Project Code/Version No

Low Carbon Networks Fund
Full Submission Pro-forma

Section 1: Project Summary

1.1 Project title

FALCON (Flexible Approaches for Low Carbon Optimised Networks)

1.2 The Lead DNO

Western Power Distribution (East Midlands)

1.3 Project Summary

The cost and limited flexibility of traditional approaches to 11kV network reinforcement threaten to constrain the uptake of low carbon technologies. FALCON will address this through trialling of a Method that comprises a Scenario Investment Model (SIM) linked to a network trials area. It will trial four technical and two commercial alternatives to traditional reinforcement. The trials area will prove the practically of these techniques. 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. 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. The objectives of FALCON are closely aligned with those of the UK Low Carbon Transition Plan and ED1. 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. It will generate learning applicable to all DNOs, shared through established LCNF dissemination channels. 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 save over 680 ktonnes of CO2 by 2050 (accounting for an additional £36m of benefits). FALCON has senior management support in WPD and our key partners. The project is compliant with default IPR arrangements and requires no derogations. MoUs are in place with partners to enable a seamless transition into project delivery ensuring timely benefits realisation.

1.4 Funding

Second Tier Funding request (£k)	12,399

DNO extra contribution (k)	0	**External Funding (£k)**	2,064

1.5 List of Project Partners, External Funders and Project Supporters

Project Partners: Logica, Alstom, Cisco, University of Bath, Cranfield University (Boeing IVHM Centre), Aston University
Project Suppliers: GE, ElectraLink, JRC, University of Birmingham, the Open University, Katalysis, Westica
Project Supporters: Milton Keynes Council, ELEXON

1.6 Timescale

Project Start Date	28th November 2011	**Project End Date**	30th September 2015

1.7 Project Manager contact details

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Section 2: Project Description

Changes since Initial Screening Process (ISP)
Some terminology has changed to clarify the Method, although the approach has not changed. The reque for funding has been reduced from £12.8 million at ISP, to £12.4 million. Partner contributions ha increased from £0.82million to £2.064 million.

2.1 Aims and 0bjectives
The transition to a low carbon economy will present significant challenges to the existing distributi networks. Demand in general, and peak demand in particular, is set to increase dramatically through t uptake of low carbon technologies such as electric vehicles and heat pumps whilst uptake of distribut generation raises the prospect of two-way power flows and power quality issues. At the same tim fluctuations in the economy, regulatory changes and the unpredictability of customer behaviour contribute to a high degree of uncertainty in the rate of demand growth and its location on the network.
This is particularly true of the 11kV network, the "backbone" of the distribution grid. This significa element of the distribution network has traditionally been designed with little or no specific monitoring. a result, DNOs have little access to real time network data, and rely instead on secondary indicators, to demand and long standing engineering guidelines to determine when and where to apply reinforceme One of the key objectives of this project is to gain an understanding of the dynamic nature of the utilisati and demands placed on this part of the network and to assess a number of alternative solutions to t existing reinforcement methodology currently used. Alternative intervention methods or a combination methods may provide a more cost effective solution to either connection or operational constrain benefiting customers with reduced connection costs and improved cost effective supply alternatives.

The Problem this project addresses is to remove constraints on the 11kV network thereby removi barriers that may hinder the uptake of low carbon technologies and therefore the transition to a low carb future. Without the means of selecting more innovative solutions from a broader toolkit of interventi techniques and the ability to evaluate these techniques and combination of techniques against each oth and against traditional reinforcement, a DNO will be unable to deliver the most cost effective and tim remedy and, therefore, deliver best value-for-money to the customer.

The Method being trialled to address the Problem can be described in two parts. It will provide DNOs w a visual image of the current and future state of the 11kV network including areas of constraint. Secondly, will provide the ability to evaluate a broad range of intervention techniques designed to address the constraints. This evaluation, modelled against a range of future demand scenarios, will determine the m appropriate technique or combination of techniques to apply including use of traditional reinforceme where most cost effective. To deliver this capability, FALCON will conduct a number of Trials.

It will develop and trial a Scenario Investment Model (SIM), a next generation network planning tool th combines network modelling, advanced engineering design software and a simulation harness, design and built to:
- model the 11kV network;
- identify areas of existing constraint by making innovative use of existing network data;
- model the impact of six technical and commercial techniques for addressing these constraints;
- determine the most cost-effective and timely solution, depending on the nature of the network and constraint, and repeat this exercise against a broad range of future demand scenarios, allowing stre testing and sensitivity analysis of potential 11kV investment strategies.

To support this, FALCON will trial a set of six technical and commercial intervention techniques addressing 11kV constraints in order to:
- increase our knowledge of the effectiveness, benefits and risks associated with each technique;
- better understand where and when these techniques are best applied;
- capture this new learning and improve the "model" of each technique within the SIM, thus enhancing t SIM's ability to select the most appropriate technique or combination of techniques depending on t nature of the constraint;
- apply this knowledge by using the SIM to plan 11kV investment strategy against multiple future dema scenarios, shaping this in line with market/regulatory events.

Figure 1 at the end of this section shows the Method components

The Solution delivered by FALCON will enable DNOs to significantly reduce the chance of 11kV netw reinforcement hindering the UK's journey to a low carbon future, by ensuring that 11kV netw reinforcement does not create any financial or time barriers to the uptake of low carbon technologies.

2: Project Description cont.

Specifically, the objectives of FALCON are to contribute to ensuring that:

- the impact on customers' bills is minimised through use of the most cost effective solutions to 11kV constraints;
- connections, particularly on to the 11kV network, are quicker and cheaper;
- 11kV network reinforcement is smarter, reducing wasted investment and stranded assets;
- changes supported within DNOs required for a transition to a low carbon future through the use of SIM;
- change is fostered within a key customer segment through participation and awareness of the benefits of the commercial trials.

Learning Objective

By selecting and refining trial areas that are reflective of the national 11kV network and ensuring effective knowledge dissemination the SIM will provide guidance and design rules, based on the intervention techniques, for inclusion in design and planning manuals. A key objective of the project is to ensure that this learning is made available nationally and used to the benefit of all UK DNOs. FALCON will build on the work of a number of existing LCNF and IFI projects, (e.g. LV Network Templates and, Customer-Led Revolution) by, for example, utilising available substation metering data to validate our innovative use of settlement data and extending the SIM's portfolio of modelled techniques by embedding knowledge gained through previous trials of smart interventions within the SIM's network model.

2.2 Technical description of the project

As described in section 2.1, the Method being trialled by Project FALCON can be described in two parts:

a. a next generation SIM for identifying, predicting and proposing solutions to constraints on the 11kV network;
b. a set of six technical and commercial intervention techniques that the SIM can call on (in addition to traditional reinforcement) to derive the most cost-effective and timely constraint remedies.

Figure 1, at the end of this section, shows a schematic representation of the key components of the Project.

a) SCENARIO INVESTMENT MODEL (SIM)

The SIM is the core of Project FALCON and will provide the agility and flexibility needed by DNOs to cope with increasing uncertainty in future demand. The SIM comprises two major components:

- a **network modelling tool** within which sections of network can be represented, various network reinforcement techniques modelled and power flows/voltages across the network calculated, highlighting areas of constraint;

- a **simulation harness** for presenting the future load scenarios, invoking multiple solutions comprising different combinations of reinforcement techniques and evaluating and comparing the results of each to determine the optimal solution.

The power of the SIM is its ability to rapidly model different network configurations under different load conditions, enabling multiple possible constraint solutions to be evaluated against a range of future load scenarios representing different economic, regulatory and customer behavioural outcomes. Initially, we will use load scenarios based on current customer behaviour, however, FALCON will also deliver the building blocks for generating sets of load profiles projected over future investment planning horizons based on different localised uptakes of low carbon technology and different economic environments. These will include profiles built on externally recognised scenarios such as those contained in DECC's UK Low Carbon Transition Plan and the Smart Grids Forum (SGF)/redpoint "central scenario" being developed for use by all DNOs in ED1.

Network modelling tool

At the heart of the SIM is a network model that holds a virtual representation of the network in a selected area and is also able to represent various possible future network states resulting from the application of various intervention techniques. Through advanced engineering design software, it has the capability to calculate power flows and voltages across the network under different load scenarios. The resulting power flows, overlaid on the network model, will provide a "hotspot" map of constraints, together with other network key performance indicators such as voltages, voltage step changes and load indices.

The network planning tool will be based on established network modelling tools, namely: GROND, a tool used extensively within the UK, and a European modelling tool called DPLAN which is at the heart of the InovGrid smart grid implementation in Portugal.

2: Project Description cont.

Simulation Harness

The simulation harness is an interface that presents scenario data to the advanced engineering design software and marshals the outputs from the analysis. The simulation harness will manage the process of running multiple power flow calculations for:

- a series of time slices along a future network load profile to assess how constraints are likely to develop over time;

- a number of revised network models to compare the effectiveness of combinations of intervention techniques.

In addition, the simulation harness will analyse the outputs from these discrete network analyses to generate a league table of preferred solutions to resolve identified constraints. The simulation harness, a key component of what makes the SIM unique, will be developed by Cranfield University during the course of the Project.

How will the SIM be used?

The SIM provides a single framework within which a variety of different technical and commercial techniques, including the traditional reinforcement "base case", can be modelled and evaluated against a common set of criteria including:

- whole life cost of ownership;
- duration of implementation (longer durations increasing the risk of volatility in future demand and potentially causing delay to new connections);
- post implementation operational network performance (measured in terms of Customer Minutes Lost (CML), Customer Interruptions (CI) and losses);
- the customer impact during implementation of the technique (measured in terms of CML and CI);
- load index (i.e. the "degree of headroom" on the network) that the solution provides;
- safety considerations emerging from the trial.

A key feature of the SIM is its ability to not only identify current and future network constraints, but also model techniques for addressing these constraints. In FALCON, we will model the six technical and commercial techniques that will be trialled in the second part of our Method. The results of these physical trials will be compared with those predicted by the SIM in order to tune and calibrate the model.
The ability to automate the running of multiple calculations for a variety of inputs and to marshal and compare the results from these calculations will provide DNOs with a powerful investment modelling tool. Specifically, it will enable DNOs to:

- assess network performance over time against a variety of possible future load profiles including various rates of uptake of low carbon technology;
- assess the relative effectiveness of different intervention solutions against a common future load profile;
- perform sensitivity analysis on a candidate network solution using a variety of possible future load profiles.

It will be possible to use the SIM to analyse any section of 11kV network, simulate interventions and calculate the associated benefits. We anticipate, over time, to formulate a set of guidelines for selecting the most appropriate solution for a given network problem.

Predicting network load

In order to calculate current network power flows and the impact of techniques, the SIM will require half-hourly load profiles. These half-hourly load profiles will be obtained by installing monitoring within the 200 substations, as has been done in WPD's LV Network Templates 2010 LCNF Tier 2 project.

So that the SIM can be developed and provide valuable learning in advance of the deployment of monitoring infrastructure it will initially use estimated half-hourly load calculated by aggregating currently available settlement data associated with individual premises to secondary substation obtained by ELEXON. To assess the impact of future load growth on the network and the effectiveness of techniques to respond to them estimated half-hourly load calculated from new customer profiles that will be developed by ElectraLink as part of this Project to better reflect customer behaviour in the low carbon economy (e.g. use of heat pumps or ownership of EVs). This data will then be superimposed on current data within the SIM.

2: Project Description cont.

Taking the SIM forward

We see huge potential in the SIM, not only as an agile and effective network planning and investment tool, but also as a repository of learning, by capturing the results of trialling physical techniques for managing constraints. Our vision for future development of the SIM includes:

- extending the SIM's scope in terms of areas of network and voltage levels modelled;
- extending the SIM's portfolio of techniques for managing 11kV constraints by taking knowledge gained from existing and future LCNF and IFI projects;
- facilitating ease of adoption by other DNOs within the UK and beyond;
- developing the SIM as a benchmarking tool with the potential for use in setting regulatory incentives.

b) TECHNIQUES FOR ADDRESSING 11kV NETWORK PROBLEMS

Network problems occur when the distribution of supply and demand across the network results in power flows that either exceed the expected network capacity and/or cause power quality issues (e.g. unacceptably high or low voltages). This occurs at peak load or supply periods. The problem can be addressed by either reducing the peak or accommodation of the peak.
There are only a finite number of ways to address these problems:

a. upgrading or supplementing the existing infrastructure without adding additional intelligence to the network (**traditional reinforcement**) - this accommodates the peak;
b. maximising network capacity usage by monitoring assets temperature and load, then using this to calculate real-time asset capacity, this can be higher for limited period than the static rating thus accommodating peak load - (**dynamic asset rating**);
c. changing the configuration of the network to improve the flow of power via re-routing of load through areas of spare capacity to accommodate peaks **(automated load transfer/meshed networks);**
d. using power stored on the network to alleviate the problem (**battery storage**) this will reduce the peak load requirements at points in the network;
e. changing the power leaving the network (**demand side management**) to reduce the peak load;
f. changing the power entering the network (**distributed generation**) to reduce the peak load.

