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FALCON

DEVELOPING FUTURE POWER NETWORKS

Project FALCON
Close Down Report

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Contents

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1. Project Background

The detailed background to Project Flexible Approaches to Low Carbon Optimised Networks (FALCON) can be found within the original bid documents and subsequent Project Direction (links are provided in the appendices). In this section we summarise the background to FALCON and the hypothesis it was attempting to test.

1.1 Introduction to the problem

The cost and limited flexibility of traditional approaches to 11kV network reinforcement threaten to constrain the uptake of low carbon technologies. Only by testing the use of other approaches on networks could we be certain that: a) they worked and that b) that they could be genuinely used as alternatives to conventional reinforcement.

1.2 Introduction to FALCON

FALCON sought to address the hypothesis through the trialling of a Method that comprised a Scenario Investment Model (SIM) linked to a network trials area. It also trialled four technical and two commercial alternatives to conventional reinforcement. The trials area sought to prove the practically of these techniques.

The Scenario Investment Model (SIM) sought to identify network constraints under multiple future network load scenarios and determine the most cost-effective and timely combination of techniques to resolve them. The trial area comprised six primary substations located on a mix of rural and urban networks representative of much of the national 11kV network.

The objectives of FALCON were closely aligned with those of the UK Low Carbon Transition Plan and ED1. In addition to enablement of the uptake of low carbon technologies, FALCON sought to deliver faster and cheaper 11kV connections and reduced DUoS charge increases for all. It generated learning applicable to all DNOs, shared through established LCNF dissemination channels. In addition, as stated within the bid we estimated a net financial benefit of £1.2m from the four year project and we estimated that *"a national rollout of the FALCON methods could realise a £660m financial benefit over 20 years and will save over 680 ktonnes of CO2 by 2050 (accounting for an additional £36m of benefits)."* Of course, these were estimates at the time of submission and predicated on expected results of the trials and the expectation that the SIM would be proven. Any UK wide implementation would have to go through regional and geographic roll outs based properly justified a business case. For the SIM it is clear that it is not at the point where it would be considered appropriate as a BaU tool.

As we detail further within this report, we see FALCON as being extremely successful. It was a vast project, with a complex set of independent and dependent deliverables and as such the project team can be justifiably proud of its achievements. This report will close the project down officially and share with our stakeholders the relevant information that can be obtained about the project.

2. Executive Summary

2.1 Scope

We have included below a diagram(Fig 1), included within the Final Submission Proforma (FSP), which we think best articulates the full scope of FALCON. The principles behind FALCON were fundamentally about planning and operations and how best to trial new approaches to planning on the 11kV network.

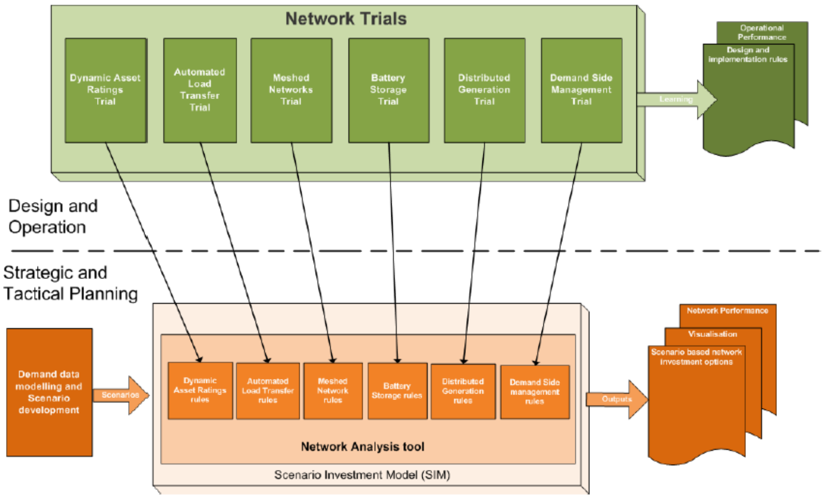

Fig 1: Design principles of the project

In order to achieve the stated objectives the project was divided into 6 workstreams. These were the Engineering Trials, Commercial Trials, Load Estimation, the SIM, Telecommunication's and Knowledge Capture & Dissemination.

Each workstream had a lead engineer and that person was responsible for delivering the scope within their workstream. The scope varied within each workstream and some had dependencies with another workstream and this of course necessitated significant collaborative working to achieve project outcomes.

2.2 Outcomes

FALCON can more representatively be described as a programme of work that in combination sought to develop, and learn from, a nodal electrical model of existing distribution network that could:

- respond to future load scenarios;
- identify network constraints (based on the future load scenarios); and
- could undertake virtual remedial work on the modelled network, based on six innovative constraint mitigation techniques plus acts of conventional reinforcement, to relieve the identified network constraints.

This programme of work included:

- the development of the SIM (the "regenerating" dynamic nodal model described above);
- Load estimation
- Trials of the four engineering techniques for constraint mitigation;
- Trials of the two commercial techniques for constraint mitigation;
- Development and learning from a new communications network to support load estimation, and technique trials; and
- Knowledge capture and learning dissemination.

Key outcomes from this programme of work can be summarised as:

1. A new communications network was installed at project-specific sites around Milton Keynes, and this network satisfactorily supported the load estimation and technique trials work packages of FALCON, and provided a wide range of valuable learning on the deployed equipment and technologies;

2. New methods of load estimation were developed. These methods were validated through comparison with measurements of substation loads in the Milton Keynes area undertaken by FALCON. These load estimation methods were then successfully used as the basis for modelling network load within the SIM.

3. Four engineering techniques were successfully trialed on the network in the Milton Keynes area. These technique trials informed the development of the SIM (as reported in December 2014), and provided extensive and detailed learning on their individual efficacy, as outlined later in this report, and as described in detail in individual technique Final Reports.

4. Two commercial techniques were successfully trialled on network in the Milton Keynes , proving that Demand Side Response(DSR) with commercial customers is possible given the right environment. We intend to explore what needs to be done more widely to make DSR a BaU tool.

5. The SIM has been an incredible success and whilst it may not offer a practical alternative for business as usual, it is clear that there is a real opportunity to use the SIM for strategic planning purposes and we are looking at ways of making this happen.

6. Significant amounts of knowledge documented throughout that has been successfully disseminated through a multitude of mediums and moreover has helped WPD inform its knowledge process internally for innovation projects.

2.3 Objectives

FALCON had a series of 9 distinct objectives and these are documented within section 5.1. It is our view that FALCON met all of its objectives and we explain why further within this close down report.

FALCON's objectives covered a broad range of desired outcomes, of course some may be viewed as more successful than others, but overall it is our view that FALCON has been incredibly successful and through its achievements will leave a significant change agenda within WPD.

2.4 SDRCs

The details of all SDRCs through the lifecycle of FALCON are provided within Section 5.2 with commentary against the SDRC and its underlying deliverables and criterion. In summary FALCON met all of its SDRCs. There were SDRCs throughout each of the phases and the team delivered against each of them. The SDRCs covered a broad range of subjects and are summarised below:

Phase	SDRC	Evidence	Status
Mobilisation	Commercial agreements in place with Logica, Cranfield University, University of Bath, Alstom, Cisco and Aston University.	No report required only confirmation of such	✓
Design	SIM design blueprint complete by September 2012, a prototype visualisation developed and shared with the industry.	Blueprint disseminated, feedback collated and blueprint accordingly updated	✓
Design	An initial report on the effectiveness of using estimates as an alternative to physical substation monitoring will be written by September 2012.	Report published	✓
Build	SIM built and an updated run will take place to identify network 'hotspots' by September 2013	SIM successfully built and results analysed & validated	✓
Trials Implementation	Load scenarios based on a range of low carbon uptakes in the trials area will be created for use by the SIM by October 2014	Achieved, results contained within Final Report	✓
Trials Implementation	The Engineering Intervention Technique trials 1-4 will be deployed onto the network and the results loaded on the SIM. The results will be analysed and available for dissemination by December 2014	Report published	✓
Trials Implementation	The Commercial intervention technique trials will be deployed onto the network. The results will be analysed and dissemination by December 2014.	Report published	✓
Consolidate and Share	Assess the suitability of the Method for mainstream adoption and produce an optimum investment plan by 30th September 2015.	Report published	✓

Table 1: SDRC's through various phases

2.5 Learning

All learning was grouped into a series of key categories and can be summarised as follows:

- Customer Engagement
- Project Management, Purchasing and Legal
- Construction Process
- Technology and Equipment
- People and Culture
- IT and Telco's
- Industry processes and Regulations

We are currently undertaking the transfer of all learning over to the business. The process briefly entails identification of the appropriate senior manager for each key learning point; agreement with the business of the relevant operational manager responsible for undertaking the actions required and sign off to certify completion. With so many key learning points this is going to be a long process by we are confident that all knowledge will be signed off by the business by the end of Q1 2016.

Below are the key learnings obtained from the project as a whole and the method:

Learning category	Learning Commentary
Project	Project Management- managing a programme of work as large as FALCON has taught us that managing the programme plan at too low level takes too much resource and effort.
Method	It is clear from the findings of the analysis undertaken by the SIM that: • Power flow analysis using a nodal network model is essential when determining the benefits of smart techniques because these are highly specific to a particular location and scenario. This suggests that while the SIM approach is onerous in terms of data handling and manipulation, this is worthwhile for strategic planning and policy evaluation. • Traditional reinforcement will continue to be the main method by which network issues are resolved, followed by dynamic asset rating and meshed networks. Batteries only tend to be selected once other options are exhausted and the relative scarcity of demand side management options limits its use. • The initial capacity at primary substations differed significantly and this affected the number and complexity of interventions required by the SIM. • Thermal issues arising under n-1 conditions are the main driver of investment with low voltage issues only occurring rarely and after 2040. Switchgear replacement may be required in addition to the expected upgrades for transformers and linear assets. No fault level issues or high voltages were observed but this may reflect the absence of large generators within the modelling. • Due to the load scenarios showing significant peak load increases, Dynamic Asset Rating (DAR) was often a temporary measure that would delay but not remove the eventual need for traditional reinforcement.

