharing the work between CGI and WPD and revised each partner's contract accordingly. Whilst requirements have been captured, this risk will remain open for the remainder of the project. In case of changes in partner scope, we have an established change management process in place. In terms of a partner withdrawing, we have ensured that designs are documented effectively and, through our knowledge capture processes, are ensuring knowledge is shared amongst the team.

Logica unable to resource the Project Office, Independent Technical Design Consultant and Quality Assurance and benefits management roles	Because of lack of understanding of the requirements leading to an inability to undertake the project	Risk closed. Logica (now CGI) resource populate these roles.
The SIM software cannot be designed within the required timescales	Lack of understanding of scope during bid phases leading to increased costs or a delay in timescales.	Risk closed. This was a key learning for WPD – the SIM is a software development, which required specialised, non-standard DNO skills. The allocated time for the design phase was not long enough for this activity; therefore the Design Phase for the SIM has been extended. This does not, however, have a negative impact on the SDRC deliverables associated with the SIM.

Risks that have arisen in the reporting period in each project area are highlighted in Section 2 Project Manager's report. Key overall project risks are highlighted below. Careful management of all risks forms a key part of our weekly Project team meetings.

Key overall project risks being monitored

RISK/ISSUE	DESCRIPTION	MITIGATING ACTION
The technology used in the Project doesn't work	As the equipment is installed it may not deliver what we expect or it fails during testing	Detailed designs, descriptions and testing plans are or have been created. The Technical Design Architect owns the whole design and it's 'deliverability'. The test lab functionality ensures that we are able to test the equipment to be deployed on the network before field testing commences. We have ensured that there has been and will continue to be close liaison between suppliers, partners and WPD to develop a deliverable solution.
The whole solution does not integrate effectively	There are a number of solutions within the overall design and there is a risk that the whole solution might not work.	Detailed requirements and designs have been developed in conjunction with impacted parties e.g. Cranfield University, TNEI and WPD IR. Interface specifications are being developed and reviewed as a technical community – members from project partners, the core project team and WPD. As stated previously the Technical Design Architect owns the whole design and it's 'deliverability'.

Costs exceed the budget	There is a risk that as the technical design becomes more detailed and clearer, costs could increase	Continuous dialogue is taking place between all the technical partner/ suppliers to ensure a common understanding of requirements, scope, budgetary constraints and the potential impact of scope creep. They are considered as part of the Change Management process and, if costs could be impacted, it's escalated for consideration.
SIM and NMT won't work together	There is a risk that TNEI and IVHM can't make the SIM work as a whole.	There is continued dialogue between Cranfield University, TNEI and WPD to ensure the requirements, roles and responsibilities are clear (and reflected contractually, where appropriate) as well as ensuring a common understanding.

10. OTHER

This section is left intentionally blank.

11. CONSISTENCY WITH FULL SUBMISSION

When the project plan was constructed, we included a Design Phase. The purpose of this was to take the bid submission and to develop it into an implementable solution. The project is broadly consistent with the full submission, however, as expected, during the Design Phase, some of the detail changed as the technical solution developed and the project team formed. For example:

Project Readiness

- The Partner Forum was replaced by one to one meetings with senior members of each partner organisation as required.
- The Technical Design Authority and the Technical Design Consultant is the same role, however the design is approved by WPD representatives. Responsibility for partner and supplier technical input sits with the project area leads.

FALCON solution

- The SIM is not taking data directly from the trials, the trials data will be modelled by Aston University
- We will use the in- built capability of IPSA to visualise the results of the SIM, rather than utilising a separate tool.
- Typology of the telecommunications network has been adjusted to more readily support interconnections due to line of sight issues. To support this, we are including nine substations, rather than six to support the implementation of the telecommunications network
- For the commercial trials, we are focussed on customer behaviour. We're asking them to change their energy usage and we'll measure the impact on the network – we don't have a forecasting tool to predict where the constraints will be. We're able to collate the learning from the trials and refine how the SIM models customer's response.
- As outlined in section 2 - Project Manager's report, we're changing our approach to Knowledge Capture and Dissemination - more will be detailed in the next report.

12. ACCURACY ASSURANCE STATEMENT

This report has been reviewed by Roger Hey, Future Networks Manager, recommended by Paul Jewell, Policy Manager and approved by Nigel Turvey, Design and Development Manager.

NOTES

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WESTERN POWER DISTRIBUTION

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LCN Fund Low Carbon Networks

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Aston University Birmingham

University of Bath

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