Whilst there are different approaches to implementing each of these options, the six techniques chosen for trialling in FALCON and inclusion in the SIM cover all of the above categories of intervention. The intention is to expand the SIM in the future to include other innovative techniques as they emerge, thus ensuring that the investment strategies produced by the SIM continue to represent best practice. We provide a brief high-level description of each of the new techniques below. For each technique, we give a description, explain the practicalities of how it is implemented, suggest the characteristics of the network to which it is best suited, explain what we intend to trial within Project FALCON, identify which partners will be involved in the trial and list previous trials which we will look to build on. This section has intentionally been kept high level. More detailed technical descriptions can be found in Appendix C.

DYNAMIC ASSET RATING

What is it?

When more electricity flows through a cable, transformer or overhead line than it is designed to carry it causes excessive heat that may result in damage. It takes a finite time for this heating to produce damage. As traditionally these assets are not monitored, a prediction of the safe capacity of the assets is used in the network design to limit their capacity. This safe unmonitored rating is the static rating for certain periods. If an asset is monitored then a dynamic rating can be used. This can be higher than the static rating to reflect the time required to heat the asset as long as the asset is allowed periods of cooling after being run at these high temperatures.

This approach of using dynamic rating is a way of accommodating peak electricity supply as it uses the cyclical nature of load to provide cooling. The use of cyclic rating creates a trade-off between asset life and its peak handling capacity. By carefully controlling the use of cyclic rating, the impact on the asset's lifespan can be minimised whilst delivering significant additional capacity to the network. This technique has been trialled on overhead lines by WPD on an LCNF project and on transformers by ScottishPower under IFI funding.

2: Project Description cont.

How is it implemented?

Dynamic asset rating first requires the asset to be monitored to determine its normal operating level. Additional monitoring is then required so that we know exactly what the ratings are at any given time, based on factors such as temperature and recent loads on the asset. Implementing dynamic asset rating involves installing remote monitoring equipment around the asset in question and changing operational procedures to include monitoring of the assets.

Where can it be used?

Dynamic asset rating can be applied to transformers and linear assets (cables and lines). Whilst it can be applied to both overhead lines and underground cables, it is most effective for overhead lines as these are easier to monitor (in the case of WPD Midlands, this accounts for some 50% of cables by length).

What are we planning to trial in FALCON?

FALCON will install monitoring equipment enabling dynamic asset rating to be applied to the transformers and cables (both overhead and underground) associated with a single primary substation and six 11kV feeders within the FALCON trial area. Additional interventions (e.g. fans, pumps) may also be deployed if appropriate.

What partners are involved?

Alstom and Aston University will be our partners in developing, modelling and implementing the monitoring equipment and controls to support the use of dynamic asset ratings.

Previous trials that we will build on

Dynamic cable ratings have already been trialled on overhead lines at higher voltages. IFI projects to investigate transformer dynamic load have also been delivered.

AUTOMATED LOAD TRANSFER

What is it?

In parts of an 11kV distribution networks there are **open rings**, in which there are two or more supply routes from a primary substation to a ring of secondary substations. It is called an open ring because the ring is divided into two sections connected by an open switch. Each substation is normally connected to only one supply route. However each secondary substation has two potential sources of supply as closing the switch provides two routes back to the primary substation.

Automated load transfer uses this feature to dynamically alter the number of secondary substations that are fed from each supply route by closing the open switch and then remotely operating switches introduced between substations. This allows load to be transferred from one supply route to another automatically. If one half of the ring has exceptionally high load whilst the other has spare capacity, load can be shifted between the two by reducing the number of substations on the overloaded side at the expense of the side which has spare capacity. For more complex ring arrangements, consideration needs to be given to the balancing of load across the number of feeders involved.

How is it implemented?

Automated load transfer requires remotely operable automated switch gear to be installed between secondary substations. This involves installing or upgrading switch gear as required depending on what is already in place. In recent years some 11 kV automation has been installed to improve restorations after faults and thus reduce CMLs. Where installed this automated switchgear shall be utilised as part of the automated load Transfer trial. Deciding when to switch requires visibility of the load at different points on the ring which may require installation of remote monitoring equipment (although it is also integral to some automated switch gear). In some cases there may be a requirement to alter protection settings remotely. Finally, operational procedures need to be changed to make use of this facility.

Where can it be used?

Automated load transfer is suitable for implementation on open ring 11kV circuits. In the case of WPD, this accounts for some 90% of the 11kV network.

What are we planning to trial in FALCON?

FALCON will trial three automated load transfer schemes using six existing 11kV feeders within the FALCON trial area, comprising both overhead and underground circuits. For overhead circuits, existing pole mounted automated re-closers and sectionalising devices will be used where possible with new equipment being installed as appropriate. In the case of underground circuits, automated equipment will be installed where it doesn't already exist.

What partners are involved?

Alstom and Aston University will be our partners in designing, modelling and implementing automated load transfer schemes based their Distribution Management System and Network Optimisers.

Previous trials that we will build on

The LCNF project, EDFT2001 Low Carbon London, is implementing Automated Network Management based on the control of demand and distributed generation. The learning from this project will be used to influence the design of the network monitoring and decision control to manage the automated switching that is

2: Project Description cont.

required for this trial. To date, network automation has focussed on improving fault response rather than improving power flow.

MESHED NETWORKS

What is it?

As with automated load transfer, meshed networks utilise the fact that each secondary substation on an open ring circuit has two potential sources of supply. However, rather than shifting load operationally between routes using switches, the meshed network is a passive solution in which a permanent closed ring is created. To do this, a set of "protection zones" need to be designed and implemented to ensure that the network can operate safely. The number of "protection zones" is a balance of practicality, cost, and improvements against customer impact in minimising the number of customers off-supply in the event of any given fault on the ring. In this solution, the power flow is improved as the mesh allows the current to choose the path of least resistance.

How is it implemented?

Protection zones that minimise loss of supply in the event of a series of fault scenarios must be designed and implemented by installing circuit breakers in strategic points around the ring circuit.

Where can it be used?

As with automated load transfer, meshed circuits are suitable for implementation on open ring 11kV circuits. In the case of WPD, this accounts for some 90% of the 11kV network.

What are we planning to trial in FALCON?

To date, meshed network implementations have been largely limited to high density load areas such as city centres. In FALCON, we intend to explore the benefits of meshed networks applied to suburban and rural areas. We will trial three meshed networks comprising six existing 11kV feeders within the trial area.

What partners are involved?

Alstom and Aston University will be our partners in designing, modelling and implementing meshed networks appropriate to the type of network.

Previous trials that we will build on

Meshed networks have been used this has been primarily in city centres. We will explore the benefits of meshed networks applied to suburban and rural areas.

STORAGE

What is it?

Storage involves installing one or more batteries onto the network, charging these at times of low demand and discharging them at times of high demand. The effect is to reduce demand on network at peak times thus accommodating additional power flows within the same available network capacity. It can be highly effective in addressing periods of high demand which may be very limited in duration.

How is it implemented?

Batteries are installed within ground mounted secondary substations on the LV side of the transformer. The charging/discharging regime is controlled by a set of algorithms that respond to network demand. The secondary substations require monitoring to be installed to drive the charge/discharge algorithms. Power conditioning units (PCUs) are typically installed with the battery arrays to optimise the performance and provide communications.

Where can it be used?

Storage can be installed virtually anywhere on the 11kV network, where space and support requirements can be met. It can be highly effective in addressing constraints that only appear for short periods of the day (e.g. one or two hours at times of peak consumption). Given that the battery solution which is being trialled can be relatively quick to deploy/redeploy, storage can also be used as a short term solution, either where there is uncertainty in future demand or as a stop gap whilst a more permanent technique is implemented.

What are we planning to trial in FALCON?

We will deploy a total of 30 sodium metal halide batteries across five secondary substations in the trial area. The sodium metal halide batteries that will be used on the project have a number of highly innovative features, including small footprints to enable them to be sited in the limited space within a secondary substation, flexible sizing to match the ratings of the secondary transformers and a long life (20 years which is typically double the life of existing technologies) Each battery array will have a capacity of 10-20% of the transformer capacity over an 1-2 hour period. Battery installations will include a PCU, communications and substation metering.

What partners are involved?

The batteries and associated communication and control equipment will be provided by GE.

Previous trials that we will build on

Other LCNF projects, EDFT1001, SSET1001, CET2001, are also trialling battery storage for different types of operation. Learning around installation and control will be leveraged from these projects to optimise the control and management of charge/discharge cycle.

2: Project Description cont.

DISTRIBUTED GENERATION

What is it?

A number of industrial and commercial customers have their own, on-site generation and this number is likely to increase with the transition to a low carbon economy. In some cases, this may be uncontrollable renewable generation (wind or solar) but the majority is in the form of either standby generators or controllable plants such as biomass, refuse incinerators or combined heat and power (CHP) plants. If customers with controllable distributed generation can be incentivised to accept instruction from a DNO to increase or decrease generation, this can be used to reduce or increase site demand and/or provide/remove supply from the grid as a means of rectifying network problems.

How is it implemented?

This technique involves putting in place commercial agreements between the DNO and the customer that allows the DNO to call upon flexibility in the customer's generation to either increase or decrease output as required in order to remove constraints from the network or rectify voltage problems.

At present, DNOs have the ability to control generation on/off as part of the distribution code and connection agreement under fault conditions. This technique will look to use the generator agreements to reduce or defer reinforcement in a proactive, pre-fault rather than reactive, post-fault manner.

Where can it be used?

This technique can only be applied on areas of the network which include customers with flexible distributed generation who are willing to offer flexibility to the DNO, generally found on urban and suburban networks.

What are we planning to trial in FALCON?

We will look to develop commercial agreements with a range of distributed generators to enable a spectrum of issues to be considered when drawing up the agreements. The trial will investigate the financial rewards and engagement models required to incentivise distributed generators to provide DNO services including the balance between availability and utilisation payments and possible scope for interaction with National Grid's Short Term Operating Reserve (STOR) market. The trial will also determine the practical operational issues such as how parties are to be notified and the amount of advance notice that must be given. To predict when generator assistance is required, the SIM will model a future time-frame, such as a week ahead, based on the expected network configuration (e.g. including any planned outages).

We are aware of three customers in the trial area that have controllable distributed generation including Thameswey, a customer with a *3MW* CHP generator who has been contacted and has expressed an interest in participating in the project.

Previous trials that we will build on

Other LCNF projects, CET2001, EDFT2001, are also trialling DNO control of distributed generation. Learning from these projects will be leveraged to understand the issues with the commercial arrangements and the control mechanism used to request network support.

DEMAND SIDE MANAGEMENT

What is it?

Similar to distributed generation, demand side management (DSM) involves putting in place commercial agreements between the DNO and industrial and commercial customers who have the ability to control appreciable amounts of load in relatively short periods of time.

How is it implemented?

Initially a stakeholder engagement exercise will be used to determine the form of commercial agreements, level and structure of remuneration (e.g. availability versus utilisation payments). The practical issues will also be addressed in a similar way to those for distributed generation, in that some predictive analysis will be required to give advance notice of likely requirements and where there is more than one potential DSM customer, to determine the lowest cost option. The trial will also identify the best way to communicate requests and confirm response and investigate issues affecting customers' ability to comply with DSM requests. The trial may also include aggregators.

Where can it be used?

This technique can be applied on areas of the network which include customers with flexible demand who are willing to offer this flexibility to the DNO. Ideally, there will sufficient willing participants to create a competitive market for demand side management services. However, the lack of customer awareness and experience combined with the need for localised response means that we will initially look to put in place bilateral contracts.

What are we planning to trial in FALCON?

We will develop commercial agreements with a range of customers capable of offering demand side management. For simplicity to both the customer and WPD, we will look to replicate the same approach across the two commercial techniques as far as possible, using similar customer engagement strategies, bilateral contract templates, financial incentives and payment structures. As with the distributed generation technique, the trial will determine practical operational issues such as how parties are to be notified, the amount of advance notice that is required and the reliability of response.

2: Project Description cont.

DSM requirements will be modelled by SIM using short term load scenarios and expected network configuration (e.g. including planned outages). Over the last year we have engaged with 10 customers based in the trial area that have a suitable controllable demand profile. We are in advanced discussions with three of these customers Thameswey, Dominos and Santander who have expressed an interest in participating in the project.

Previous trials that we will build on

The LCNF project, EDFT2001 Low Carbon London, is also scheduled to trial DSM with some options including bi-lateral contracts. Learning from this project will be leveraged to understand the issues with the commercial arrangements and the control mechanism used to request network support.

COMMUNICATIONS

The techniques require measurement, control and protection which, in turn, require a communications infrastructure linking the 200 substations within the FALCON trial area. The communication infrastructure will consist of an inter-substation physical layer of WI-Max technology provided by Westica, with planning support from the JRC. Over this layer will run an IP protocol providing interconnects between Cisco ruggedized routers. At the substation level connections from devices will be provided into the Cisco units directly as digital signals or via an analogue convertor. As cyber-security of this architecture is seen as critical to the future of the smart grid, the whole communications infrastructure will be independently tested and the results shared as part of the project learning.