Learning category	Learning Commentary
Project	Purchasing & Legal- we believe that collaboration agreements do not necessarily work effectively on these types of projects- it is important to consider more traditional terms and conditions with detailed scopes of work that can be varied accordingly as certainty increases.
Project	Load Estimation: • Electric Vehicle charging assumptions have a significant impact on the overall shape of load curves and the timing of peak loads. • Clustering of Low Carbon Technologies is a key sensitivity with greater concentration of technologies resulting in earlier appearance of voltage issues and networks that the SIM could not fix. This suggests that it is vital that DNOs are provided with accurate data for their location to enable accurate planning. • Estimate accuracy is highly dependent on data quality but generally improves for larger substations • Issues were concentrated on the peak days and weekdays for Winter and Spring. Some of the day types could be removed to improve the performance. Further information is available in the Load Estimation Final Report which also contains the links to other reports • http://www.westernpowerinnovation.co.uk/Document-library/2015/Project-FALCON-Load-Estimation.aspx
Method – Commercial Trials	• The Commercial Trials were an undoubted success and prove that a) they can be made to work and b) the industry needs to change structurally(e.g. in the current market, the supplier retains the relationship with the end customer) in order to support DSR type services. Further information is available in the Commercial trials Final Report : • http://www.westernpowerinnovation.co.uk/Document-library/2015/Project-FALCON-Commercial-Trials.aspx
Method – Dynamic Asset Rating	Key points of learning from the DAR trials were that: • DAR is dependent on well-tuned thermal models. Significant tuning of thermal models was required to achieve agreement between model and measured asset temperatures. • Once adequately tuned, the thermal models for the asset classes included in the trials agreed well with measured parameters - generally to within 5oC over 90% of the time, indicating a modelling error of better than 10%. • A dedicated DAR relay is not essential, other computing devices/systems could perform real-time assessment calculations (e.g. the network management system), if these are required. The three asset (OHL/cable/transformer)-variant relays provided limited functionality

Learning category	Learning Commentary
	and both variants (OHL-only and three asset-variant) were inflexible. In addition, offline modelling (an alternative to real time relays) was particularly important because it allowed extension of the work into forecasting of future ampacity. • For overhead lines, the variation in dynamic rating calculated at an instant in time was principally driven by wind speed/direction. This offers some immediate operational opportunities, but very limited long term planning opportunities (hence exclusion from SIM). However, measurement of wind speed/direction needs to be implemented with care to ensure values are representative of conditions experienced along the OHL. • For Primary transformers and outdoor Distribution transformers, dynamic ratings are principally driven by the relatively slow moving ambient air temperature, and the time constants are hours in duration. The trial results suggest that over the winter period there is scope to run the transformers with a 10% increase in rating, but with a lower rating in the summer • For transformers located in indoor Distribution substations, trials suggest that for many sites the (indoor) ambient air temperature is above standard assumed values that form the basis of ratings. The implication of this is that many of these transformers are operating with hot-spot temperatures above what would have been expected for their electrical load. However, this does not imply that they were operating above the nominal life usage rate temperature of 98°C. Reducing this air temperature (towards surrounding outdoor air temp) would tend to reduce experienced hot-spot temperatures, reduce life-usage, and could have a significant ratings benefit • The dynamic asset rating associated with cables appears to offer up to 7% increase in (sustained) static rating in winter months. Investigation of the experienced cyclic loading suggests that the load curve shapes seen on the trial assets had a higher minimum load and suggests that there is less DAR benefit with cyclic rating than sustained rating over the winter months. • A limitation in the practical application of real-time dynamic ratings is the variability that was experienced. This was particularly the case for overhead lines where the key determinant of variation (wind speed/direction) could change very quickly, and with the asset having low thermal capacity, consequential conductor temperature changes can occur quickly (within moments). This led to consideration of the ability to estimate future ampacity, and the development of an approach that was implemented for each of the trial asset types. The approach takes ambient parameters from weather forecasts and provides shapes to these values over time. From the arrays of shaped ambient conditions, a

<table>
<tr><th>Learning category</th><th>Learning Commentary</th></tr>
<tr><td></td><td>profile of maximum current values is iteratively calculated that causes the asset to heat up to its limiting temperature (allowing for an uncertainty margin). This maximum electrical current profile allows the ampacity of the asset to be assessed based on the forecast time-varying ambient conditions. This method of estimating future ampacity was tested by comparing the forecast ampacities against outturn real-time ampacities and found to provide a satisfactorily reliable indicator.
With respect to learning that shaped the SIM, generalisation of thermal modelling of cables within the trials provided size-scalable construction-specific models that enabled the widespread assessment of cables in the SIM network area. In addition, a range of parameters amendments were proposed for transformer DAR algorithms, based on learning from operating experience.
Further discussion and points of learning are presented in to the technique detailed reports which can be found here:
http://www.westernpowerinnovation.co.uk/Document-library/2015/Project-FALCON-Engineering-Trials-DAR-OHL.aspx
http://www.westernpowerinnovation.co.uk/Document-library/2015/Project-FALCON-Engineering-Trials-DAR-Cables.aspx
http://www.westernpowerinnovation.co.uk/Document-library/2015/Project-FALCON-Engineering-Trials-DAR-Distribution.aspx
http://www.westernpowerinnovation.co.uk/Document-library/2015/Project-FALCON-Engineering-Trials-DAR-Primary-Tran.aspx</td></tr>
<tr><td>Method – Automatic Load Transfer</td><td>Key points of learning from the Automatic Load Transfer (ALT) trials were that:
Distinct algorithms were required to optimise for different criteria, illustrating the complexity inherent in modelling for ALT. This also demonstrated that ALT benefits are not all simultaneously realisable. Method 1 looked at minimising losses, and Method 2 looked at increasing capacity headroom.
Improvements in 11kV capacity (at first branch out of the primary) of up to 12 percentage points are possible. These improvements are dependent on the algorithm used, Method 2 gave superior results to Method 1.
Improvements of up to 12% of losses, using method 1, are also possible.
Voltage improvement was also calculated under method 1. This is more noticeable on a rural overhead line Network, and overall was marginal in magnitude.
Customer numbers per feeder varied consequentially according to the algorithms developed to improve losses/voltage, and capacity. Depending on the specific network, potentially more customers are at risk of being impacted by a fault (CIs/CMLs)if the Network is reconfigured to reduce losses or increase capacity headroom. This could be simply</td></tr>
</table>

Learning category	Learning Commentary
	mitigated through implementation of “along-feeder” staged protection. • It seems possible that much of the improvements that have been indicated from these technique trials could be captured through a one-off adjustment to NOPs • It should be noted that the trials do indicate that further (more marginal) benefit may be obtained by implementing within day, over the week, and across season changes to NOPs. • Where the analysis shows potential variation in switching points (across the day, within week or across seasons) then the potential switching points are closely clustered. It is considered that further load monitoring would have to occur around the indicated switching points to conclude if these additional benefits really existed, and their magnitude relative to the complexity that would be required to capture them. discussion and points of learning are presented in to the technique detailed report which can be found here: • http://www.westernpowerinnovation.co.uk/Document-library/2015/Project-FALCON-Engineering-Trials-ALT.aspx
Method – Meshed Networks	Key points of learning from the mesh trials were that: • Meshing of a simple (two feeder) network changed loading on the source breakers, but not to reduce load on the more heavily loaded source during peak load periods. • Voltage and power quality (PQ) were found to be largely unaffected on this small compact urban network. In general, it may be expected for there to be only marginal change in these respects. • A 5% reduction, from current levels, in losses was estimated on this trial network, though this should not generally be assumed to be the case (dependence on relative feeder impedances). • High-speed protection communications over the FALCON communications network did not operate as expected. That is , the desired level of communications response times could not be achieved. • Security/reliability was maintained compared to the pre-existing condition, through the installation of a protection relay operating on an overcurrent basis at the trial-installed circuit breaker closest to the NOP. The trial was not able to implement additional sectioning as originally planned due to encountered slower than designed tele-protection signalling on the FALCON communications network; and limits in achievable certainty within conventional protection discrimination (i.e. without interconnection of relays). • Installation of circuit breakers and directional-capable protection relays imposes complexity and on-going operational/maintenance requirements (e.g. additional ring main units, star connected VTs, and

Learning category	Learning Commentary
	tripping batteries at Distribution substations). Further discussion and points of learning are presented in to the technique detailed report which can be found here: • http://www.westernpowerinnovation.co.uk/Document-library/2015/Project-FALCON-Engineering-Mesh.aspx
Method – Energy Storage	Key points of learning from the mesh trials were that: • Battery chemistry and manufacturer design philosophy impacts greatly on performance characteristics (e.g. differing charge/discharge rates, auxiliary power loads and consequential efficiency, battery calibration/maintenance requirements). • At 11kV, and for fixed systems, a single site energy storage system (if a suitable site can be found) would simplify the challenges of installing/commissioning multiple times, and complexity of control equipment coordinating across multiple sites. • Audible noise was also a concern with the equipment and its locations. Work with the manufacturer led to modified inductors being fitted to the converters which reduced audible noise. The construction and electrical size of such components is clearly important to achieving satisfactory performance. • Reliable peak-shaving at individual sites was repeatedly achieved, and combined ES systems discharge also reduced the peak at 11kV feeder level over successive days of high winter demand periods. • Manufacturer set-points of 50kVAr resulted in limited measurable voltage response impact on LV voltage. • ES was found to increase losses in aggregate (considering both feeder I^2R losses, and ES system losses). • Frequency response was demonstrated for both above and below 50Hz. • PQ was improved at one site (highly circumstantial relating to the specific disturbing load, and the sizes of inductors and capacitors within the ES system), though not at the other more representative monitored site. Further discussion and points of learning are presented in the technique detailed report which can be found here: • http://www.westernpowerinnovation.co.uk/Document-library/2015/Project-FALCON-Engineering-Trials-Batteries.aspx

Table 2 Learning categories and commentary

3. Details of work carried out

FALCON was a complex programme of work, separated out into a series of workstreams. The methods used for each workstream are summarised within Table 3 below:

Workstream	Scope	Activities Summary
Engineering Trials- T1	• DAR 11kV overhead lines – three sections of OHL • DAR 33/11kV transformers – two transformers at a Primary substation site • DAR 11kV/400V transformers – 16 transformers over a range of indoor and outdoor substations; with a range of capacities, build dates and physical sizes • DAR 33kV & 11kV cables – three sections of cable, two at 33kV and one at 11kV. • Utilisation of project installed trial communications network – see Telco's section below	• Installation of: thermal modelling input sensors; online DAR relays; thermal modelling output measurement sensors; and common data capture and storage infrastructure • Development of offline thermal models and identification of parameters for thermal models • Operation of thermal models (using collected data), comparison to key measured output parameters, and tuning of thermal models • Operation of plant to test thermal models • Collection of forecast environmental data, development of forward DAR estimates (based on forecast data) • Benefit analysis and reporting
Engineering Trials- T2	• Assessment of network performance impacts of alternative normal open point locations on two sections of 11kV network, exemplifying suburban/commercial and industrial underground network, and rural overhead network.	• Network modelling for power flow analysis of two sections of 11kV networks (section 1 - 137 buses and 143 branches, section 2 - 266 buses and 269 branches) • Development of algorithms to identify alternative normal open points • Use of algorithms to identify alternative normal open points, and anticipated network performance impacts • Installation of remote control to facilitate changes to network open points • Operation of 11kV network with alternative normal open point locations • Benefit analysis and reporting
Engineering Trials- T3	• Assessment of network performance impacts of meshed/closed normal open point operation of radial designed network	• Installation of additional circuit breakers and protection relays to two example 11kV circuits ("simple" and "complex" mesh examples) • Testing of project installed trial

Workstream	Scope	Activities Summary
	• Utilisation of project installed trial communications network – see Telco's section below	communications network capability to transmit protection signalling • Installation of power measurement equipment • Operation of network in mesh configuration • Benefit analysis and reporting
Engineering Trials- T4	• Assessment of network performance impact from the operation of five 50kW/100kWh battery energy storage units, located at five separate locations on the same 11kV feeder. • Utilisation of project installed trial communications network – see Telco's section below	• Identification of suitable sites for the installation of LV connected battery energy storage facilities • Installation and commissioning of five 50KW/100kWh battery energy storage sites • Operation of energy storage facilities, both as individual operating sites, and as combined operating facilities to investigate network performance impact. • Data collation, benefit analysis and reporting
Commercial Trials	• Undertake end to end trial of Commercial techniques	• Produce financially justified propositions in order that they could be compared with conventional and alternative techniques. • Recruitment of participants both directly and indirectly by inclusion of UKs Aggregator industry. • The development of the frameworks to support commercial trials, including contracts, systems and interfaces within the business to enable the effective trialling of the commercial techniques within Milton Keynes.
Scenario Investment Model	• Development of new network modelling tool for the 11kV network. • The SIM is really innovative in that it models out to a much longer time horizon and models the application of smart techniques by applying "patches" to a nodal network model. • The patches are generated using algorithms to act as a virtual network planner.	• The design, build and test of the Scenario Investment model, including building the algorithms and models to support the analysis of each technique used.