Selection of Techniques

As described in section 2.1, the key objective of the project is to provide DNOs with a tool (the SIM) for identifying constraints on the 11kV network and determining the best technique or combination of techniques to address these constraints. To do this, the SIM needs to be able to model the impact of a comprehensive set of techniques for managing constraints and these models need to be tuned based on real life experience from network trials. The set of techniques we have chosen to include within the scope of the project have been selected to reflect best practice based on current knowledge and to provide coverage across a wide range of the possible solutions.

Selection of Trial area

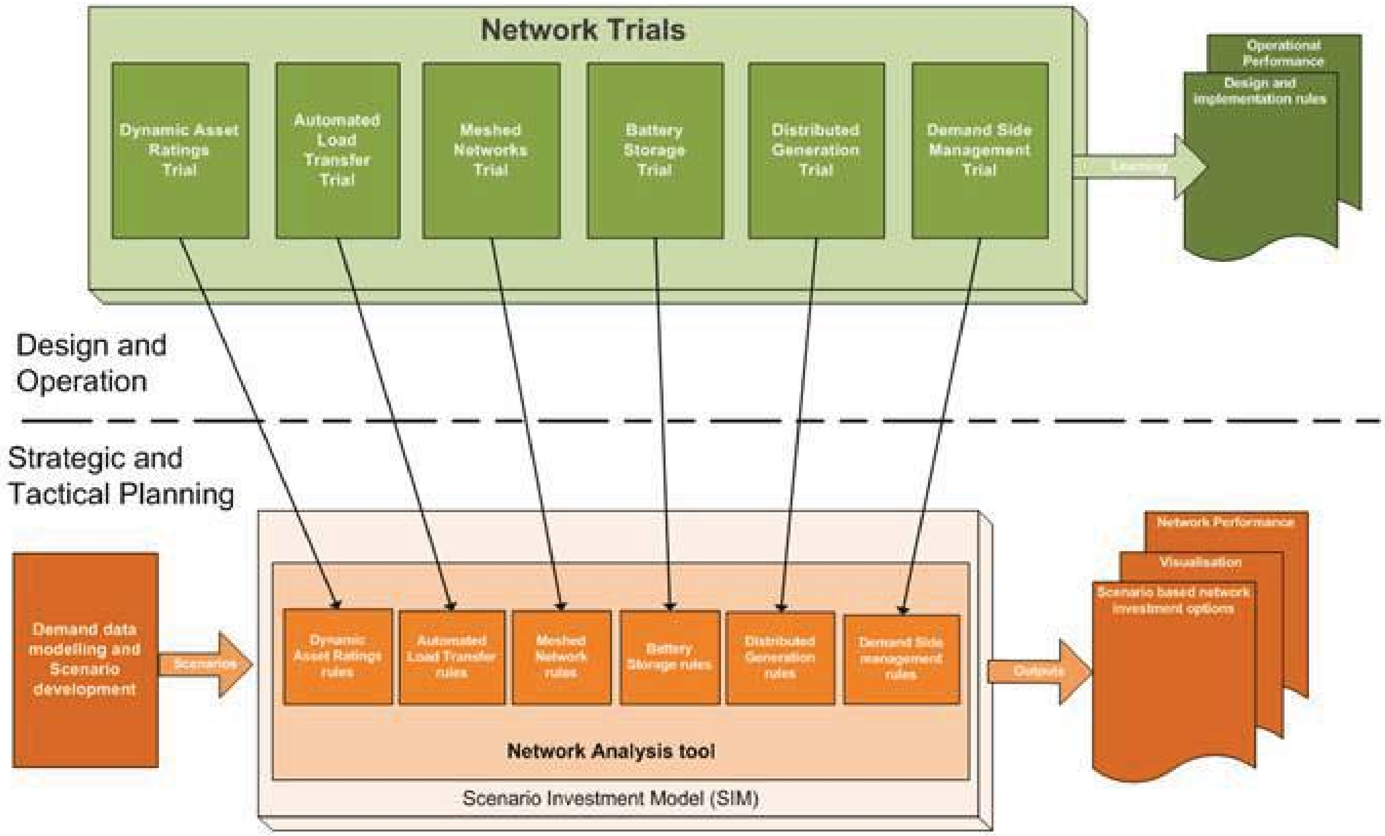
The area selected for the project is the South East Midlands (see appendix B). We believe this area provides a representative mix of customers and assets, allowing the results of the trials to be scaled to address the whole 11kV element of the national network. In determining the scale of deployment, we have attempted to strike the optimum balance between maximising the statistical validity of the trials and minimising the cost and risk of delivery in order to provide best value-for-money to the customer. Given this consideration, our trial area will comprise six primary substation transformers. These substations supply 52 HV feeders, totalling 345 km of linear assets (both overhead and underground). The six primary substations serve 200 secondary substations which, in turn, serve both industrial and commercial and residential customers.
This set of primary substations has been selected to provide a representative set of distribution assets that:

- includes a mix of urban, suburban and rural networks;
- includes both overhead and underground linear assets;
- is reasonably geographically contained to minimise travel;
- avoids areas designated for DCPR5 investment;
- is appropriate for the technique(s) being trialled (e.g. includes open ring circuits, for automated load transfer/mesh networks techniques, has sufficient HV customers for the DSM technique etc.);
- has a high probability of becoming constrained in the future.

When trialling the use of settlement data to identify constraints on the 11kV network, we will initially trial within WPD's South Wales network in order to utilise existing substation metered data obtained from WPD's LV Network Templates 2010 Tier 2 Project. We will subsequently validate the results from the South Wales trial using metered data from substations within WPD's East Midlands network once substation metering has been installed to support FALCON.

2: Project Description Images, Charts and tables.

Figure 1 – Project FALCON



The figure above shows how the Method links both the Network Trials Area and the SIM to maximise learning.
The six intervention techniques are implemented in the trial area and also modelled in the SIM. This parallel interlinked approach maximises the learning and ensures that it is directly applicable to future load scenarios.

Section 3: Project Business Case

Background

This project is aimed at reducing the cost of reinforcing the 11kV network to practically deliver the benefits indicated in the Imperial College/ENA study `Benefits of Advanced Smart Metering Demand Response Based Control of Distribution Networks' thus enabling the Government's climate change targets to be met. Ofgem has estimated a need for £32 billion of network investment in the next ten years, a doubling of the rate of investment over the last 20 years. Investment needs to be smarter, drawing on a range of new, innovative intervention techniques as an alternative to, or to supplement conventional network reinforcement.

These techniques need to be planned to align with the ED1 timetable. We have therefore focused the project on generating early learning that can be developed into policy and delivery mechanisms. We will generate improved load forecasting information to inform load-related reinforcement analysis, especially on the hitherto unmonitored but essential 11kV network. From the outset iterations of the Scenario Investment model (SIM) will enable alternative techniques to be actively considered during the early stages on ED1.

This project is designed to align with ED1 incentives. It will:

- provide a better understanding of the applicability and costs associated with alternatives to conventional reinforcement;
- enable tuning of the common set of evaluation criteria used by the SIM in evaluating network investment solutions to align with ED1 incentives;
- enable the addition of new criteria (e.g. % network utilisation) as required to allow the SIM to evolve with RIIO and ED1 incentives;
- provide better asset information, enabling a greater focus on minimising total lifetime costs;
- support investment decisions made within longer term investment timeframes;
- base network investment decisions on a broader range of criteria including managing uncertainty, ensuring deliverability and minimising risk.

Project Deliverables

Our vision is to deliver the following outputs which will be made available to a wide range of stakeholders in a timely manner:

- The SIM which includes:
  - a Network Modelling Tool for quantifying and predicting available capacity on the 11kV network, which, as well as utilising existing data, will identify constraints using industry recognised forecasts of predicting low carbon technology uptake;
  - a decision support too embedded within the Simulator Harness. This will enable DNOs to make planning decisions and design their future network based on an accurate understanding of alternative costs and benefits.
- Learning about the individual and combined applicability of six intervention techniques, which will be deployed in constrained areas of the 11kV network.
- A set of design rules and an enhanced set of solutions that can be applied to 11kV network planning.

Project Description and Context

Traditional methods of designing and operating electricity distribution networks have so far served customers well. The predicted mass adoption of low carbon technologies and the impact of two way load flows will challenge this approach.

The project has been constructed to address these challenges by:

- identifying both current and future constraints on the network based on future demand scenarios;
- determining the optimal combination of smart techniques and conventional reinforcement to provide the most timely, cost-effective and flexible solution to any given network constraint;
- testing this solution against future demand scenarios to determine which technique or combination of techniques to minimise the risks associated with investment decisions.

3: Project Business Case contd.

To date, the impending rollout of smart metering and the role that this could play in a smart grid has rightly focused attention on the LV network. Work is underway to define LV network templates to prepare DNOs for smart LV reinforcement. However, unlike the LV network, 11kV network constraints need to be modelled on a case-by-case basis and we feel it is timely to turn attention to this essential, though largely unobserved, part of the network.

The 11kV system has been designed as a passive system to accommodate predicted load growth for the life of the asset. There has been an escalation in the rate of load growth due to the adoption of low carbon technology. This rate of growth is predicted to increase therefore the key challenges are to deliver increasing capacity by making these networks more flexible. We will identify which areas of the network need additional capacity through the creation of a network scenario planning tool. This tool, housed within the SIM, will be populated with existing network data, measured network data collected during the project trials, modelling data for each of the intervention techniques and independently sourced future energy scenarios.

The project will then trial, different technical and commercial intervention techniques, or combinations thereof, in order to provide information which will enable informed, cost effective decisions to be made when transforming the 11kV network into the flexible network required to enable the uptake of low carbon technologies. This information will be provided by the investment tool module within the SIM.

Project Benefits

Customer benefits

FALCON offers the potential of delivering significant customer benefits across a number of customer segments.

- **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).

- **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.

- **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.

DNO Learning benefits

The Project will generate the following benefits for asset owners and network operators:

- **Investment planning**: the project will provide new insight into the current and future state of the 11kV network. It will allow DNOs to test the relative effectiveness of technical and commercial techniques in solving the same network constraint and evaluate these solutions against a range of different future load profiles reflecting varying economic, regulatory and customer behavioural outcomes.

- **Commercial service procurement**: the project will inform best practice in identifying and engaging with customers offering flexible demand and/or generation.

- **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.).

- **Technical**: the project will impart technical learning regarding the practicalities and effectiveness of individual technical intervention techniques.

- **Telecommunications:** the project will evaluate the security of the infrastructure required for future networks.

3: Project Business Case contd.

- **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.

- **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.

Environmental benefits

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.

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.

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%.

Industrial Benefits

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.

Financial benefits

In constructing the business case we have considered the following:

- 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.

- 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.

- 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.

We estimate that the Project will deliver a net financial benefit of £1.2m (see Appendix A).

Assuming the estimated GB 11kV network reinforcement cost under business as usual operation is £3.7 billion (based on the 50% scenario of combined EV/heat pump penetration contained in the joint ENA/ICL paper), we calculate the savings associated with a national rollout of the generated learning to be approximately £659 million over a 20 year period (our workings can be found in Appendix F).

3: Project Business Case contd.

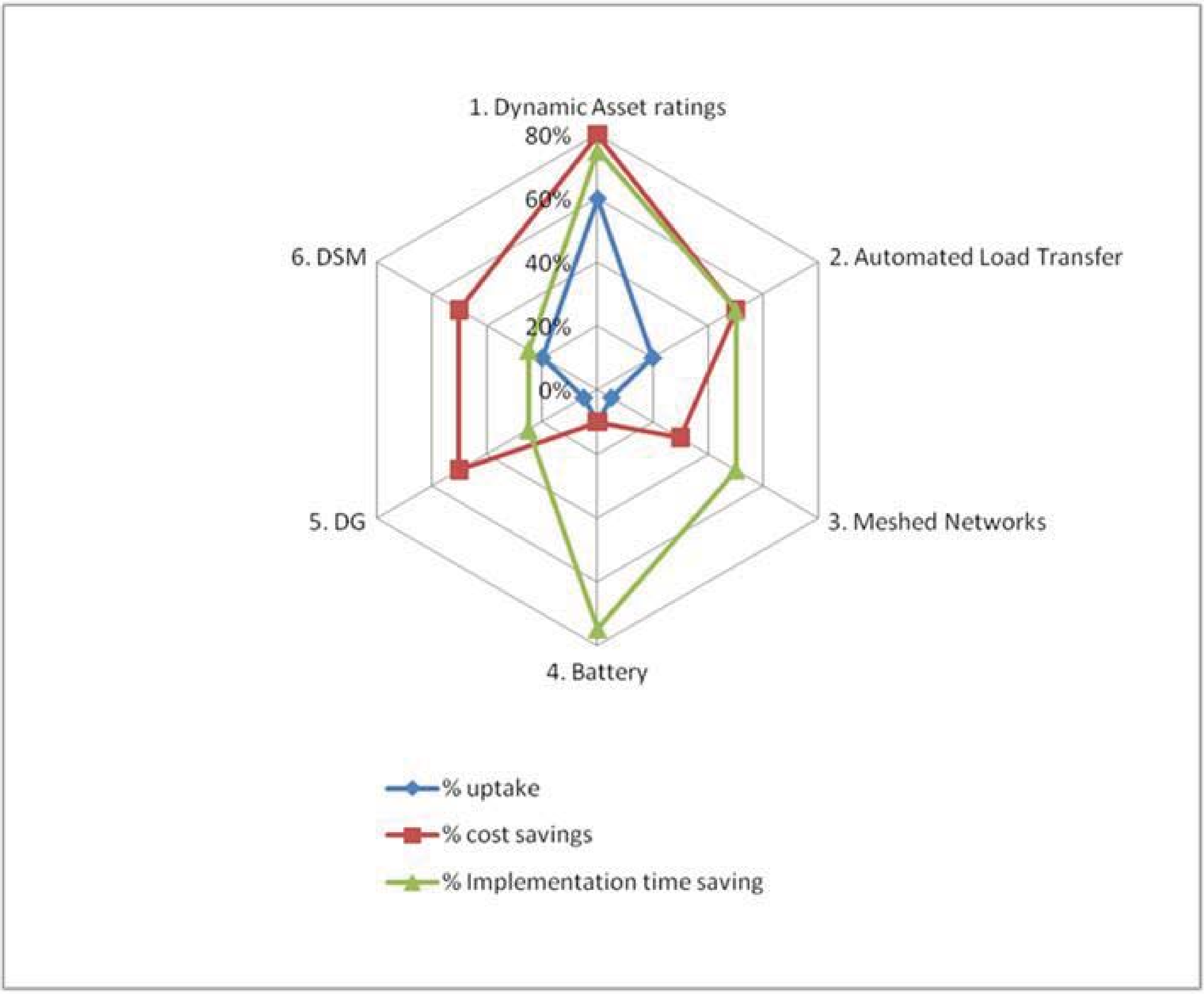
In addition to direct financial benefits, the project has the potential to deliver indirect financial benefits. For example, we will trial innovative use of existing settlement data and new customer profiles as an alternative to installing metering at secondary substations/LV feeders. If this proves successful we anticipate savings in avoided metering costs.

The spider diagram at the end of this section is a pictorial analysis of the percentage uptake, percentage cost saving and percentage implementation time saving for each of the intervention techniques. These savings are an assessment of the reductions when compared with the traditional reinforcement method used currently by DNOs to address load issues. Detailed descriptions of how the percentages have been derived are in Appendix F.

3: Project Business Case contd.

3: Project Business Case contd.

3: Project Business Case images, charts and tables.



Project Business Case images

Section 4: Evaluation Criteria

a) Accelerates the development of a low carbon energy sector

The Solution generated by FALCON will make a significant contribution to achieving the UK Government's strategy for reducing green house gas emissions, as set out in "The UK Low Carbon Transition Plan" published by DECC on the 29th July 2009 (URN: 09D/716). Specifically, we have identified the following areas where FALCON will have a meaningful impact:

- Transforming our power sector (chapter 3);
- Transforming our homes and communities (chapter 4);
- Developing a roadmap to 2050 (chapter 8).

Transforming our power sector
The UK Low Carbon Transition Plan (UK LCTP) identifies the need for "**a smarter, more flexible grid that will be able to manage electricity generated from new technologies and respond to changes in energy demand**". FALCON aims to give DNOs the necessary agility to plan for increased network load in an environment of volatile change, in terms of economic outlook, regulatory transformation and uncertainty in customer behaviour. The need for such flexibility is highlighted in the Year 1 Progress Reports of the 2010 LCNF Tier 2 projects published in June this year. UKPN's Low Carbon London project (EDFT2001) observed that the delay in the domestic Renewable Heat Incentive (RHI) has had a detrimental impact on early access to heat pumps, an observation shared by CE's Customer-led Revolution (CET2001). This highlights the effect of regulatory change on the low carbon transition. Equally, EDFT2001 has also blamed prevailing economic conditions on the slow uptake of new generation electric vehicles, highlighting the impact of economic uncertainty on network planning.

The ability to rapidly evaluate multiple network solutions, comprising different combinations of technical and commercial techniques and to test these solutions against multiple future load scenarios will allow DNOs to reduce the risk associated with investment decisions and deliver cost-effective, timely capacity where it is required.

The UK LCTP sets out the need for "**a smarter grid for the future**" to enable increased active management of fluctuations in supply and demand that will exceed those we experience today. To do this, the plan identifies the need for DNOs to have "more real time information on energy use and supply and network conditions and capability for more automated response to changes on the network" - all capabilities that FALCON is looking to increase.

The plan also acknowledges that the "costs and benefits of a smart grid will ultimately depend on the combinations of technologies that are brought together - some are well understood, some at an early stage of development, others do not yet exist". To date, many innovative alternatives to network reinforcement have been trialled in isolation. FALCON, however, will provide a framework within which new interventions can be evaluated against, and in combination with, existing techniques (including traditional reinforcement) to determine the most timely and cost-effective solution.

By reducing the risk of 11kV network reinforcement hindering the uptake of low carbon technologies, FALCON will also contribute to the UK LCTP's objective of "**using electricity more efficiently**". Similarly, the increased visibility of the 11kV network brought about by FALCON will contribute towards the Government's objective of "**keeping our electricity supplies safe and secure**" by giving early warning of constraints and thus minimising the risk of asset failure.

FALCON is both a product and an enabler of the Government's desire for **increased innovation in regulation**. By providing a framework for modelling and evaluating new, innovative alternatives to traditional reinforcement, FALCON will help "industrialise innovation", allowing DNOs to model new ideas for managing the network against, and in combination with, established techniques, prior to validating the designs through trialling.

The much improved visibility of the 11kV network that FALCON will deliver will also support the Government's objective of "**quicker and fairer connection to the grid**" since unnecessary reinforcement will be avoided, connection costs and time will be reduced and cost of connections will be more reflective of actual constraints on the network.

4: Evaluation Criteria contd.

Transforming our homes and communities

By 2020, the impact of the measures contained within the LCTP are expected to, on average, add 6% to household bills. Other announced climate policies may increase this figure to 8%. FALCON, through enabling more timely and cost-effective solutions to increased demand on networks, will enable greater cost transparency and targeting of investment. This will lead to reductions in both connection and DUoS charges and will, therefore, directly benefit customers.

Developing a roadmap to 2050

The objective of FALCON is to create a long-term network modelling tool designed to help a DNO cope with the shift from slow, predictable increases in electricity demand to the large, volatile demand profiles that are anticipated during the transition to a low carbon economy. Although initially focused on the 11kV network, the concept of an extendable network model coupled with powerful scenario testing, is equally applicable to other voltage levels within the network and is a future goal for FALCON (see section 2.2).

Carbon savings

The UK LCTP target is to reduce CO_2 emissions by 80% by 2050. Though modest in comparison, a national rollout of the FALCON method would produce cumulative CO_2 savings of 680 ktonnes compared with business as usual (BAU) over the period 2016 to 2050. (BAU is taken as the Ofgem LENS Report `Big T&D' scenario.) Approximately 90% of these savings come from reduced distribution losses, the remaining 10% being attributable to reduced network reinforcement.

A national rollout would additionally reduce carbon emissions by enabling cheaper and quicker adoption of low carbon technologies such as distributed generation, electric vehicles and heat pumps. This is because the Project will provide the most timely and cost effective 11kV network infrastructure necessary to support the implementation of these technologies. Although not realistic to quantify, the carbon savings enabled in this way are expected to be far greater than the direct project benefits.

We have calculated the **NPV of carbon benefits** to 2050 attributable to a GB wide rollout of the Methods to be £36.3 million due to the sources of CO_2 saving summarised above.

b) Has the potential to deliver net financial benefits to existing and/or future customers
FALCON has the potential to deliver:

- lower connection costs, particularly for 11kV connections but also, potentially for LV connections that trigger constraints on the 11kV network;
- lower DUoS for all customers through a reduced asset base;
- potential for a new revenue stream for distributed generators and customers able to offer demand side management services.

FALCON will achieve this by:

- providing early visibility of the 11kV network, an area of the network which DNOs have traditionally never monitored and, hence, have little or no visibility of capacity and quality of supply across the network;
- using this visibility to target 11kV network investment where it is needed, avoiding stranded assets;
- enabling the selection of the optimum technique or combination of techniques for a given constraint through a network investment tool that has been tested and tuned against the results from physical trials;
- supporting stress testing of selected solutions against a wide scenarios of future demand profiles to understand the sensitivities and trigger points for changing solutions.

Traditional reinforcement of the 11kV network in the first year of DPCR5 for WPD's East Midlands network was £3.7m. Clearly, such low levels of network reinforcement do not incentivise innovative projects such as FALCON.

4: Evaluation Criteria contd.

However, a 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, Table 6.1) predicted future national 11kV investment based on traditional reinforcement in the range of £0.7 bn to £4.5 bn. The range in predicted investment reflects different scenarios of low carbon technology uptake ranging from 10% to 100%.

The investment costs used in the preparation of this submission are taken from this report as it has direct relevance to the Project as both Central Networks and WPD contributed to the base data including network details of parts of the Central Networks system and actual network capital investment costs. Therefore the investment costs in the ENA/ICL paper are reflective of WPD's direct experience of the costs of network reinforcement. LCNF recognises the need for preparation if we are to minimise this actual investment.

The Base Case Cost and Method Cost for this Project are contained in the Full Submission Spreadsheet in appendix A. These are based on the ENA/ICL predicted national 11kV network investment of £3.7 bn (based on traditional reinforcement to cope with a 50% uptake of low carbon technologies). This equates to an 11kV traditional network reinforcement cost in our trial area of £7m.

Based on our estimates of cost savings for each technique and their expected usage, the Method Cost for the project is calculated as £5.8m, giving a net financial benefit of £1.2m for our trial area. Our assumptions and calculations for arriving at this figure are explained in more detail in Appendix F.

The estimated cost saving of each intervention technique has been estimated based on the initial development of network design rules for the implementation of the technique. The project cost of £16.19m includes testing, trialling, validation, scenario modelling and dissemination of learning for each intervention technique, the SIM and the demand profiling. The majority of these are one-off costs which will not be incurred once the technique has been proven and is verified for implementation. The learning from the SIM will enable DNOs to select the optimum intervention technique for each constraint.

c) Level of impact on the operation of the Distribution System

Once it has been proved successful, the results of the Project will have a profound impact across all areas of WPD's business (and, following dissemination, all DNOs' businesses)

- **Investment strategy**: through the SIM, the Project will enable investment strategy to be set and tested against a set of internal and external load profile scenarios that reflect different economic, regulatory and customer behavioural outcomes. Performing such sensitivity analysis will facilitate a better understanding of investment trigger points which can then be used to revise strategies in the light of changes in future demand.

- **Investment planning**: the SIM will provide network planners with better visibility of current and future 11kV constraints and predict how these constraints may change under different load profile scenarios. Through the SIM, the Project will allow network planners to model multiple techniques and combinations of techniques for alleviating these constraints, comparing each solution against a common set of evaluation criteria in order to determine the optimal solution. As a follow on to this project, and subject to further investment in the SIM, we envisage other DNOs adopting the new guidance and design rules that are a key deliverable and success criteria for the Project, and we also envisage other DNOs adopting SIM use for network planning.

- **Network operations**: of the intervention techniques trialled within the Project, two of these techniques will require active management. To reduce the impact on customers we have introduced a trials network manager which is separate from the existing operational network management platform. The operational network management platform will take priority and can override the network management platform at any point to ensure that supply to customers is not impacted during the trial phase of the project.

- **Payments and settlements**: the two commercial techniques will require development of new contracts and payment terms. Response to DG/DSM calls will need to verified and appropriate payments made, depending on the contracts put in place.

4: Evaluation Criteria contd.

d) Generates knowledge that can be shared amongst all DNOs

The Project will deliver incremental learning in a number of areas:

- It will enable DNOs to compare the relative merits of a variety of different alternative techniques or combination of techniques for solving network constraints by applying a common set of evaluation criteria (previous trialling having concentrated primarily on evaluating the effectiveness of a single technique).

- It will allow DNOs to test the relative effectiveness of technical and commercial techniques in solving the same network constraint.

- It will allow DNOs to stress test their 11kV investment strategies by comparing their effectiveness under a range of different future load profiles that reflect varying economic, regulatory and customer behavioural outcomes.

- It will provide insight into current and future constraints on the 11kV network, an area of the grid which has, to date, had little or no monitoring.

- It will evaluate the use of existing settlement data in modelling secondary substation and LV feeder load as an input to power flow modelling. It will also evaluate the use of revised settlement profiles in generating future load profiles based on varying degrees of uptake of low carbon technology, validating these profiles against real metered profiles for areas with installed low carbon technology by leveraging WPD's existing LV Network Templates 2010 LCNF Tier 2 bid (WPDT2001).