Workstream	Scope	Activities Summary
	• While data intensive, this is a more realistic way to model the impact of smart techniques on the network. • The optimisation process within the SIM harness focusses the simulation on options likely to provide value for money. • The workstream included the design, build, test and running of the SIM and the analysis of the results.	
Load Estimation	• The development of the Energy Model was preceded by some analysis of the Milton Keynes area to determine hotspots. • Comparisons were made with other estimation methods. • The work undertaken is summarised in the Load Estimation final report.	• The design, build and test of a new Energy Model and the analysis of data collected from the LV trials sites in order to compare and contrast current and new forms of energy modelling.
Telco's	• Design and development, build , test and management of new WiMAX telco's network in order to retrieve data for Load Estimation workstream and the SIM(data was required to be analysed and then inform the algorithms within the SIM to improve performance).	• The design, build, test and trialling of a new WiMAX telco's network to enable effective communications from the engineering and LV Monitoring sites back to data collection facilities within WPD.
Knowledge Capture and Dissemination	• Construct robust framework to ensure the robust collection of knowledge throughout the lifeycle of the project. • Ensure dissemination in line with agreed communications plan	• Provide the framework and tools for knowledge capture within the project team. Key tool was a master spreadsheet of all knowledge and this was compiled from interviews with stakeholders.

Table 3: Workstreams, their scope and activities

4. Outcomes of the Project

The outcomes of the project are detailed below in Table 4 by workstream

Workstream	Outcomes
Engineering Trials – T1	Dynamic Asset Rating of 11kV overhead lines (OHL), 33/11kV transformers, 11kV/400V transformers and 33kV and 11kV cables sections were undertaken. For all the asset types (OHL, cables, and transformers) periods of time were found where the real-time dynamic ratings were above the applicable static rating, and there were periods when the dynamic ratings were below static ratings. For example, for a trialled 11kV OHL, all months except September saw the mean dynamic rating for the month being greater than the applicable static rating; however, the minimum real time values were lower than the static rating for the majority of months. In addition, extensions to the technique were developed in the area of estimating likely future dynamic ratings (based on forecast weather). Recommendations based on this technique are: • Widespread application of 11kV OHL DAR is not recommended due to high variability, difficult to rely on in real-time, and complexity of widespread application • Primary Transformer DAR should be further considered as a method of delaying and potentially avoiding reinforcement. This could be progressed by further trials with transformers that are approaching operational limits. • Widespread application of Distribution transformer DAR is not recommended due to the likely requirement for bespoke transformer modelling Further work is required on developing operational methods of assessing whole feeders (made up of numerous cable types, and lay arrangements) before widespread application could be considered. Selective application to circuits approaching thermal limits is recommended as the approach to any follow-on work
Engineering Trials – T2	Automatic load transfer trials on two portions of networks (one characterised as rural with predominately OHL, and one as urban with cables) suggested that this technique may be able to remove capacity constraints, though this is dependent on specific network circumstances. Of more immediate benefit, the technique trials suggest a potential widespread reduction in network losses may be possible through a one-off review of normal open point locations. Recommendations based on this technique are: • FALCON NOP positions are considered for adoption on the trial network, subject to review and mitigation of customer number changes. • ALT appears to offer potential to reduce losses through a one-off/occasional re-assessment of NOP position across the network. Further work would be required to complete specification of cross-network data requirements, and consolidate modelling algorithms for

Workstream	Outcomes
	bulk network assessment purposes for example, the trade-off between losses and network security (CI/CMLs). It is recommended that the potential of such an exercise is further considered. • ALT also appears to offer potential to optimise a network that is approaching thermal limits. It is recommended that a candidate portion of network could be assessed using this technique to trial actual solution provision, where network is currently approaching/is at limits.
Engineering Trials – T3	The mesh implementation and trialling under FALCON was restricted to simpler configurations due to new learning from the FALCON Telecoms Workstream which showed that the speed of telecoms signalling can be a limiting factor for complex mesh deployment. Consequently the commissioning and testing scope consisted of a two feeder mesh with two zones of protection. The completed testing showed that meshing does not necessarily tend to equalise load across feeders, because current re-distribution is a function of feeder impedance and load location. For the trial circuit, no improvement in useful capacity headroom was achieved. However, the potential to affect this key issue is predictable and network specific. Recommendations based on this technique are: • The development of techniques to identify network that might benefit from the mesh technique is required. • the installed infrastructure is retained in a mothballed condition to provide a test environment for any continuing work on high-speed performance of the FALCON communications network.
Engineering Trials – T4	The energy storage trial installed systems at five Distribution substation locations on one 11kV feeder, and provided valuable learning on site selection and installation challenges. Operational performance demonstrated: effective peak-shaving at both individual substation and feeder level; limited voltage management through reactive power output; and the potential to satisfactorily react to grid frequency (one example of an ancillary service). The trial provided valuable insight into the operational capabilities of such devices, and their wider impact on the network. Recommendations based on this technique are: • Clear and detailed discussions with the manufacturer on proprietary data (both for access and dissemination) is recommended prior to purchase - good availability of technical performance parameters (including battery state of charge) and data logging from the battery management system are key on demonstration and research projects • Historic costs don't justify DNO-only implementation for relief of distribution network thermal constraints • Technology and cost tracking should be undertaken, particularly around the potential for connected customer applications.
Commercial Trials	The viability of Demand Side services has been proven to be possible. There is

Workstream	Outcomes
	still some work to do and in particular around market structure, but overall the outcomes from FALCON in this workstream have proven the viability of using demand side services on a commercial footing where acceptable reliability can be achieved. WPD acknowledges that there is a general principal that can be applied that DSR participants will be connected at a voltage level lower than the assets or constraints that they are seeking to manage.
Scenario Investment Model	We designed and built a functioning Scenario Investment Model and a modified version of this model is likely to form part of our strategic planning tool set into the future.
Load Estimation	We designed and refined a functioning Energy Model that was able to produce the required data for the Scenario Investment Model. The output from the model was validated using data from substations with monitoring equipment installed.
Telco's	We designed, built and provided a new WiMAX network that had a reasonably reliably level throughout the project. The network covered a significant geographic area with c.200 operational sites.
Knowledge Capture and Dissemination	We captured some 640 pieces of knowledge throughout FALCON, presented at numerous events and published many papers and reports. Links to all documents and presentations are contained with Sections 13 & 15.

Table 4: Workstreams and outcomes

5. Performance compared to the original Project aims, objectives & SDRCs

FALCON sought to demonstrate how smart techniques could be used to remove constraints on the 11kV network thereby removing barriers that may hinder the uptake of low carbon technologies and therefore the transition to a low carbon future. It intended to address this by firstly using various techniques (engineering and commercial) on the network and then use the results of these trials to inform a new modelling tool that was specifically built to help planners(both operational and strategic).

The project team has achieved its objectives. Not only have the trials been very successful and with ideas for further research but the SIM has provided further evidence that smart techniques do not of themselves offer a silver bullet, they afford the DNO a measure of flexibility as a short term measure to solving system constraints. This is extremely powerful learning and helps WPD(& other DNO's) in planning its network into the future. The engineering trials were a success, the team were able to make this new techniques work in the real world and test them in real situations. In planning for the take up of LCTs FALCON has provided significant insight and data to enable us to plan effectively.

The Telco's workstream was extremely successful with the network broadly 100% available throughout and was the subject of a new bid for funding to explore how telco's network should be designed, built and maintained into the future. WPD will now be looking at other ways to trial and determine the most effective solution for the future.

Furthermore FALCON has offered WPD additional opportunities for further research and the SIM(or a new version of it) will we feel become a fundamental part of strategic planning for future price controls.

Elsewhere within this report we provide the relevant evidence to support achievement of its SDRC's, aims and objectives.

5.1 Objectives

The key objectives of FALCON are detailed in Table 5 below and we have detailed where we believe the project has been successful:

Objective	Status	Status
The Method comprises a Scenario Investment Model (SIM) linked to a network trials area.	We achieved this objective. The SIM has been developed and successfully run many Low Carbon Future Scenario's.	✓
It will trial four technical and two commercial alternatives to traditional reinforcement.	We achieved this objective and the final results were disseminated via a Final Report for each technique and presented on 10th November to the wider stakeholder audience.	✓
The trials area will prove the practically of these techniques.	We achieved this objective. We have significant learning as detailed within the spreadsheet in order that the techniques can, if chosen, be	✓

Objective	Status	Status
	implemented far more readily.	
The SIM will identify network constraints under multiple future network load scenarios and determine the most cost-effective and timely combination of techniques to resolve them.	We achieved this objective. More information on the results can be found in the SIM Final Report a link to which can be found in Section 15.5	✓
The trial area will comprise six primary substations located on a mix of rural and urban networks representative of 90% of the national 11kV network.	This was achieved through the use of Milton Keynes, which was a mix of urban and rural networks.	✓
The objectives of FALCON are closely aligned with those of the UK Low Carbon Transition Plan and ED1.	We met this objective and moreover were able to run the SIM to inform an ED1 plan for the trials area. The results of this are within the SIM Final Report.	✓
In addition to enabling the uptake of low carbon technologies, FALCON will deliver faster and cheaper 11kV connections and reduced DUoS charge increases for all.	The trial techniques have resulted in disseminated learning that show a range of potentials to facilitate the uptake of low carbon technologies by customers that connect to distribution networks. The technique trials and the results from scenario modelling of the future suggest that whilst some delay in reinforcement work is possible from application of the techniques, conventional reinforcement will still have a major role in the provision of networks of the future.	✓
It will generate learning applicable to all DNOs, shared through established LCNF dissemination channels.	Objective met- FALCON has a wealth of valuable knowledge and learning that we are sharing with stakeholders and have been throughout.	✓
In addition to a net financial benefit of £1.2m from the four year project, we estimate that a national rollout of FALCON will realise a £660m financial benefit over 20 years and will	Objective met by virtue of the demonstration through the SIM that the techniques demonstrated appear to show a 20% reduction in cost on average when compared to conventional reinforcement. FALCON delivered as planned and provides a good foundation for further work in	✓

Objective	Status	Status
save over 680 ktonnes of CO_2 by 2050 (accounting for an additional £36m of benefits).	this area.	

Table 5: Objectives and achievement status

5.2 SDRCs

The following is a list of all the phases and their SDRCs.

5.2.1 Mobilisation Phase

The key deliverables for mobilisation were:

Task	Evidence	Due by Date
Commercial agreements in place with Logica(subsequently CGI), Cranfield University, University of Bath, Alstom, Cisco and Aston University.	This SDRC did not require a report, only confirmation of compliance. Agreements with the relevant partners were made in time for transition to the design phase on 1st March 2012.	28/02/2012

5.2.2 Design Phase

"The SIM design blueprint was to be completed by September 2012, a prototype visualisation to be developed and shared with the industry."

This was SDRC 1 and the following tasks were completed and evidence is detailed below:

Task	Evidence	Due by Date
Documented SIM design blueprint	The SIM Design Blueprint was shared with the industry and Ofgem and comments received back as appropriate Press release to announce release of the blueprint is contained within Section 13.5.	30/09/2012
Prototype visualisation available for viewing	Visualisations were provided within the blueprint and shared at subsequent events.	30/09/2012
A customer data privacy strategy developed and documented	The data privacy strategy was developed and a link is provided within the appendices	30/09/2012

Data resilience and back up methods developed and documented	The data resilience and back up methods was developed and can be provided upon request	30/09/2012
A draft operations manual developed	Developed and updated on completion of the SIM	30/09/2012
A comprehensive communications plan detailing knowledge dissemination roles and responsibilities and activities will be complete.	Developed and can be shared upon request.	30/09/2012
A specific workshop will be held with other DNOs and LCNF project partners to share the output of the final trials design.	Two events were held, one in July to share initial thoughts about trials design and the SIM/Load Estimation approach and gain feedback from stakeholders. A subsequent event was held in December to share with other DNOs our approach to knowledge capture. The trials design was also shared via a report.	30/09/2012
A FALCON website, e-newsletter and podcast established	Achieved. WPD Innovation website and lowcarbonuk.com website used throughout. Newsletters used throughout the project and other media.	30/09/2012

"In addition an initial report on the effectiveness of using estimates as an alternative to physical substation monitoring was to be written by September 2012.

New profile curves will be created and, [using an early version of the SIM], these curves will be compared with real data from the telemetry equipment already installed as part of the LV Network Templates project. "

This was SDRC 2 and the following tasks were completed and evidence is detailed below:

Task	Evidence	Due by Date
Data access agreements will be in place with required processes approved for use by ELEXON by 31st March 2012.	Achieved, this can be provided upon request subject to confidentiality.	31/03/2012
New customer groups will be defined and estimated demand profile curves developed.	Achieved this was achieved as part of the Hot Spot Map SDRC 3	19/09/2012

A dataset from the LV Network Templates Project data will be chosen, (based on the new customer groups) to validate the estimated demand profile curves.	Achieved this was achieved as part of the Hot Spot Map SDRC 3	28/09/2012

5.2.3 Build Phase

"An interim report containing analysis results i.e. the applicability of calculated data vs. measured data, including analysis of error margins and model data validity across network types and time variations will be shared in October 2012. "

This was SDRC 3 and the following tasks were completed and evidence is detailed below:

Task	Evidence	Due Date
An interim report containing analysis results i.e. the applicability of calculated data vs. measured data, including analysis of error margins and model data validity across network types and time variations	Achieved- this was achieved as part of the Hot Spot Map SDRC 3	31/10/2012
In October 2012,a specific workshop will be held with other DNOs and LCNF project partners to share the initial identified 11kV 'hotspots' from the data obtained from the LV Network Templates project.	Achieved- we disseminated a report on the analysis of the hotspots. We did this as part of our participation in the annual LCNF Conference.	30/10/2012
Estimated demand profile curves will be applied to the trial area in order to refine the SIM.	Achieved- as part of the refinement of the SIM and subsequent Webinar.	27/09/2013

"The SIM built and an updated run will take place to identify network 'hotspots' by September 2013. "

The evidence for this will be demonstrated via for the following deliverables.

Task	Evidence	Due Date
The hardware and software to develop the SIM will have been purchased	Achieved.	30/09/2013
A system design specification will have been developed.	Achieved- this forms part of the final deliverables of the SIM and will be available upon request.	30/09/2013
A system test plan will have been created	Achieved- this forms part of the final deliverables of the SIM and will be available upon request.	30/09/2013

Task	Evidence	Due Date
The first outputs from the SIM will be available for viewing.	Achieved- this form part of our dissemination activities at the time of completion of SDRC 3.	30/09/2013
The wider learning gained from the Build phase of the project will be disseminated as per the communications plan	Achieved- this form part of our dissemination activities at the time of completion of SDRC 3.	30/09/2013

5.2.4 Trials Implementation Phase

"Load scenarios based on a range of low carbon uptakes in the trials area will be created for use by the SIM by October 2014. "

This was SDRC 4 and the following tasks were completed and evidence is detailed below:

Task	Evidence	Due Date
Real network data will be gathered from the trials and loaded onto the SIM *(via models)* by 19th September 2014.	Achieved – information pertaining to this is available within the SDRC 4 report	19/09/2014
Purchase agreements for specialist datasets will be in place.	Achieved	31/10/2014
At least four future low carbon uptake scenarios will be developed and published. Details of the scenarios and the underlying assumptions will be documented and consulted upon (including other energy network operators, DECC and Ofgem).	Achieved – information pertaining to this is available within the SDRC 4 report	31/10/2014
Design scenarios requirements will be shared, which will be included within the testing specification.	Achieved – information pertaining to this is available within the SDRC 4 report	31/10/2014

"The Engineering Intervention Technique trials 1-4 will be deployed onto the network and the results loaded on the SIM (the outcomes of the trials will be used to modify the model, which feed into the SIM). The results will be analysed and available for dissemination by December 2014. "

This was SDRC 5 and the following tasks were completed and evidence is detailed below:

Task	Evidence	Due Date
The equipment, resourcing and deployment specifications for Intervention Techniques 1-3 will be documented.	Achieved – report published and link is provided within the learning section.	31/12/2014
Functional specification for substation batteries (Intervention	Achieved – report	31/12/2014

Task	Evidence	Due Date
Technique 4- Storage) will have been created.	published and link is provided within the learning section.	
Technical arrangements with battery supplier will be documented and supported by formal commercial agreement.	Achieved, example is provided within report.	31/12/2014
The results of the field testing, loading the results of the trials in the SIM (*via the models in the SIM*), and subsequent analysis will be available and disseminated as detailed in the communications plan.	Achieved - report published and link is provided within the learning section	31/12/2014
A specific workshop will be held to present the analysis of the network data by the SIM.	Achieved- this formed part of the webinar covered in January 2015.	31/12/2014

The Commercial intervention technique trials will be deployed onto the network. The results will be analysed and dissemination by December 2014.

This was SDRC 6 and the following tasks were completed and evidence is detailed below:

Task	Evidence	Due Date
A comprehensive specification document detailing Intervention techniques 5 and 6 will be produced i.e. components and locations of each of the trials.	Achieved – report published and link is provided within the learning section.	31/12/2014
Use cases detailing the learning requirements and outputs from the implementation of the two commercial trials.	Achieved – report published and link is provided within the learning section.	31/12/2014
Commercial agreements with customers will be signed.	Achieved, example is provided within the Commercial trials report .	31/12/2014
The learning obtained from loading the results of the trials in the SIM, *(the results will be modelled in the SIM),* and their subsequent analysis will be available and disseminated as per the communications plan.	Achieved - report published and link is provided within the learning section	31/12/2014
A specific workshop will be held to present the analysis of the network data by the SIM and the outputs of the trials.	Achieved- a webinar was held on 19th January to share our findings.	31/12/2014

5.2.5 Consolidate and Share

"Assess the suitability of the Method for mainstream adoption and produce and optimum investment plan by 30th September 2015. "

This was SDRC 7 and the following tasks were completed and evidence is detailed below:

Task	Evidence	Due Date
Improved industry data will be documented and shared with the industry.	The Final Load Estimation Report and its previous workstream deliverables cover this deliverable	30/09/2015
An investment plan will be developed and operational manuals for each intervention technique will be developed and available for dissemination.	The final SIM Report covers this deliverable	30/09/2015
A final report consolidating the learning and the recommendations from the SIM will be developed and available for dissemination.	The final SIM Report covers this deliverable	30/09/2015
Workshops will take place with other DNOs and Government to explore how the SIM can inform network investment and policy (Milestone DE5)	The final event occurred on 10th November to disseminate learning and gain industry feedback.	30/09/2015
A final report on the effectiveness of using estimates as an alternative to physical substation monitoring and consolidating all the learning from the project will be produced. This will include recommendations for follow on projects, if appropriate and lessons learnt from each phase of the project by 30th September 2015 (Milestone DE6)	The FALCON Final Report covers this element of the deliverable.	30/09/2015

6. Required modifications to the planned approach during the course of the project

The delivery methodology at the outset was envisaged as a traditional waterfall one with a series of contiguous phases. At the time of writing the bid this was deemed a deliverable and viable plan and was agreed by all parties. The partners were taken through this plan at the kick off meeting in January 2012. Whilst it was always a challenging plan, it was deemed by all to be deliverable.