- It will deliver new learning from the six technique trials such as the use of mesh networks in suburban and rural areas, the use of automated load transfer, DSM and DG in a proactive, pre-fault manner to improve power flows rather than the more traditional reactive, post-fault rectification mode and the use of a highly innovative new battery technology.

- It will inform deployments of secondary substation metering based on the results of the evaluation of existing settlement data in power flow modelling. The Project will provide a quantitative assessment of the accuracy of aggregated settlement data by comparing this with load data metered at secondary substations. Depending on the accuracy of the load profiles derived from existing settlement data, meter deployment can be targeted in areas of constraint, thus focusing investment where it is most needed.

- Finally, the Project will generate learning that extends beyond the DNOs. The results of the comparison between estimated and measured substation demand will enable assessment of the accuracy of settlement profiles and feed into the work of the Profiling and Settlement Advisory Group that is debating the future of non-interval settlement in light of the mandated rollout of smart metering.

e) Involvement of other partners and external funding

Logica (Project Partner)

Role: Project support functions of overall project together with specialist roles such as Quality and Benefits Management. Logica will also provide assistance obtaining and processing existing settlement data provided to generate half-hourly load profiles at secondary substations and, potentially, LV feeders. Logica is also an implementer of DPLAN, one of the network modelling tools being considered for the SIM.

Credentials: Logica currently programme manages UKPN's 2010 Tier 2 Low Carbon London project, having previously helped UKPN in the design and bid for the project. Logica combines deep industry experience (based on long involvement at the heart of the GB utilities market) with a proven track record for delivering complex programmes and projects to time and budget (e.g. 1998 settlement systems, NETA, BETTA etc.). Logica designed, developed and has operated for the past ten years, the ELEXON settlement systems which will be required to calculate substation load profiles from existing settlement data. Logica has also implemented DPLAN for EDP in Portugal as part of their EU-funded InovGrid project.

4: Evaluation Criteria contd.

Aston University (Project Partner)

Role: Construction of the simulation harness for the initial defined network incorporating six primary and two hundred secondary substations which will be used to simulate the six specified technical and commercial intervention techniques.

Credentials: Aston University has a strong track record of engagement with the power industry. It has current CASE and KTP Projects with WPD (East), including an ongoing project investigating meshed networks, and a further CASE Award with Alstom Grid.

Cranfield University (Project Partner)

Role: Cranfield University, through its IVHM Centre, will lead the design and build of the SIM, a computer simulation of the 11kV system that will include visualisation.

Credentials: Cranfield University has extensive expertise in the construction of simulators. They have provided the technical know-how to diverse projects such as Unmanned Combat Air Vehicles through to a complex science investigation into the concepts of the Smart Grid using agent-based modelling to address energy supply and usage issues.

University of Bath (Project Partner)

Role: The University of Bath will lead the knowledge capture, dissemination and customer engagement within Project FALCON. The University of Bath will also be responsible for modelling the commercial techniques within the SIM.

Credentials: The University has significant experience in engaging with DNOs and the power sector in a variety of power and low carbon related projects. They have been involved in a significant number of relevant large projects across the 132kV, 33kV, 11kV and LV distribution networks. They are currently managing knowledge dissemination for WPD's LV Network Templates 2010 Tier 2 project (WPDT2001), are proposed to perform this role on WPD's BRISTOL 2011 Tier 2 project (WPDT2003) and will bring this experience to bear on FALCON. In its dissemination management role, Bath will also manage the **Open University** who will provide dissemination services through their award winning public engagement internet operations.

Cisco (Project Partner)

Role: Cisco will be responsible for the design and supply of the communications infrastructure required to remotely monitor and control the substations involved in the FALCON technical intervention techniques. They will also be responsible for cyber security testing of the communications infrastructure.

Credentials: Cisco has worked with several utilities to provide IEC 61850-compliant substation communications architectures. They have experience of delivering standards-based, secure and scalable IP architectures for substation SCADA including a project for Duke Energy, one of the largest electricity companies in the United States.

ELEXON (Project Supporter)

Role: ELEXON will assist in obtaining the customer settlement data to be used to build substation load profiles for modelling purposes. They will also provide access to the systems required to process and aggregate this data to specific substations/HV feeders.

Credentials: ELEXON delivers the Balancing and Settlement Code (BSC) and the services that underpin the successful operation of Great Britain's electricity trading arrangements.

4: Evaluation Criteria contd.

ElectraLink (Project Supplier)

Role: ElectraLink will be responsible for the development of enhanced customer load profiles based on physical and demographic characteristics of residential and non-domestic properties, including uptake of low carbon technologies such as electric vehicles, heat pumps and photovoltaic cells.

Credentials: ElectraLink has managed the Data Transfer Service, a network central to the GB electricity retail market since 1998. ElectraLink's subcontractor **(Katalysis)** has an extensive background in the data sources required for this modelling and have recently supported the Department of Energy and Climate Change (DECC) in the development of its National Energy Efficiency Data Framework, a project set up to develop DECC's understanding of energy use and the impact of energy efficiency measures. This framework brings together energy consumption data at property level and matches this with property attribute data and records of energy efficiency measures installed and will form the basis for the new profiles that Katalysis will produce.

GE (Project Supplier)

Role: The design and supply of Energy Storage Systems (ESS) for distribution level electrical installations.

Credentials: GE has a proven track record of innovative installations and safely working in distribution substations globally. Given the innovative nature of the technology, there are no case studies for ESS, however GE's new batteries last up to 10 times longer than traditional backup storage systems, need little maintenance, produce no toxic chemicals, are recyclable and have remote monitoring capabilities.

Milton Keynes Council (Project Supporter)

Role: As a Project Sponsor, Milton Keynes Council will be stimulating targeted initiatives throughout the borough where the effects of monitoring and interventions can be seen and measured. They will also help facilitate discussions with prospective DG/DSM providers.

Credentials: It is our belief that by involving a major Borough within the WPD region demonstrates the local commitment to FALCON and furthermore demonstrates the Council's commitment to their carbon reduction programme. This is evidenced by their Low Carbon Living Programme and their ambition to be an exemplar to their community.

Alstom (Project Partner)

Role: Alstom will be responsible for the development of the dynamic asset management, automated load transfer and meshed network. They will undertake protection design, equipment and trials network platform supply.

Credentials: Alstom is a global leader in power transmission design, development and equipment supply

JRC (Project Supplier)

Role: JRC will provide radio planning and frequency allocation for the telecommunications infrastructure.

Credentials: The JRC have for many years provided radio frequency management and planning to several DNOs and National Grid.

4: Evaluation Criteria contd.

f) Relevance and Timing

FALCON is focused on identifying and solving constraints on the 11kV network in the most cost-effective and timely manner possible. Since the 11kV network is not currently monitored, the degree of headroom within this area of the grid is not well understood. It is, therefore, difficult to be definitive regarding the imperative for gaining visibility of the 11kV network. However, there is justification for doing this sooner rather than later to inform the 11kV investment strategy. If there is found to be more capacity in the 11kV network than previously thought, this will allow investment to be diverted to more constrained areas of the network; if there is found to be less capacity in the 11kV network than previously thought, this will reduce the risk that 11kV constraints hinder the uptake of low carbon technologies and potentially extending 11kV asset life spans.

Assuming that the Project's use of existing settlement data proves to be a valuable tool in assessing the state of the 11kV network, this offers the DNOs the prospect of obtaining an initial insight into the state of their 11kV networks via an office-based exercise involving no field deployment of assets. This enables a national 11kV “health check” to be rapidly performed and the results used in subsequent planning for the low carbon technology transition.

One of the first deliverables will be visibility of the current and likely future state of the selected 11kV network. This will enable investment in general reinforcement of the 11kV network (£3.7m and £2.7m, respectively between WPD East and West networks) to be better targeted or, possibly, deferred if there is found to be sufficient capacity within the existing infrastructure.

The imperative for evaluating and comparing multiple alternatives to traditional 11kV network reinforcement is dependent on the current and predicted future state of the 11kV network, something that will be understood once we have delivered our first network model. However, current experience of the 2010 LCNF Tier 2 projects has highlighted the sensitivity of low carbon technology uptake to economic, regulatory and customer behavioural influences, reinforcing the need for testing network investment strategies against a broad range of future demand profiles, an ability that we will deliver.

The project spans four years and we are planning dissemination of learning throughout the life of the project, focusing specifically on influencing the ED1 submission. We have also started discussions with Ofgem to explore the means by which the phased learning will be made generally available to influence ED1 submissions.

4: Evaluation Criteria contd.

4: Evaluation Criteria contd.

4: Evaluation Criteria contd.

4: Evaluation Criteria images, charts and tables.

Evaluation Criteria Images

Section 5: Knowledge dissemination

☐ Put a cross in the box if the DNO does not intend to conform to the default IPR requirements

Knowledge capture and dissemination

New knowledge will be delivered in the form of a SIM. This will determine the best combination of technical and commercial techniques for managing a wide range of current and future network scenarios. Knowledge capture and transfer are vital to this project because it must provide GB with evidence for the future planning of investment in the electricity grid. In particular, DNOs and power companies not directly involved in FALCON need to be able to learn from the project and effectively employ its models, methods and insights in the planning and development of their own 11kV networks. The Project will also work best if it can capture knowledge from network trials that are completed or currently underway.

Knowledge capture

To maximise the value of the knowledge generated by the Project it must be properly recorded, stored, effectively shared with the right parties, resulting in appropriate learning and behavioural change. For these reasons, it is vital that a robust plan exists, in advance, for capturing and sharing new knowledge with key stakeholders and other interested organisations. Knowledge will begin to be generated very shortly after the inception of the project; it is therefore vital that our plans allow early capture and dissemination.

In Appendix G, we have listed a number of methods, tools, and systems for capturing, analysing and storing knowledge produced by the project, leading in turn to to a number of outputs (e.g., technical reports, papers and manuals). Our approach is based on practical experience of applying these methods by the University of Bath and the Open University (OU) in projects such as E.ON/EPSRC Transition Pathways to a Low Carbon Economy, MK Electric Vehicle plugged in places programme, and Department for Transport behaviour change work.

To ensure quality, outputs of the project will be audited. Our intention is to use a review panel of independent experts to review outputs to ensure that they are accurate, understandable and fit for purpose (we are in the process of approaching such people as Professor Raj Aggarwal (University of Bath), Phil Bowley (ex-Manager of Electronic Controls & Instrument group at RWE NPower, now independent), John Scott (Chiltern Power Ltd), David Tolley (ex-Commercial Director NPower, now independent)). The team also need to capture inputs through feedback from stakeholders and from other LCNF Tier 2 funded projects and other ongoing projects. We have identified four existing LCNF Tier 1 projects (EDFT1002, EDFT1001, SSET1001, SSET1003) and three existing Tier 2 projects (CET2001, EDFT2001, WPDT2001) with which we would benefit from sharing learning.

Key knowledge capture outputs

The new knowledge that will be generated about the 11kV network can be used to inform other LCNF projects and RIIO ED1 framework. Some of the key outputs to be captured and disseminated are, in chronological order:

- **Settlement/metered data comparison**: initial results from comparing substation/LV feeder aggregations of existing settlement data with load profiles from substations metered as part of WPD's LV Customer Network Templates 2010 LCNF Tier 2 project.
- **Final trial design** - captured in a set of Use Cases which define exactly what is to be trialled on the network and modelled within the SIM. This will be published in a report containing proposed technical solutions, associated benefits cases for each solution and initial outputs from modelling these solutions (comprising both individual and combined techniques) using network data.
- **Outputs of modelling intervention techniques within the SIM** - including analysis of network data and the superimposed load growth scenarios. This will be published as a technical report, supported by the SIM itself and additional technical design manuals and user guidance.
- **SIM investment plan** - using the outputs of the developed model to simulate 11kV investment for a range of demand scenarios. The results of running the model will be published.

Key audiences

The outputs need to be delivered to a number of audiences. The motivations, knowledge, needs and beliefs of each of these audiences will be different. As a result the content of different outputs must be tailored to audience needs. The dissemination team has identified four main audiences which must be reached:

5: Knowledge dissemination contd.

1. **DNOs, UK government, regulator and equipment manufacturers** - this audience re detailed interaction so that they are able to use the outputs of the project to inform investment decisions for the network, inform their other ongoing projects, support future development, and inform RIIO ED1 decisions. Dissemination will be primarily through spec workshops, training sessions, and ENA LCNF conferences. Examples of where this approach has undertaken successfully are in disseminating of outputs from the Long Run Incremental methodology by the University of Bath and the Open University's provision of training mater the Energy and Utilities sector.

2. **Industrial and commercial customers and distributed generators** - the benefits realise experience gained from participation in the demand side and distributed generation trials need disseminated to other parties who may be able to support similar commercial techniques dissemination to this audience will draw in particular on learning from the Milton Keynes Low Living Programme.

3. **Academia** - this group will benefit from the approaches and models being developed and th time network data available for the 11kV network. All the academic partners have long experie partnership working and joint publication and well know how to communicate to this audience.