The plan contained within the FSP was as follows:

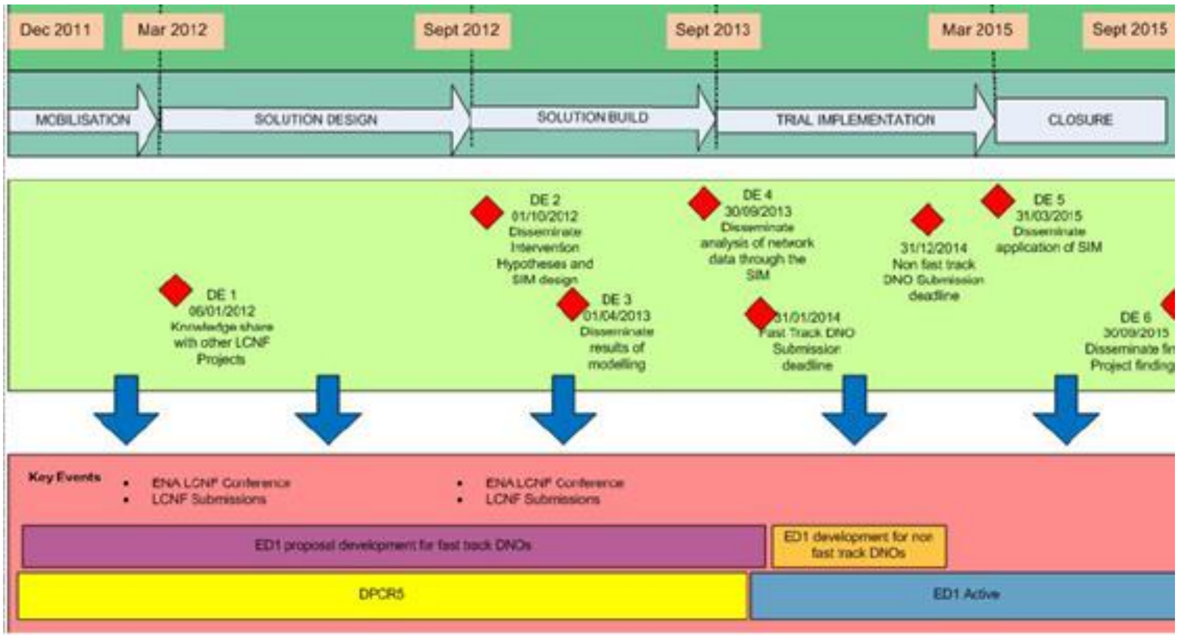

Fig 2- Plan detailed within the FSP

As can be seen from Fig 2, FALCON was a complex programme of work and therefore it is not surprising that adjustments had to be made as we progressed through the project lifecycle. The build work did take longer than envisaged and this necessitated a change to a more "agile" delivery, with work being delivered in parallel with other related work in the later phases.

As mentioned previously in other reports the planning at the outset we feel in hindsight was done at too a low a level and this made maintaining the plan harder, so we moved to a high level plan with each workstream using either their own sub plans or task lists. This we feel really improved the communication within the team as the detail remained with the workstream and therefore interactions tended to move "up a level" when we came together. This did not have any detrimental effect on the delivery and deliverables.

We also applied the agile approach to the delivery of the SIM as this workstream had many dependent workstreams- this though worked well as it allowed the project team to be involved more readily with early versions of the SIM and undertake some "use" of the system earlier.

Fig 3 below shows the adjusted final phases, this was an approach agreed within the Project Team at the time and reflects the fact that build for some elements of the trials took longer than envisaged(albeit some trials started on time for data collection purposes):

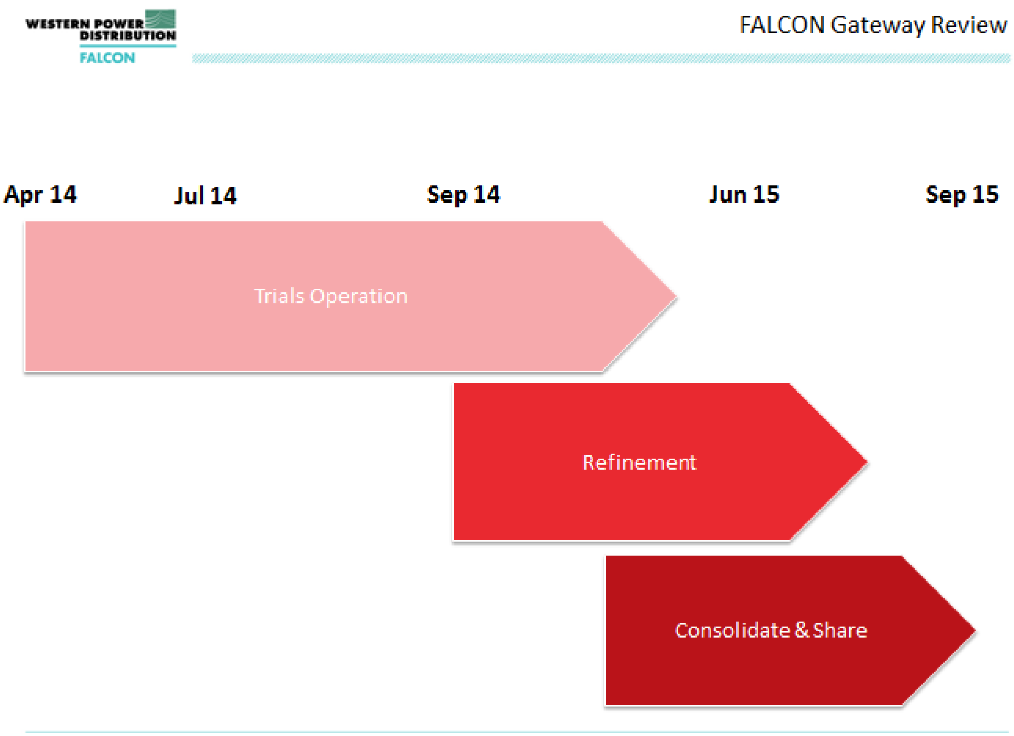

Fig 3- Simplified high level plan presented to the PRG

Overall the modifications we made were not significant and we feel were pragmatic ones based on real life operation of the project. The learnings from FALCON though have and continue to influence what we do in subsequent projects.

There were three formal change requests approved by Ofgem as follows:

1. Changes to wording of some of the SDRCs
2. Changes to reflect delivery of knowledge
3. Budget changes

The budget change request is discussed in more detail within Section 7, and all change approvals are provided as links within Section 15.1.

No other changes to the method of delivery were made throughout the lifecycle of the project.

7. Significant variances in expected costs

FALCON came in under budget; the budget was amended in 2015 to reflect the actual spend profile rather than the one within the original bid submission. This was needed because the original budget was not categorised at the level of detail required to furnish the SIM with accurate costing detail for the evaluation of each technique. It also contained a couple of areas where we believe some of the anticipated costs were erroneously placed. This didn't impact on the overall expected spend, just the presentation of it. This was all reflected within the change request. This has been a key learning for WPD and has meant a change in approach to costings and frameworks in future bids and projects.

The subsequent change request is contained within Appendix D, along with a copy of Ofgem's approval of the change.

The final spend is detailed within Table 5, with Table 6 containing any accompanying notes against significant cost variances:

CATEGORY	DESCRIPTION	BUDGET	ACTUAL	VARIANCE	VARIANCE %	NOTE
Labour		**1,601**	**1,472**	**129**	**-8%**	
	Technique 1 - Site Works	35	23	12	-34%	1
	Technique 2 - Site Works	135	123	11	-8%	
	Technique 3 - Site Works	219	210	9	-4%	
	Technique 4 - Site Works	86	75	11	-12%	2
	LV Monitoring - Site Works	95	87	8	-8%	
	WPD Project Management & Design Team	1,032	954	78	-8%	
Equipment		**1,900**	**1,900**	**-**	**0%**	
	T1 - Dynamic Asset Relays, Enclosures & Sensors	182	182	-	0%	
	T2 - Phasor Measurement Units, GPS, Enclosures	89	89	-	0%	
	T2 - WiMax & CT Mods	15	15	-	0%	
	T2 - Switchgear	146	146	-	0%	
	T3 - Protection relays	256	256	-	0%	
	T3 - Switchgear	184	184	-	0%	
	T4 - Battery Storage Devices x 5	786	786	-	0%	
	LV Monitoring - Installation Materials	242	242	-	0%	
Contractors		**6,640**	**6,286**	**354**	**-5%**	
	T1 - Site Works	9	6	3	-34%	3
	T1 - Design Support	106	75	31	-30%	3
	T1 - Academic Support	51	50	1	-1%	
	T2 - Site Works	34	31	3	-8%	
	T2 - Design Support	106	75	31	-30%	3
	T2 - Academic Support	51	50	1	-1%	
	T3 - Site Works	55	52	2	-4%	
	T3 - Design Support	106	75	31	-30%	3
	T3 - Academic Support	51	52	1	3%	
	T4 - Site Works	22	19	3	-12%	3
	T4 - Academic Support	51	50	1	-2%	
	LV Monitoring - Site Works	24	22	2	-8%	
	Telecoms - Planning & Design	901	891	10	-1%	

CATEGORY	DESCRIPTION	BUDGET	ACTUAL	VARIANCE	VARIANCE %	NOTE
	SIM - Design, build and support	1,104	1,104	1	0%	
	SIM - Academic Support	160	149	10	-6%	
	Techniques 5&6 - Design & Develop	288	238	50	-17%	4
	Techniques 5&6 - Attitudinal Surveys	30	30	-	0%	
	Load Estimation - Design & Develop models	950	950	-	0%	
	Logica Project Management & Design Team	1,448	1,450	2	0%	
	WPD Design & Build Team	701	541	161	-23%	5
	Bath Uni - Knowledge Capture & Dissemination	395	378	16	-4%	
IT		**3,073**	**2,982**	**91**	**-3%**	
	Telecommunications Equipment	891	891	-	0%	
	Telecommunications Installation Services	309	304	5	-2%	
	Telecommunications IT software & licenses	239	219	20	-8%	
	Telecoms Engineers	86	81	5	-6%	
	Telecoms Planning & Design	164	164	-	0%	
	Trials Data - Distribution Management System	1,032	1,032	-	0%	
	Trials Data - Ihost integration	15	15	-	0%	
	SIM - Network Modelling tool	166	164	2	-1%	
	SIM - IT equipment	20	19	1	-5%	
	Techniques 5&6 - Billing System	54	54	-	0%	
	WPD IT	97	40	57	-59%	6
Travel & Expenses		**2**	**2**	**-**	**0%**	
	Technique 1	0.3	0.3	-	0%	
	Technique 2	0.3	0.3	-	0%	
	Technique 3	0.3	0.3	-	0%	
	Technique 4	0.3	0.3	-	0%	
	SIM	0.5	0.5	-	0%	
Payments to Users		**240**	**302**	**62**	**-26%**	**7**
Other		**668**	**619**	**49**	**-7%**	
Contingency		-	-	-	**0%**	
		14,123	**13,562**	**561**	**-4%**	

Table 5: Final costs for FALCON delivery

Note	Description
1	Reduced cost due to use of contractors
2	Reduced cost due to use of contractors
3	Contractors costs less than originally envisaged
4	Design costs less than estimate
5	Contractors filled some roles where WPD could not due to availability of staff
6	Less expenditure due to use of other solutions that didn't require internal IT resources
7	Payments to users were lower than expected due to lack of reliability and also due to lack of take up on Technique 5 despite increased incentive in season 2