4. **General public / schools** - although the project is focussed on the 11kV rather than t network, the general public would benefit from messages about energy use, energy efficiency, network development and lower energy lifestyles that can be distilled from the outputs of FA This will draw on planned dissemination in the BRISTOL project led by the University of Bath a the Open University's expertise from their involvement in the Milton Keynes Low Carbon programme, which showed public engagement through mass and web-based media an engagement of users of low carbon domestic technologies.

Dissemination methodologies

A comprehensive list of the dissemination methodologies to be undertaken with the different audien given in Appendix G. The project will use traditional media such as interactive workshops, conference training sessions combined with newer and electronic media to communicate to the various audience key dissemination events are illustrated in the figure at the end of this section and described in more below:

- **DE1: Month 0-3**: Two-day workshop with all LCNF Tier 2 funded and related Tier 1 projects req to attend. A similar workshop was undertaken by the CE Electric Customer Revolution P funded under LCNF 2010, and represents an example of good practice that can be replicate purpose of this workshop is threefold: 1) to outline the project, intended outputs, methodologi data gathering to be undertaken; 2) to gather feedback on the detailed synergies with projects, showing where information can be shared, additional validation undertaken and kno transferred - thus avoiding any duplication of work; and 3) to provide an early opportunity projects funded under LCNF 2011 to engage with each other. This could be jointly organise Project BRISTOL and the LV Network Templates project. This workshop will form a key part market research to inform the final version of the communications plan to different stakeholders.

- **DE2: Month 6-9**: workshop to share the outputs of the final trial design and identified 11kV h (from LV network template trial) with other DNOs / LCNF project partners, to highlight where developing learning that informs their work, and to receive feedback. This would be a fol workshop to the above, allowing the FALCON team to feedback to the other DNOs and LCN changes of scope resulting from the initial “show and tell” workshop.

5: Knowledge dissemination contd.

- **DE3: Month 15** - combined workshop with the LCNF LV Network Templates project to deliver of the modelling validation, the outline customer templates, and associated methodologi addition, DNOs begin to identify areas of their own networks on which data could be collect methodologies applied. Project partners from all LCNF Tier 2 projects funded in 2012 will be to identify further synergies with other projects. The outputs from FALCON and from this wo could be used by Fast and Non-Fast Track DNOs to inform submissions to RIIO ED1.

- **DE4: Month 24** - workshop to present the analysis of the network data through the S Investment Model and the outputs of the simulations of the intervention techniques to DNOs, UK Government and other LCNF project partners. The presented outputs of this workshop and technical reports could be used to inform proposals of DNOs not selected as "fast track" into th ED1 framework.

- **DE5: Months 33-45**: Workshops with DNOs and Government to explore how the SIM can network investment and policy. Through these engagements the FALCON team will elicit fe from stakeholders. Outputs from these meetings and workshops will be captured within the outputs, technical papers, and a final report.

- **DE6: Month 45-48**: Final project symposium to share outputs from SIM with stakeholders workshop will be used to disseminate all the findings and outputs of the project.

Track record

The knowledge capture and dissemination will be led by the University of Bath in conjunction with the OU. Bath has a long-standing track record with WPD is currently leading the dissemination within the LCNF Tier 2 LV Network Templates project. Bath is also the nominated dissemination partner for 2011 LCNF Tier 2 BRISTOL project. The University of Bath plans to co-ordinate dissemination across three projects to provide a single channel for communication to stakeholders thus simplifying dissem and maximising value-for-money to the customer.

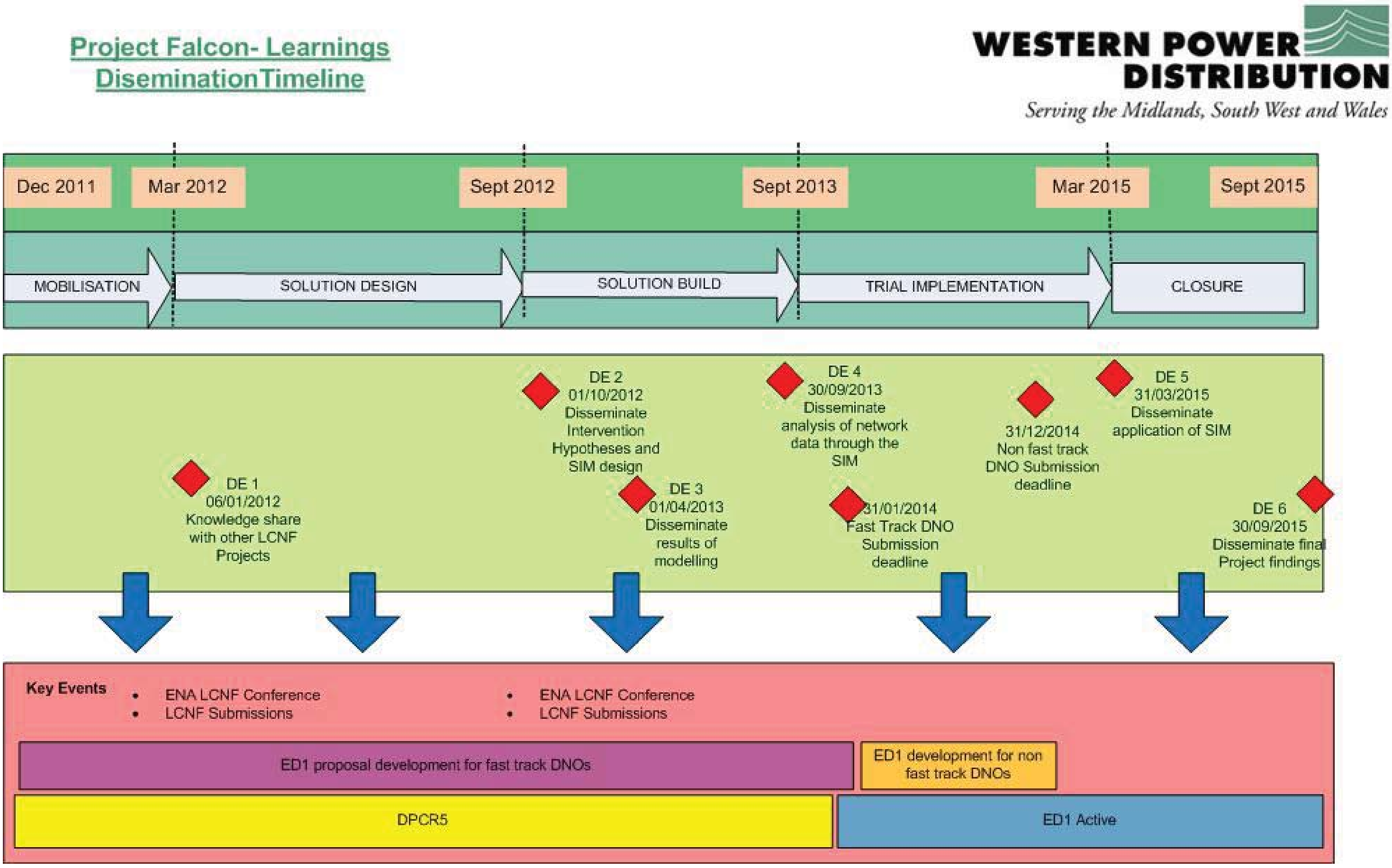
Similarly, the FALCON project will benefit from the stakeholder database, secure server, workshop and the experience gained from the dissemination activities currently underway in the LV N Templates project. FALCON can also benefit from the school engagement planned within the B project. Consequently, dissemination activities within FALCON can be developed more efficiently an effectively than if starting from scratch. The dissemination activities will be co-ordinated by Dr Ian currently project mentor for a Department of Transport knowledge capture and dissemination proje University of Bath is one of the UK's leading research institutions and has outstanding resources, ex and experience in industry collaboration and knowledge gathering that will support this project. Of pa note is the learning gained from Bath's many previous energy projects, not least Dr Furong Li's endorsed work.

The University of Bath will work in conjunction with the OU to utilise their innovative dissem methods. The OU is an internationally renowned as a distance learning university and has conducte standing research programmes on the influence of behavioural factors upon housing energy effi Since 2009, the OU has been working on activities for the Milton Keynes Low Carbon Living progr drawing upon their outstanding expertise in public engagement through mass and web-based media, their specific experience in engaging users of low-carbon domestic technologies. For example, the hosted user workshops in connection with the MK Electric Vehicle programme, produced an e-new and supported the programme's website and data repository development. The architectures for e these delivery elements are readily transferable to the dissemination of FALCON. The OU has experie working with industry sectors, including the energy and utilities sector, to provide interactive t materials, including the energy and utilities sector and award-winning public engagement i operations, e.g., OpenLearn, OU's iTunesU pages, OUverte and its Elluminate platform for conferencing.

IPR Status

We conform with the default IPR requirements.

5: Knowledge dissemination images, charts and tables.



Knowledge dissemination images

Section 6: Project readiness

Requested level of protection require against cost over-runs (%).	5%
Requested level of protection against Direct Benefits that they wish to apply for (%).	50%

How can we ensure a timely start to the project?

Senior management commitment
WPD board directors have been fully engaged in FALCON, from project inception and throughout the entire bidding process. WPD board directors have obtained commitment from the directors of Pennsylvania Power and Light, WPD's owners. This senior management engagement and commitment has been extended to our partner organisations and we are confident that this level of internal and external commitment will continue post bid submission and throughout the project lifecycle.

Our proposed governance model includes a Partner Forum comprising key stakeholders and decision makers within WPD and our partner organisations. The Partner Forum will be responsible for ensuring that FALCON achieves its stated Successful Delivery Reward Criteria (see section 9). Our chosen partners have all committed to attending this forum, as evidenced by the letters of support contained in Appendix H.

WPD internal engagement
Pre-acquisition, WPD and Central Networks (CN) had individual visions of low carbon and sustainability. Upon acquisition, it transpired that these were complementary. We now have a joint vision, reflected in a single Future Networks Programme. The alignment of the vision, programme and teams mean the Programme has more resource to develop and deliver innovative low carbon projects.

During the bid key internal stakeholders have been identified and actively engaged to ensure successful project delivery. The key project roles have been defined in Appendix D figure 4.

WPD is currently delivering two of the four winning 2010 LCNF Tier 2 projects. The experience gained through this will help to ensure that FALCON achieves a timely start and is delivered successfully.

Project readiness considerations
In planning this project, we have focused on what is required to achieve a timely start. In particular, we have considered the following key areas:

- developing a robust project plan;
- seamless transition from bid to delivery;
- clear governance model;
- experienced and capable project team;
- partner engagement;
- customer engagement;
- project logistics;
- learning from 2010 projects.

Project Plan
With the support of our partners we have developed a high level milestone plan supported by a detailed Project Plan. The high level plan and a snapshot of the detailed plan contained in Appendix D, figures 1 and 2. This establishes a strong foundation for detailed design activities to take place in a timely manner.
The full detailed plan can be provided upon request.

6: Project readiness contd.

Key early activities include:

- finalising the detailed scope with our partners;
- initiating the banking arrangement process;
- confirming the formal appointment of the Project Manager, Project Team members and the Technical Design Authority.

In parallel to a detailed plan we are actively managing the risks associated with the Project, a snapsh the latest risk register is shown in Appendix D, figure 3.

Early engagement with partners, particularly in the planning stages, has been vital to gaining a con understanding of the aims and objectives of FALCON and the roles and responsibilities of WPD anc partners for achieving these. This open approach has also led directly to the creation of the Partner F and, from our experience of working on other LCNF projects, will be a key factor in the successful de of the project.

Seamless transition from bid to delivery
In order to ensure a timely start to the project, key members of the bid team will move into the pı delivery phase, thus ensuring continuity. This approach will mitigate the risk of knowledge gaps and on the partner relationships that have been forged during the bid process. This approach will als adopted by Logica, our project partner designated to provide project support, who intends to retaiı project and technical expertise that has been deployed on the bid on into the delivery stage.

Governance model
WPD's strong internal senior management oversight and reporting regime will ensure the Proje monitored and governed appropriately.

A Project forum will provide for external parties to provide peer group input and to be updated oı progress of the Project.

Experienced and capable project team
We have engaged Logica as our partner in the development of the bid with the intention of combinin extensive experience and capability in successfully delivering large, complex projects to deliver the Project.

As evidence of this capability, we have included below recent examples of successful projects which been delivered by the WPD and by Logica:

> ***WPD - GIS data capture and data upgrade***
> This was a complex data capture and data update project, which realigned over 17 million records. Production commenced in Sept 2007 with 182 Rolta staff based in Mumbai. The project over £7 million and at its peak used over 350 staff in India as well as support from of approxim 220 other staff. It was delivered to time and budget.
>
> ***WPD Network Innovation projects***
> We have successfully delivered the first UK Registered Power Zone (RPZ), which has been v acclaimed. This used the innovative method of "Dynamic Asset Rating" on the 132 kV circuits int RPZ, allowing connection of new generation more quickly and at lower cost. The learning from project will be used in developing the Dynamic Asset Rating technique for the 11kV system. W also on track with delivering two out of the four winning 2010 LCNF Tier 2 projects, namely templates and Low Carbon Hub.
>
> ***Logica- Police National Database*** - This is an example of a large scale, complex project with visibility to the general public. In April 2009, the National Policing Improvement Agency (I awarded Logica a £75.6 million contract over seven years to design, build and operate the National Database (PND). This was recently successfully delivered with a number of partners incl Northgate Information Solutions (NIS) and SunGard Public Sector (SPS).