Table 6: Notes to costing variances

8. Updated business case and lessons learnt for the Method

The FSP detailed a number of potential benefits that FALCON sought to validate and exploit as part of the overall business case. These are detailed below along with the outcome:

Area	Benefit	Outcome
Customer	All customers will benefit from lower than predicted DUoS charges as a result of the use of alternatives to conventional reinforcement. Similarly, better visibility of the 11kV network will provide the DNO with more insight into power quality across the network, enabling them to target areas of poor quality of supply. Additionally, those customers served by meshed networks or networks to which automated load transfer has been applied are likely to experience reduced customer interruptions (CI and customer minutes lost, CML).	The SIM has been able to show which networks have the most and least capacity in the area and the optimum mix of smart and traditional reinforcement for several different scenarios. While traditional reinforcement is still the main method used to resolve network issues, where other techniques are used this provides better value for money. In some cases the smart technique delays the need for traditional reinforcement rather than removing it altogether, however this is still beneficial as it reduces the risk of stranded assets. SIM results show that where smart techniques are used in conjunction with traditional reinforcement the investment costs are reduced compared to analysis where only traditional reinforcement is used. This saving varies significantly between primaries but is in the order of 20% An overall reduction in CML and CI is seen where meshed networks are applied. Automatic Load Transfer would improve CMLs and CIs if implemented
Customer	11kV-connected customers with controllable load and/or generation: the project will explore the best way of working with these customers to utilise their flexibility in load/generation to help support the distribution grid. In return, participating customers will receive agreed availability and/or utilisation payments - essentially opening a new revenue stream to customers.	Customers that took part in the demand response trials received relevant payments.

Area	Benefit	Outcome
Customer	New customers wishing to connect to the 11kV network will also benefit from the project if their connection would normally trigger reinforcement of the 11kV network which could be avoided by employing one or more smart intervention techniques. For these customers, connection will be quicker and/or cheaper. This also applies to new LV customers if their connection triggers 11kV reinforcement.	This is a longer term objective relating to the adoption of smart techniques for speedier, cheaper connections. New connections will benefit in the future as a result of FALCON
DNO	Commercial service procurement: the project will inform best practice in identifying and engaging with customers offering flexible demand and/or generation.	This objective was met, with WPD playing a major role in the community as well as in industry around DSR through the shared services group
DNO	Operations: the project will generate practical experience relating to business-as-usual operation of smart technical and commercial intervention techniques (e.g. automated load transfer, storage, dynamic asset rating, engagement with customers offering flexible demand and/or generation etc.).	Throughout FALCON we have shared with stakeholders the learning from the trials and regard this as a very successful element of the project.
DNO	Technical: the project will impart technical learning regarding the practicalities and effectiveness of individual technical intervention techniques.	The closing event of FALCON enabled us to share considerable insights into the techniques and the final reports show also the value that other DNOs can gain from FALCON
DNO	Telecommunications: the project will evaluate the security of the infrastructure required for future networks.	This was also a very successful part of the project and we intend to develop further the learning from FALCON.
DNO	Data: We will trial the use of aggregated customer profiles based on existing settlement data, aggregated customer profiles based on new customer profiles, use of smart metering data and metering at secondary substation/LV feeder. These will be validated against real network data. We envisage this learning directly impacting DNOs' substation metering deployment strategies.	Settlement data was used to estimate load at substations as was data from half hourly metered customers. Rather than developing a set of new customer profiles the Energy Model allows for a number of customer parameters to be set which gives a greater level of flexibility. Estimates were validated against monitoring data. It was shown that it is difficult to categorise substations in terms of their likely error and therefore the DNOs data gathering strategies are

Area	Benefit	Outcome
		likely to be bespoke according to the purpose for monitoring.
DNO	Asset management: We will provide more information on asset usage. Some will be used operationally to provide additional capacity on the network (i.e. dynamic asset rating). However, the additional power flow and voltage information generated by the SIM will provide a new insight into asset usage on an area of the network which has traditionally suffered from a lack of information. This will enable smarter asset management.	The SIM calculated metrics for network utilisation. The degree of investment required at different primaries was also a key indicator of existing network capacity.
Environmental	To obtain a conservative estimate of the carbon benefit of reduced reinforcement we performed a carbon study of the potential CO2 emissions savings enabled by a national rollout of the FALCON Method based on the Ofgem LENS `Big Transmission and Distribution' scenario. A number of assumptions were made. Firstly, only overhead lines and underground cables were considered. Then, the SIM was considered applicable across 90% of the network, and gross savings of 40% could be obtained. Other constraints (practicality, operational etc.) are thought likely to reduce this by 10%. Thus overall savings of 32% of the carbon cost of reinforcement on lines and cables have been estimated as the potential for a total CO2 saving of 680 ktonnes from a GB wide rollout of our method.	FALCON, through the SIM, proved that there is the potential for savings by using other methods. Further work in this area is currently under discussion.
Environmental	These savings do not include the carbon savings that will be lost as a result of delays in the uptake of low carbon technologies attributable to 11kV constraints (i.e. customers unable to install heat pumps, charge electric vehicles at home etc. until 11kV reinforcement is complete). Without visibility of the current state of the 11kV network (an output from FALCON), it is difficult to quantify the associated carbon savings but they are expected to be significantly higher than the direct project carbon savings.	FALCON, through the SIM, proved that there is the potential for savings by using other methods. Further work in this area is currently under discussion.

Area	Benefit	Outcome
Environmental	Line losses on the 11kV network have been taken as 0.67% of total demand, in line with the figures from "TDP/CN 16 2008: Loss Calculations for Central Networks, September 2008". Savings from reduced line losses arising from the implementation of meshed networks has been estimated to be 40% where this technique can be used. We estimate that meshed networks will give this level of savings across 5% of the network, giving an overall estimate for reduction in line losses of 2%.	The SIM analysis confirmed some reduction in losses when meshed networks were applied. One key output from the analysis around Automatic Load Transfer is that a relocation of normal open points is likely to have a greater contribution to reducing losses than the operation of ALT itself.
Industrial	This project will enable equipment suppliers to understand the DNO needs and business drivers of the low carbon environment. They can incorporate this knowledge into their business cases and product development plans.	We have provided significant information to suppliers on the project about their equipment and have extensively engaged the wider stakeholders to ensure that our findings are widely disseminated for the benefit of suppliers and DNOs alike.
Financial	The business case for the Project has a range of benefits depending, on the degree of 11kV network reinforcement that will be required under future demand scenarios.	FALCON, through the SIM, proved that there is the potential for savings by using other methods. Further work in this area is currently under discussion.
Financial	Current and historic 11kV reinforcements are unlikely to be representative of future 11kV investment requirements. The recent joint ENA/ICL paper ("Benefits of Advanced Smart Metering for Demand Response based Control of Distribution Networks - Summary Report", version 2.0, April 2010, ENA/ICL) suggested future demand will result in a reversal of conventional reinforcement spend from the EHV to the LV network.	FALCON, through the SIM, proved that there is the potential for savings by using other methods. Further work in this area is currently under discussion.
Financial	Current annual spend on reinforcing the 11kV network of £3.7m, (WPD's East Midlands general reinforcement costs for year 1 of DPCR5), is unlikely to warrant the risk of adopting innovative new intervention techniques. LCN funding is, therefore, essential for this work.	Through undertaking the analysis within the SIM it is clear that whilst longer term, reinforcement is a key tool, the short term benefits that can be gained through the intelligent use of the techniques are worth further investigation.
Financial	We estimate that the Project will	FALCON of itself did not deliver

Area	Benefit	Outcome
	deliver a net financial benefit of £1.2m.	financial benefit (since the estimates were based on predicted load growth from EV and HP which hasn't happened yet), but its finding did provide significant evidence that cost savings are possible. We will be able to exploit the findings as load growth does occur in the future. .

Table 7: Benefits in business case and outcomes

9. Lessons learnt for future innovation projects

FALCON was a substantial project and because of this a robust approach across the board was required. This was vital for the knowledge workstream. At the outset learning was categorised into the following categories:

- Customer Engagement
- Project Management, Purchasing and Legal
- Construction Process
- Technology and Equipment
- People and Culture
- IT and Telco's
- Industry processes and Regulations

Any learning from FALCON will clearly also impact on future innovation projects and so the approach taken had to be widely communicated and agreed early so that wherever possible future and ongoing projects could benefit.

There were a number of learnings in the category of Project Management, Purchasing and Legal which we think are of value to the wider DNO community and we intend to discuss these in a little more detail here. We also discuss some thoughts around People and Culture which we referenced at the FALCON Final Dissemination Event on 10th November.

Overall there were well over 600 individual learning points captured throughout FALCON. Of course most are within the technical categories and therefore don't necessarily impact on future management of innovation projects.

9.1 Project Management, Purchasing and Legal Learnings

Firstly, the management of programmes of this scale with the level of uncertainty that research projects have at the outset is complex and the use of "task lists" with an accompanying high level plan we found a more pragmatic way of managing things. Maintaining a detailed plan was far too time consuming and as such we now believe that we have a more robust method for managing large projects in a way that allows the workstreams to function effectively whilst maintaining the required level of control. We found it impractical to micro manage each workstream with what became unnecessary admin- the approach evolved through trial and error, but we feel that this worked well given the complexity of the delivery

Secondly, we do believe that partner agreements which are collaborative are not necessarily the way forward- whilst collaboration is the underlying purpose of these projects you do need certainty at the outset and having a standard set of terms and conditions with liabilities in the event of underperformance is far more valuable. We have applied this approach to subsequent projects and found it to work well.

Thirdly, if you do use standard sets of conditions this does make the management of everyone involved easier as they are contracting in the same way. This also cuts down on the use of legal expertise as well. For future projects we are moving to far more standard contracts in order to reduce risk, increase certainty and reduce management costs.

Finally, as mentioned previously within this report we also feel that some learnings have been gained around the presentation of project costs at the outset. With the FALCON budget we feel in hindsight that it was at too high a level. However, the fact that the overall costings of the project were accurate is comforting. We have some thoughts around budgets for these projects that form part of the detailed knowledge Section and associated appendices.

9.2 People and Culture

Innovation should be at the heart of what we as an industry do. The LCNF and more latterly NIC competition have been extremely powerful for the industry, bringing the industry together in the pursuit of new ways of working.

Whilst they have worked well, our view is that more change is required. The industry has been successfully serving customers with reliable energy for many years, but to do this in the future requires a new mindset. FALCON has been extremely powerful for WPD, it has shown us what we are capable of, but more change is required to ensure that the maximum benefit where possible is leveraged from the findings. With this in mind we are currently undergoing an exercise to officially move all of the learning into business as usual wherever possible and practical to do so. This we think is not only a must but also ensures that the learnings from this project and its successors bring real change in our company and by disseminating the learning widely that it will help all stakeholders.

10. Project Replication

In order for DNO's to replicate all or parts of the FALCON project they should reference the final reports and seek any additional information from WPD directly. We have actively engaged with DNOs around what we have been doing in the past and are more than happy to continue this dialogue. To publish a list of all of the components would, we feel, not be practical within this summary report, the final reports though provide significant background and detail in order for the reader to be able to replicate what was trialled.

The links to the final reports for each workstream are provided within Section 15.5. As far as was possible all the relevant design documentation is provided within those reports. Any additional documentation that may be required can be provided upon request.

Most of the IPR generated by FALCON fell into two categories, background, or existing IPR and new Foreground IPR. The newly generated IPR is predominantly around the SIM and all documentation pertaining to it can be provided by WPD should a DNO wish to use it.

A number of the engineering techniques trialled in this project have also now been tested by a number of other DNOs. It is therefore recommended that learning around these techniques should be pooled, and a combined proposal for any further deployments be developed cooperatively that leverages the range of learning for the different implementations.

An example of this is in the area of primary transformer dynamic asset rating (real time thermal rating). Work in this area has been undertaken by WPD, SP Energy Networks, Northern Power Grid, and by UKPN. Similarly DAR work has also been undertaken on overhead lines and cables.

As mentioned previously, the results from FALCON suggest that there are only short term benefits from the use of the trials over conventional reinforcement. Our current analysis suggests a figure of a 20% reduction in cost on average when compared to conventional reinforcement of course these numbers are predicated on a number assumptions about load growth and more work on this is under discussion. As stated previously we believe that FALCON delivered as planned in this area and provides a good foundation for further work in this area. Over the longer term the analysis suggests that reinforcement will prove more cost effective in most instances. Within the SIM final report we detail future works that we think would be of benefit to test this initial analysis further.

11. Planned Implementation

11.1 Modifications to Distribution System

The method for FALCON was clearly a series of very complex things, including new engineering, new IT, new telecommunications and perhaps just as importantly, new learning. We are currently in the process of discussing with the business how the learning from FALCON can be implemented, where appropriate. Of course, this is a substantial exercise given the volume of learning (the list of all learning is provided within Section 15.2). It is our intention that wherever possible we will take all learning into the business- this is evidenced by those changes in policy that we have identified throughout the lifecycle of FALCON.

Once these work is completed we will have a list of modifications to the business, and if appropriate the Distribution System, that can be implemented.

At this stage it is difficult to say whether any of the outputs from FALCON will result in large scale deployments. There are a number of key areas where we believe there to be some benefit to wider use and these are as follows:

Workstream	Potential roll out opportunities
Telecoms	We believe that subject to further research that the learnings from FALCON will result in a change in telecoms across the business. We are currently looking at a focused project to further explore what options DNOs should be looking at for the future.
Commercial Trials	The results of the trials were encouraging and with proactive work in industry and changes within the business, we foresee significant change in WPD to facilitate the use of DSR through a series of focused projects.
Load Estimation	The work undertaken on FALCON has reinforced the need for the business to take stock of what our data requirements will be in the future and we are exploring currently how we exploit fully the opportunities we see through more intelligent use of the data we have and how we might improve performance throughout the business. In addition there is a new project in development around load estimation.
Engineering trials	We currently believe that the industry has some work to do collectively on the use of techniques. Cost is major factor when considering how to service the customer requirement whilst doing it in a way that maintains security of supply and cost effectively. Currently we believe that the cost element of this equation is not viable, but we are happy to share our thoughts and

Workstream	Potential roll out opportunities
	reflections with other DNO's as part of a wider discussion. We are currently looking into the Use of storage, active management of Distributed Generation and Demand.

Table 8: Potential roll out opportunities

11.2 Planned Future Implementation

For each workstream we discuss below the current status in terms of planned future implementation in more detail:

11.2.1 Engineering Techniques

As it currently stands we are unlikely to implement the engineering techniques into business as usual as alternatives to conventional reinforcement in the form undertaken during the trial, because although they may be used in the future as short to medium term remedies they do not currently appear to represent value for money. We are though happy to discuss with other DNO's in more detail the rationale for our thinking around this.

In order for the technologies and techniques to be more viable we believe that there needs to be more work done to establish other ways of using the technology or finding ways to reduce the overall cost of the technique. As short term remedies they appear to work well, but on longer time horizons the case is weakened. We would like to see more discussion on how the industry can collaborate more on this subject.

In addition we are undertaking the following exploratory projects/analysis:

- Open point review
- Primary transformer DAR- further based on results of FALCON
- Energy storage – Optimisation, regulatory rules and technologies

11.2.2 Commercial Trials

We are currently looking at a number of options to develop the FALCON Commercial Trials in these areas:

- Improved load flow data/telemetry
- Testing load shifting (NIA Project SYNC)
- Coordination with GBSO

11.2.3 Scenario Investment Model

We still see a role for longer term and strategic planning that uses nodal network modelling. We expect this to be reflected in our ED2 submissions. Other DNOs are more than welcome to discuss how they may wish to exploit the SIM as well.

In addition we are undertaking the following actions:

- Planning the development of a full SIM type tool
- Data and connectivity data improvements
- Standards and interfaces
- Energy forecasting and customer insight

11.2.4 Telecommunication Network

The telecommunications network was subject to a NIC bid as we believe more analysis is required to determine the optimal solution for DNOs but we have gained so much knowledge as a direct result of the FALCON project that we do not want to lose it. As our NIC bid for 2015 Telecoms Templates was not awarded funding we are currently reviewing alternative ways of undertaking the required analysis.

In addition we are undertaking the following activities to support the exploitation of FALCON's findings:

- Development of new functional requirements
- Testing of new technologies
- Maintaining the FALCON systems in Milton Keynes for DC and new trials

11.3 Exploiting FALCON's outcomes

There are a number of key areas where we feel FALCON is going to or could be further exploited as follows:

11.3.1 WiMAX/Telecommunications

There is a definite need for a review of how and what communications will be needed by DNO's in the future. FALCON provides clear insight in how to run trials and these sorts of networks into the future. Exploiting the learning from FALCON would be relatively simple as it provides a template for the future. It is our intention to undertake further research into how we can use the learning from FALCON to determine the optimal Telco's model for the future.

11.3.2 Scenario Investment Model

The SIM as envisaged for FALCON served different users with different needs. We believe that the SIM has shown the value in modelling networks to determine short to medium term investments, but that there will be a point where the benefit of nodal modelling reduces due to high level of uncertainty for both the network configuration and the load estimates. More work is required to determine that optimum timeframe. The SIM also requires improvements to how networks are visualised and performance speeds before it would be acceptable for use by planners. There are a number of potential options to be explored to improve performance which includes operating over a cluster of machines, rather than a single machine and using other network modelling tools. Cranfield University are currently examining the potential of PSS®SinCal as an alternative modelling tool. There are plans to developing the Authorised Network Model to include other voltages and to enable import / export of network data in the Common Information Model format.

Implementation of the Energy Model requires sourcing of demographic data at a reduced cost to that paid during the FALCON project. Changes to the functionality would also be required to support individual customer level outputs.

11.3.3 Engineering Trials

We can use the learning from the dynamic asset rating work to understand the impact of loads on the ageing of assets and use this to inform our assumptions on asset health and our asset replacement policies. Similarly we are considering options to improve ventilation for GRP housings to reduce temperatures. We are unlikely to monitor 11kV assets widely but dynamic asset rating systems may be cost effective for higher value assets at higher voltages.

The learning from automatic load transfer suggested that a review of normal open points would be beneficial. We are considering the methods for this optimization which may benefit from optimizing against a set of objectives rather than for losses alone. e.g. losses, CML/CI impact, accessibility for manual switching, etc. Meshed networks remain an option for sharing 11kV network capacity and are supported by the existing modelling tools.

DNO owned storage at 11kV is unlikely to be adopted as business as usual but work continues to investigate storage potential at higher voltages and to create regulatory frameworks that allow for multiple revenue streams to be combined.

11.3.4 Commercial trials

This has been a key area of success for FALCON and building on this success, we are currently running one, possibly two, NIA projects within the WPD area to further develop our thinking and learning in respect of these new services.

We are proposing to take the contracts and customer engagement principles and the back office systems forward into a further NIA to create a demand response/commercial arrangement in an attempt to manage a different type of constraint to that of FALCON. As opposed to targeting high demand periods in winter, we shall apply similar principles but in reverse to manage generation constraints resulting from high density solar installations during the summer.

11.4 Technology Readiness Level

There was a significant technological element to FALCON project- some of the technologies are clearly more “ready” than others, this is particularly true of the engineering technologies that we used- most of which has been well utilised in other innovation projects. We do not therefore feel at this stage that significant work is required on these.

For the telecommunications elements of the project again we feel that the underlying technologies were fairly stable technology wise. The primary action falling out of this work is really to test WIMAX against other technologies to find the most cost effective and efficient solution.

The SIM does require some work, whilst the solution worked and worked well, we feel that without some further work in key areas (e.g.visualisation of networks) that it would not be suitable for more widespread implementation. Further consideration is currently being given to how we progress this important output.

12. Learning Dissemination

Learning has been a fundamental part of the success of FALCON. It has been a very informative exercise for WPD and helped shape how knowledge on innovation projects should be managed in the future.

Throughout FALCON there has been a series of stakeholder events, including the SIM Blueprint consultation, a UKPN Site workshop, and LCNI events for broader consultation. WPD has also been at the forefront of the Shared Services Group on DSR. The SIM Blueprint consultation was extremely fruitful and a document produced detailing all feedback and responses. WPD has deliberately tried to engage throughout FALCON with Stakeholders across as wide a spectrum as possible and this can be seen in the next section where a number of links are provided to relevant slides and documentation.

More detailed information about the process and findings can be found in the final report in this area, a link to which can be found in Section 15.5.

The information sharing mechanisms that have been widely used have been:

- DNO consultation
- Presentations and Events
- Webinars
- Workshops

Some of the specific outcomes have been:

WPD has consulted on the SIM Blueprint with Stakeholders, it has shared extensively throughout the duration of the project it's progress and learnings along the way. As mentioned previously a document was produced detailing all feedback and sent to all respondents.

WPD has undertaken a final presentation on FALCON in which DNOs were invited to provide feedback. In addition the Overall Final Report (not the detailed underlying ones) has been peer reviewed by project partners and feedback taken onboard where appropriate. As part of the final process of sharing, stakeholders have been invited to provide feedback on all parts of the final reporting. All comments are being taken in account and responses provided back to those that have taken the time to comment.

We can confirm that this Close Down Report has been peer reviewed by SP Energy Networks and feedback incorporated accordingly.

In order to provide further transparency about the overall process we have included within Section 15.2 the following documentation on learning:

1. Communications strategy document
2. Learning spreadsheet detailing all learning throughout the project

In addition WPD has taken a proactive role in Demand Side Response on an industry wide basis and in particular as part of the Shared Services Group. Throughout the programme of work the project team has also presented widely on the findings and this is particularly true of the Load Estimation work and DSR.