6: Project readiness contd.

Partner engagement

We have been working with our partners since March 2011. We selected our partners through a structured Request for Information (RFI) process prior to the Initial Submission Process (ISP). The RFI process included an evaluation which was finalised on 4th April. This process laid the foundation for a clearly defined work share with clearly defined terms of reference for each partner.

During the period April to July, working under signed NDA agreements, we conducted a series of clarification question and answer sessions to refine both project scope and work share. On completion of these sessions, we held an all partner workshop confirm overall awareness of the project, the individual trials and each of the partner's roles. Based on this common understanding, we put in place individual Memorandum of Understandings (MoUs) with each of the partners during August, all of which have now been agreed.

Throughout this process we have been cognisant of the need to ensure consistency, transparency and openness in order to get all partners aligned.

The work share and individual scoping documents have been refined with all parties along the way and now have full agreement. This ensures alignment with project objectives as well as a partnership approach to planning.

Customer engagement

Over the last year, we have engaged with ten Industrial and Commercial customers in the areas where the network trials will be conducted. These include customers such as: Thameswey (the local heat and power operator for parts of the central business district of Milton Keynes), Santander (banking group) and Dominos (food manufacturer). These customers have indicated their willingness to participate in demand side management and distributed generation trials.

Project logistics

We have been working as a co-located team since March 2011. We believe that co-location of resource from the different project partners has been instrumental in producing this bid and therefore we would look to continue this approach throughout the project. A suitable project space has been identified in the WPD Milton Keynes offices and will be made available should this bid be successful.

Learning from 2010 projects

Our LCNF Tier 1 Programme and existing Tier 2 projects, LV templates and Low Carbon Hub have provided FALCON real insights into the intricacies of delivering large scale LCNF projects. We have coupled this learning with that of Logica's in their programme management role on UKPN's 2010 Tier 2 Low Carbon London project to produce what we believe is a comprehensive set of insights to embed into and improve our project.

How we have estimated our costs and benefits?

We have undertaken a bottom up approach to building the cost model and top down reviews to ensure sensible cost apportionment across the project. During the bid development phases and through the RFI process, we have spent time with partners agreeing scope and work break down structures. This enabled the partners to generate detailed costs based on the scope. The costs have undergone rigorous review by both the bid team and the WPD Central Finance team. During the reviews, duplicated scope and the associated costs have been identified and eliminated where appropriate.

Benefits

We have based the benefits on the projected HV investment as identified in the Imperial College/ENA Summary report on “Benefits of Advanced Smart Metering for Demand Response based Control of Distribution Networks”. This report identified a number of scenarios based on varying levels of low carbon technology penetration and the consequential investment required. In calculating the benefits of the Project, we have taken the Base Case Cost as the traditional reinforcement investment for the 11 kV system based on the 50% penetration scenario. Details of how the benefits of the Project have been calculated are contained in Appendix F.

6: Project readiness contd.

How will we minimise the possibility of cost overruns or shortfalls in Direct Benefits?

Costs have been estimated with the greatest level of accuracy and granularity as practicable at the time of bid submission. Based on the level of rigour we have applied to reviewing the cost model, we believe the possibility of overrun is minimal. To eliminate the possibility of cost overruns or shortfalls in Direct Benefits we will:

– implement strong governance;

– reduce uncertainty in the project at an early stage;

– implement risk management processes; and

– ensure costs are controlled.

Implement strong governance: WPD senior management will set project tolerances during the Project initiation phase against which progress will be monitored throughout the Project lifecycle.

Reduce uncertainty in the project at an early stage: It is essential to identify as many potential risks to cost overrun and shortfalls in Direct Benefits as possible: understand their likelihood; causes and impacts so that appropriate mitigations can be planned. We have already started this process as evidenced from the project delivery risks listed in Appendix D, figure 3. A very relevant example of our early use of the risk register relates to risk FAL001 on the risk register. Earlier on in the bid phase, during the WPD acquisition of Central Networks, the risk associated with resourcing the project team was given a high probability due to the organisational uncertainty. However, the risk register is a live document and is continuously updated. At the time of bid submission, WPD senior management identified and committed project team resources and appointed the project manager. External resources were committed from our partner organisations, (now captured in the form of an MOU). As a consequence of these actions the probability of resources not being available at the time of bid submission was substantially reduced.

We recognise, however, that risk management is iterative and we will continue to monitor, identify and mitigate risks as more information becomes available. We would anticipate the number and severity of the risks to diminish as we move from project initiation and mobilisation into solution design.

Implement risk management processes: Every risk will be assigned a specific owner based on the risk rating and the individual's ability to manage the risk. It is their responsibility to monitor the possibility of the risk occurring and implement the mitigation plan, if required. Through regular project team meetings and reporting, the Project Manager will be able to monitor the likelihood of the risk occurring and escalate, where appropriate, to WPD senior management.

Ensure costs are controlled: Quantitative risk assessments will conducted by the Project Accountant. They will ensure that all aspects of project financial control are implemented and adhered to throughout the project lifecycle. The appointment of the Project Accountant will strengthen the financial controls applied to the project.

How can we verify all the information contained in this proposal?

All data relating to the WPD network used in this proposal has been downloaded from operational information and is as used in the regulatory returns. Current 11KV investment of £3.7m for WPD's East Midlands network has been taken from WPD's 2010 business plan.

Base Case Costs

Base Case Cost data has been sourced from the joint Imperial College/ENA study `Benefits of Advanced Smart Metering Demand Response Based Control of Distribution Networks' (version 2.0, 07 April 2010). Specifically, the anticipated cost of 11kV investment based on traditional reinforcement has been taken from the 50% low carbon technology penetration scenario. This is an industry-accepted and peer-reviewed document.

6: Project readiness contd.

Hardware costs

To obtain costs for the hardware to be deployed in the project, we have issued a Request For Information (RFI) to a number of vendors with whom we have subsequently held detailed one-to-one discussions to set out the objectives of the trials and gain a better understanding of their products. As part of this process, we have requested and received case studies of previous installations.

The switchgear proposed for implementation of the automatic load transfer trial has been through the Energy Networks Association (ENA) Switchgear Assessment Panel. Similarly, the protection relays proposed for the implementation of the mesh network trial have been assessed by the ENA Protection Assessment Panel. The dynamic asset management trial has been designed based on experience gleaned from previous LCNF and IFI projects for overhead lines and transformers.

Environmental data

We have calculated the anticipated CO_2 emissions savings resulting from a national rollout of FALCON based on the Ofgem LENS `Big T&D' scenario. Appendix J gives full details of the assumptions and data sources used in our calculations.

Future verification

In order to further verify and refine the information we have used in developing our project, we have built into our plan a number of key processes and gateways. During the design phase, as described in our plan contained in Appendix D, we have included activities which allow us to conduct peer reviews of the information. Following these peer reviews, we will hold gateway reviews which are decision points for determining whether the project should proceed based on the current information or whether more information is required prior to continuing.

Our project team includes the role of an independent Technical Design Consultant. Part of this role will be to consider and review all the information used in the project from the perspective of verifying this before use. We have also included within our proposed project management office a Quality Assurance role. Part of this role will be to ensure all quality controls are applied correctly in a timely fashion and the results are recorded and circulated to appropriate parties.

6: Project readiness contd.

How will we identify the circumstances under which the Project should be halted?

In order to ensure that the project proceeds smoothly, the project contains gateway reviews at critical stages in its lifecycle, which are clearly indicated in the Project Plan.

The aim of gateway reviews is to assess whether or not the project can progress successfully to the next stage. They provide assurance that the project is on track and being run in an efficient and cost-effective manner and give further assurance to stakeholders and project team members alike that the project can proceed.

The gateway review is a snap-shot at the point at which the review takes place. As such, recommendations are based on the documents provided and the review process is intended to be supportive and forward looking.

WPD senior management, with the Project Manager will:

- review the project plan, cost model and RAID log;
- review the output of the phase;
- assess them against the Successful Delivery Evaluation criteria; and
- ensure that the best available skills and experience are deployed on the project.

WPD senior management will review and agree the risk level associated with the project and assign a status as outlined in Table 1 at the end of this section: **Delivery Confidence Assessment.**

They will then provide the Project team recommended actions. Actions fall in the following categories:

- **Critical (Do Now)**: to increase the likelihood of a successful outcome, it is of the greatest importance that the project should take action immediately;
- **Essential (Do By)**: to increase the likelihood of a successful outcome, the project should take action in the near future. Whenever possible, essential recommendations should be linked to project milestones and/or a specified timeframe;
- **Recommended**: the project would benefit from the uptake of this recommendation. If possible recommended actions should be linked to project and/or a specified timeframe;
- **Halt the project:** the project has exceeded the tolerances set and agreed at project initiation and the situation is deemed to be irrecoverable. The Project is to be halted and WPD senior management will contact Ofgem to discuss and agree the way forward.

We believe that this approach will give all the parties involved clarity and consistency from the outset.

6: Project readiness contd.

6: Project readiness images

Table 1: Delivery Confidence Assessment

Colour	**Criteria Description**
Green	Successful delivery of the project to time, cost and quality appears highly likely and there are no major outstanding issues that at this stage appear to threaten delivery significantly
Green/Amber	Successful delivery appears probable however constant attention will be needed to ensure risks do not materialise into major issues threatening delivery.
Amber	Successful delivery appears feasible but significant issues already exist requiring management attention. These appear resolvable at this stage and if addressed promptly, should not present a cost/schedule overrun.
Amber/Red	Successful delivery of the project is in doubt with major risks or issues apparent in a number of key areas. Urgent action is needed to ensure these are addressed, and whether resolution is feasible. At tis point we will notify Ofgem.
Red	Successful delivery of the project appears to be unachievable. There are major issues on project definition, schedule, budget required quality or benefits delivery, which at this stage do not appear to be manageable or resolvable. The project/programme may need re-base -lining and/or overall viability re-assessed.

Project readiness Images

Section 7: Regulatory issues

☐ Put a cross in the box if the Project may require any derogations, consents or changes to the regulatory arrangements.

At this stage we do not believe that the Project will require any derogations. In arriving at this conclusion, we have specifically considered the three areas which gave rise to derogation requests in last year's LCNF Tier 2 bids, namely:

- derogation from ER P2/6 (SLC 24) for reduced security level;
- derogation from SLC 13A.18 for relief of obligations under SLC 13A.1 to 13A.4 (obligation to comply with Common Distribution Charging Methodology (CDCM);
- relief from Interruption Incentive Scheme (IIS) for planned outages.

We discuss the rationale behind our conclusion for each of these areas below.

- **ER P2/6 (SLC 24)**: in selecting our trial area, we have deliberately avoided areas of the network that are already designated for DCPR5 reinforcement.
- **SLC 13A.18**: we are not planning to alter the current DUoS charging methodology for any customer within the trial area. This includes those customers actively participating in the two commercial intervention techniques (distributed generation and demand side management). The payments that these customers will receive in connection with their participation will be made independently of their DUoS charges, thus, we do not believe a derogation is required.
- **Relief under IIS**: the Project will necessitate installation of monitoring equipment on the network. Although every effort will be made to minimise impact on the customers during this installation (see section 8), some customer interruptions (CI) may be unavoidable. We currently estimate that CI will be required for 50% of the 200 secondary substation installations required, affecting approximately 10,000 customers in total. We estimate that the customer minutes lost for each affected customer will be approximately 120 (i.e. 2 hours). Based on these estimates, the protection of £125k has been calculated as shown in the table. This sum has been included in our project costs, accordingly.

In addition to the three areas listed above, we have also considered the wider implications of the Project but have not identified the need for any other derogations.

7: Regulatory issues contd.

7: Regulatory issues images, charts and tables

Variable	Item	Value	Source
A	Customers in WPD (East Midlands)	2,500,000	From WPD data
B	Secondary Substations	200	FALCON planned substations
C	% Secondary Substations affected	50%	Estimate of affected substations
D	Customers/Secondary Substation	100	Estimate of average number of
E	Interruption duration (mins)	120	Estimate of interruption time at each substation
F	Customers Affected	10,000	=B*C*D
G	Customers Interrupted	10,000	=F
H	Customer Minutes Lost	1,200,000	=G*E
I	Planned Interruption Factor	0.5	From IIS
J	CI Incentive Price (£/100 customers)	120,000	From IIS
K	CML Incentive Price (£/minutes lost per cust)	420,000	From IIS
L	Cost of CI (£)	24,000	=I*G*J/(A/100)
M	Cost of CI (£)	100,800	=I*H*K/A
	Total IIS cost (£)	124,800	=L+M

Regulatory issues images

Section 8: Customer impacts

The greatest impact on customers will be in providing lasting customer benefits which are outlined in section 3, the benefits section of this document. In describing the impact that the Project will have on customers within the trial area, it is useful to segment the customer base into groups:

1. all customers;
2. existing 11kV customers with controllable generation or load;
3. new 11kV customers.