At the 2015 LCNI Conference in Liverpool we had a FALCON based exhibition and shared knowledge through the events with other DNOs and Stakeholders. This led directly to requests for bilateral events including with National Grid.

We can confirm that we are in discussion with EA Technology about the provision of data for inclusion in the next release of the TRANSFORM Model. The data will be provided to EA Technology in Q1 2016.

13. Key project learning documents

There are a large number of documents that have been published through the lifecycle of FALCON they are grouped as follows:

13.1 White Papers in relation to the Telecoms part of the project

We published a paper on the trade-off between coverage and latency when using networks:

http://westernpowerinnovation.co.uk/Document-library/2013/FALCON-White-Paper-Telecomms-Trade-off-Coverage-La.aspx

We also published a paper on design security for these new telecommunications networks for DNOs

http://westernpowerinnovation.co.uk/Document-library/2013/Designing-Telecommunications-Security-Infrastructu.aspx

13.2 Other publicity

DSR brochure provided to local businesses

http://www.westernpowerinnovation.co.uk/Document-library/2013/wpd_FalconDSR_PublicBrochure-(1).aspx

http://www.westernpowerinnovation.co.uk/Document-library/2013/wpd_FalconDSR_PublicInformation-(1).aspx

13.3 Presentations

July 2012 event at University of Bath

http://www.westernpowerinnovation.co.uk/Document-library/2012/lcnfpresentations.aspx

WPD introduced FALCON's energy storage system design at GE's digital energy summit.

http://westernpowerinnovation.co.uk/Document-library/2013/1-GE-Digital-Energy-Summit-16-05-13.aspx

This presentation was delivered by Western Power Distribution, to delegates at European Utility Week held in Amsterdam in October 2013

http://westernpowerinnovation.co.uk/Document-library/2013/Project-FALCON-Presentation-EUW-13.aspx

This presentation was delivered by WPD at the Project FALCON Commercial Trials Dissemination event held on 19th June 2014.

http://westernpowerinnovation.co.uk/Document-library/2014/DSR-Dissemination-Event-190614-Full-Day.aspx

WPD's Future Networks Team presented the FALCON energy storage solution at the Energy Storage world Forum in London.

http://westernpowerinnovation.co.uk/Document-library/2014/2-Energy-Storage-World-Forum-Energy-Storage-for-Di.aspx

Presentation by WPD in 2014

http://westernpowerinnovation.co.uk/Document-library/2014/3-Balancing-Act-_-Presentation-v1-0.aspx

Presentation at ESOF

http://westernpowerinnovation.co.uk/Document-library/2015/4-ESOF-_-WPD-Presentation-2015_02_24-v1.aspx

Presentation at Utility Week

http://westernpowerinnovation.co.uk/Document-library/2015/Utility-Week-Demand-Side-Response-Presentation.aspx

Smart Energy Analytics 2015

http://westernpowerinnovation.co.uk/Document-library/2015/Smart-Energy-Analytics-2015.aspx

Smart Grid GB event June 2015

http://westernpowerinnovation.co.uk/Document-library/2015/Smart-Grid-GB-9th-June-2015.aspx

Event at the OU with Local Milton Keynes stakeholders:

http://westernpowerinnovation.co.uk/Document-library/2015/Project-FALCON-WPD-220915.aspx

Closedown Event Presentation

http://www.westernpowerinnovation.co.uk/Document-library/2015/FALCON-Close-Down-Event-Presentation-FINAL.aspx

13.4 Webinar

29th January 2015- Network Data Analysis Workshop, this webinar was related to SDRCs 5 & 6

http://www.westernpowerinnovation.co.uk/Document-library/2015/Project-FALCON-January-2015-Webinar.aspx

13.5 SDRCs

The first two SDRCs were published, as appropriate, on the University of Bath's lowcarbonuk website where appropriate as the WPD Innovation website was undergoing a significant refresh and the arrangement at the time with the University required one medium for dissemination.

Links to the old documents are provided for information, but all documents can be provided on request and have been published retrospectively on the WPD Innovation website.

SDRC 1 did not require a formal report as it was at the end of mobilisation and required confirmation only that contracts were in place with the project partners.

All other SDRC links are provided below:

SDRC 2

SIM Design Blueprint

http://www.westernpowerinnovation.co.uk/Document-library/2012/SIMblueprint.aspx

Press release: http://www.westernpowerinnovation.co.uk/News/Design-phase-for-Project-Falcon-successfully-compl.aspx

Data Protection Plan

http://www.westernpowerinnovation.co.uk/Document-library/2014/Falcon-Customer-Data-Protection-Plan-v1-20121213.aspx

Hotspot Map

http://www.westernpowerinnovation.co.uk/Document-library/2012/Hotspot-Map-Initial-Report-FINAL.aspx

SDRC 3

http://www.westernpowerinnovation.co.uk/Document-library/2014/5-Hotspot-Map-SDRC-3-Report-v1.aspx

SDRC 4

http://www.westernpowerinnovation.co.uk/Document-library/2014/SDRC4-Report-October-2014.aspx

http://www.westernpowerinnovation.co.uk/Document-library/2014/FALCON-SDRC-4-Output-Falcon-Scenarios-Report-v2-0.aspx

http://www.westernpowerinnovation.co.uk/Document-library/2014/FALCON-SDRC-4-output-Energy-Model-Comparision-of-E.aspx

SDRC 5

http://www.westernpowerinnovation.co.uk/Document-library/2014/SDRC-Report-Initial-FALCON-trials-learning-Dec-201.aspx

http://www.westernpowerinnovation.co.uk/Document-library/2014/SDRC5-Report-December-2014.aspx

http://www.westernpowerinnovation.co.uk/Document-library/2014/Technique-4-Functional-Spec-v1-issued.aspx

SDRC 6

http://www.westernpowerinnovation.co.uk/Document-library/2014/SDRC6-Report-December-2014.aspx

SDRC 7

http://www.westernpowerinnovation.co.uk/Document-library/2015/Project-FALCON-SDRC-Report.aspx

13.6 Project Progress Reports

All project progress reports are provided as links below:

http://westernpowerinnovation.co.uk/Document-library/2013/WPD-PPR-Project-FALCON-December-2012.aspx

http://westernpowerinnovation.co.uk/Document-library/2013/PPR_WPD_FALCON_MAY2013_PUBLIC.aspx

http://westernpowerinnovation.co.uk/Document-library/2014/Project-Falcon-Progress-Report-December-2013.aspx

http://westernpowerinnovation.co.uk/Document-library/2014/WPDT2002_Falcon_May14PPR_Issue1.aspx

http://westernpowerinnovation.co.uk/Document-library/2014/Falcon-Nov-14-PPR-V1-0.aspx

http://westernpowerinnovation.co.uk/Document-library/2015/Project-FALCON-Progress-Reports.aspx

14. Contact Details

The DNO should state name and contact details (email address, telephone number, and postal address) of the best contact to provide access to the Project’s learning.

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15. Appendices

15.1 Full Submission and Project Direction (including amendments)

Bid submission documents: https://www.ofgem.gov.uk/publications-and-updates/low-carbon-networks-fund-submission-western-power-distribution-falcon

Original Direction: https://www.ofgem.gov.uk/publications-and-updates/low-carbon-network-fund-project-direction-falcon

Changes to SDRC wording: https://www.ofgem.gov.uk/publications-and-updates/low-carbon-networks-fund-amendments-western-power-distribution-east-midlands-falcon-project

Knowledge changes to Direction : https://www.ofgem.gov.uk/publications-and-updates/low-carbon-networks-fund-%E2%80%93-amendments-western-power-distribution%E2%80%99s-falcon-project.

Budget change request – this is detailed below in Section 15.3

15.2 Knowledge Capture and Dissemination

We provide below the following important learning documents:

Communications Strategy

FALCON Comms Strategy v0.9-2.docx

Master spreadsheet detailing all project learning

Consolidated Learning List.xlsx

15.3 Budget Change Request

Change Request

FALCON Change Request 0002 01062(

Ofgem Approval

Falcon_budget_change_approval.pdf

15.4 Project Newsletters

April 2014

http://www.westernpowerinnovation.co.uk/Document-library/2014/FALCON-Newsletter-April-2014.aspx

July 2014

http://www.westernpowerinnovation.co.uk/Document-library/2014/DSR-Dissemination-Newsletter_v1.aspx

October 2014

http://www.westernpowerinnovation.co.uk/Document-library/2014/Project-FALCON-Newsletter-Oct-2014.aspx

April 2015

http://www.westernpowerinnovation.co.uk/Document-library/2015/Project-FALCON-Newsletter-April-2015.aspx

15.5 Final Reports

Overall Project Final Report

http://www.westernpowerinnovation.co.uk/Document-library/2015/Project-FALCON-Overall-FALCON-Project-Summary-Repo.aspx

SIM Final Report

http://www.westernpowerinnovation.co.uk/Document-library/2015/Project-FALCON-SIM.aspx

Telco's Final Report

http://www.westernpowerinnovation.co.uk/Document-library/2015/Project-FALCON-Telcos.aspx

T1- DAR Distribution Transformer Final Report

http://www.westernpowerinnovation.co.uk/Document-library/2015/Project-FALCON-Engineering-Trials-DAR-Distribution.aspx

T1- DAR Primary Transformer Final Report

http://www.westernpowerinnovation.co.uk/Document-library/2015/Project-FALCON-Engineering-Trials-DAR-Primary-Tran.aspx

T1- DAR Cables Final Report

http://www.westernpowerinnovation.co.uk/Document-library/2015/Project-FALCON-Engineering-Trials-DAR-Cables.aspx

T1- DAR OHL Final Report

http://www.westernpowerinnovation.co.uk/Document-library/2015/Project-FALCON-Engineering-Trials-DAR-OHL.aspx

T2- ALT Final Report

http://www.westernpowerinnovation.co.uk/Document-library/2015/Project-FALCON-Engineering-Trials-ALT.aspx

T3- Meshed Networks Final Report

http://www.westernpowerinnovation.co.uk/Document-library/2015/Project-FALCON-Engineering-Mesh.aspx

T4- Energy Storage Final Report

http://www.westernpowerinnovation.co.uk/Document-library/2015/Project-FALCON-Engineering-Trials-Batteries.aspx

Commercial Trials

http://www.westernpowerinnovation.co.uk/Document-library/2015/Project-FALCON-Commercial-Trials.aspx

Load Estimation Final Report

http://www.westernpowerinnovation.co.uk/Document-library/2015/Project-FALCON-Load-Estimation.aspx

Knowledge Capture and Dissemination

http://www.westernpowerinnovation.co.uk/Document-library/2015/Project-FALCON-KCD.aspx