The impact on each of these segments is described below.

1. All customers

National Energy Efficiency Data Framework
Part of the learning that the Project will deliver is the ability to model future demands on the network based on various different customer uptakes of low carbon technology. To do this, we intend building on the work already done by DECC in their National Energy Efficiency Data Framework, an initiative to develop understanding of energy use and the impact of energy efficiency measures. This will include a continuation of the customer engagement used within this programme to which Katalysis, one of the contributors to the Project, has been an instrumental part. We will also look to draw on the experience of the Open University such as the user workshops they ran in connection with the Milton Keynes Electric Vehicle Programme plugged in places and the customer engagement strategies they have developed including their award-winning public engagement internet operations such as OpenLearn, iTunesUpages, OUverte and their Elluminate platform for virtual conferencing. Only those customers who agree to participate in the Katalysis trials will be impacted.

Planned Supply Interruptions
The intervention technique trials will require us to install new equipment on the network. However, we believe that much of this can be installed with either minimal or no disruption to customers, using the same techniques that are used every day to minimise the customer impact of planned work. In the case of new technology (e.g. battery storage), we will look to learn from previous trials (e.g. EDFT1001) and, if deemed necessary, will first conduct installation trials, including off-line trials on a test network. The learning from this process will be applied to the detailed connection, technical design, planning and installation of this equipment.

WPD's LV Network Templates 2010 Tier 2 project has provided a great deal of learning regarding installation of substation monitoring equipment and, in particular, minimising customer interruptions (CI) and customer lost minutes (CML). WPD has also recently proposed an LCNF Tier 1 project specifically looking at what substation monitoring equipment is available on the market and its relative strengths and weaknesses. This has shown that there is a wide choice of metering solutions available and that choice is a balance of scope of usage, accuracy required, cost to the customer and customer impact (the installation of more expensive devices may have less customer impact). The final report is anticipated to be available in time to inform FALCON.

Based on our experience from WPDT2001 and this subsequent research, we believe that CI as a consequence of metering installation can be restricted to around 50% of sites (i.e. 100 secondary substations, equating to approximately 10,000 customers), each customer experiencing an interruption of approximately 2 hours.

We believe that all alternatives have been considered and that the proposals we have are the best for the customer and offer the least impact.

8: Customer impacts contd.

Unplanned Interruptions
We do not anticipate any unplanned interruptions to supply. Should the unforeseen need arise to reduce c customers' normal level of supply service we will follow our normal business processes of informing them the impact. Supply disconnection as a result of this project will only be considered as a last resort, followi utilisation of a switched alternative or temporary generation.

Charging
The impacts on customer charging will, where appropriate, be communicated by the agreed mechanisn Benefits to customers could include reduced connection charges and the potential for reduced DUoS.

Benefits through Automated Load Transfer and Meshed Networks
In the case of customers involved in the automated load transfer and meshed networks interventi technique trials, we anticipate a small beneficial CML and CI impact.

2. Existing 11kV customers with controllable generation or load
The greatest impact on those 11kV-connected customers who decide to actively participate in t commercial techniques (DNO control of distributed generation and demand side management) within t portfolio of alternative interventions that the Project will model and trial. For these customers, th involvement will span initial engagement, contractual negotiations and business-as-usual participatio Each of these phases is described in more detail below.

- **Initial engagement** in the early stages we will confirm candidate customers based on custom information held by WPD and supplemented with information from our Project Sponsor, Milton Keyr Council (MKC). MKC has also offered to help facilitate introductions in a series of one-to-one meetir with candidate customers (we have already held discussions with companies such as Thameswa Santander and Dominos and have received positive interest in participation in the project).

  The purpose of this phase of engagement is to identify a candidate set of participants. However, we v be equally interested in those customers who decline the opportunity of involvement, to bet understand the perceived barriers to participation.

- **Contractual negotiations:** Given our desire to manage constraints on HV feeders, it is highly unlik that we will have sufficient customers on any given HV feeder to set prices via an auction or competiti market. We will use our knowledge of traditional reinforcement costs to establish benchmarks to he with these negotiations. We will then look to establish appropriate bi-lateral commercial agreements give us access to generator support (technique 5) and demand side management (technique 6). The agreements will outline the terms and conditions under which we will be allowed to instruct t generation or load changes or, where appropriate, variations in power factor. The agreements will a cover practicalities such as submission of forecasts, mechanisms for issuing notifications, the periods notice that will be given, the form of payments (e.g. capacity and/or utilisation), the value of paymer to be made We want to be sure that the agreements and procedures we put in place will be applical and acceptable to a wide range of generators and commercial customers to enable a wider rollout at later stage once the value of these commercial techniques has been established.

- **Business as usual participation:** Once we have contracts in place, we will commence trialling of t commercial methods. The learning we are looking to gain from this phase of the trial is specifically t practicalities of using these techniques (i.e. reliability of response, ease of use etc.), its effectiveness as balancing tool and of equal, if not greater importance, the customer's experience of participation (we v be looking to the OU to engage with participating customers throughout the trial to capture this in number of innovative ways).

In order to maximise learning for all DNOs, we will capture the customer's perspective at every stage of t customer engagement process, from initial engagement through to business-as-usual operation. We v use this to derive meaningful insights into the best way of working with customers to deliver effecti commercial techniques.

8: Customer impacts contd.

3. New 11kV customers

Future new customers connecting to the 11kV network may receive faster and/or cheaper connections if the connection requires 11kV reinforcement and alternative techniques can be used (we have assumed, for business planning purposes, that 50% of 11kV constraints will be best alleviated using traditional reinforcement).

In regard to the connection offer process, for the duration of the Project, new connection offers will remain based on the existing network reinforcement methodology.
The full value of the project cost for a new connection in the FALCON trial area is to be costed on the assumption that the trial equipment will be removed, therefore designed in accordance with the traditional reinforcement strategy. If, at the end of the FALCON project, the benefits borne and technology is suitable to be left on the network and means that the works quoted for the new connection are no longer required, then the additional money from the customer will be returned.

We will also make all 11kV customers connecting within the Project trial area, if they have the required characteristics, aware of the project and the benefits of participation.

Cheaper, faster connections apply equally to new LV customers, if their connection triggers 11kV reinforcement that can be avoided using one of the six intervention techniques.

8: Customer impacts contd.

8: Customer impacts images, charts and tables

Customer Impacts images

Section 9: Succesful Delivery Reward Criteria

Criterion (9.1)

The Scenario Investment Model (SIM) design blueprint will be complete by September 2012 and a prototype visualisation developed.
Cranfield will lead design workshops to determine the user requirements and detailed functionality required. Attendees at the workshops will be ElectraLink, ELEXON, University of Bath and WPD. The workshops will determine aspects such as the database sizing, the data architecture, and the input and output criteria required. A customer data privacy strategy will be developed. Coding standards, version control and back up methodologies will be developed. A separate activity will take place to determine the means of loading measurement data from the 200 trial substations and other available SCADA data. This will include the design of the Cisco telecommunications network infrastructure. We will have a fully designed blueprint of the functionality and equipment required for the SIM. At this stage, Cranfield University will have recruited the development and build team. The design will be reviewed by all the partners and signed off by WPD Technical Experts and responsible managers and the learning from this phase will be shared with other DNOs and the wider industry.

Evidence (9.1)

Commercial agreements will be in place with Cranfield University, ElectraLink, ELEXON, University of Bath, Alstom, Cisco and Aston University by March 2012. Decision made on the required hardware and software to be purchased. The SIM design blueprint will be documented. A prototype visualisation of the SIM will be developed and available for viewing. A customer data privacy strategy, data resilience and back up methods developed and documented. A draft operations manual for SIM will be produced by 28th September 2012, which will be refined in the subsequent phases. All documents will be stored in the project files and subject to version control as per the configuration plan.
A comprehensive communications plan detailing knowledge dissemination roles and responsibilities and activities will be complete. A specific workshop will be held with other DNOs and LCNF project partners to share the output of the final trials design (Milestone DE2). A FALCON website, e-newsletter and podcast will be developed and established to disseminate the learning to a wider audience.

Criterion (9.2)

Substation load estimates will be developed based on industry and consumer data (initial report by September 2012). The effectiveness of using estimates as an alternative to physical substation monitoring will be established by the project. The SIM will compare the effectiveness of estimated and measured load data. ELEXON, ElectraLink and Katalysis will establish the estimated consumptions using total consumption data, and applying new profile curves to determine half hourly usage. The profile curves will be defined building on work carried out in previous studies by WPD and others (reflecting drivers such as building heating efficiency and heat loss, economic factors, etc). The initial load estimates will be developed based on the substations within the WPD LV Network Templates project. Measured substation data for comparison purposes will be obtained from the telemetry equipment already installed.

Subsequently the estimated load data will be applied to customers in the FALCON trials area for use in the SIM. The estimated data will be further refined using measured data from the 200 intelligent substations later in the project. The effectiveness of using estimated substation load data will thus be determined.

Evidence (9.2)

Data access agreements will be in place with required processes approved for use by ELEXON by 31st March 2012. New customer groups will be defined and estimated demand profile curves developed by 19th September 2012. By 28th September 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. The data gathered will enable improved demand profile curves to be developed and further comparative iterations carried out. 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. By 27th September 2013 the estimated demand profile curves will be applied to the trial area in order to refine the SIM. Real network data will be gathered from the trials and loaded onto the SIM by 19th September 2014. Demand profile curves will be further refined. A final report on the effectiveness of using estimates as an alternative to physical substation monitoring will be disseminated by 30th September 2015 (Milestone DE6)

9: Succesful delivery reward criteria contd.

Criterion (9.3)

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.

Multiple Load scenarios will be developed reflecting different assumptions for the future values of the consumption drivers. There will be a minimum of four scenarios but there may be many more. Some of the scenarios will use similar assumptions to those underlying the load scenarios put forward by DECC and Ofgem.

UK wide assumptions will be separated into regional values using publicly available data or purchasing specialist datasets. E.g. economic forecast data will be applied at the lowest level that it is cost effective to obtain data. The required network design scenario requirements for the SIM will be determined. Scenarios where the network designs to be tested can not be automatically generated will be identified. Designs will be created manually and stored as scenarios for use by the SIM.

Evidence (9.3)

Purchase agreements for specialist datasets will be in place.

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).

We will share the design scenarios requirements, which will be included within the testing specification.

Criterion (9.4)

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

Cranfield will issue a system design document based on our functional design specification. The hardware and software to build the SIM will be purchased and Cranfield will commence coding and integration of the software components. They will agree the system test specification with WPD and load the scenario data, the industry data and the measurement data. The SIM will then be run in line with the system test previously agreed.

After the period of testing, an initial run will take place. We will have a better understanding of where the `hotspots' are in the network now, and the available headroom to accommodate low carbon technologies. Utilising the forecast scenarios we will understand where the hot spots will be under a series of low carbon uptakes. This will allow us to confirm a range of investment needs of the 11kV network in the target area. The learning from this phase will be shared with other DNOs and the wider industry.

Evidence (9.4)

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

A system design specification will have been developed.

A system test plan will have been created.

The first outputs from the SIM will be available for viewing.

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(Milestone DE2).

The wider learning gained from the Build phase of the project will be disseminated as per the communications plan.

9: Succesful delivery reward criteria contd.

Criterion (9.5)

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. Alstom and Aston University will prepare and agree with WPD equipment, resourcing and deployment specifications for Intervention Techniques 1-3. WPD and Aston University will prepare and agree a functional specification for substation batteries and agree technical and commercial arrangements with GE. Alstom and GE will build the key components and WPD will witness factory testing. Key components will be deployed in the trials area with the Cisco monitoring equipment. A programme of field testing will take place. Trial data input into the SIM and analysis will demonstrate effectiveness in terms of time saving, customer service and cost efficiency of the deployment of T1 - DAR onto one primary substation and 6 11kV circuits; T2 - ALT: three automated load transfers schemes across 6 11kV feeders; T3 - Meshed Networks: on 6 11kV circuits; T4 - Storage: batteries in 5 distribution substations. The learning from these activities will be shared with other DNOs and the wider industry. The results obtained from these trials will be fed into the SIM and further modified trials will be deployed with final results available in March 2015.

Evidence (9.5)

The equipment, resourcing and deployment specifications for Intervention Techniques 1-3 will be documented.

Functional specification for substation batteries (Intervention Technique 4- Storage) will have been created.

Technical arrangements with GE will be documented and supported by formal commercial agreement.

The results of the field testing, loading the results of the trials in the SIM, and subsequent analysis will be available and disseminated as detailed in the communications plan.

A specific workshop will be held to present the analysis of the network data by the SIM (Milestone DE4).

Criterion (9.6)

The Commercial intervention technique trials will be deployed onto the network. The results will be analysed and dissemination by December 2014.
Customers taking part in trialling Intervention Techniques 5 - DG and 6 - DSM will obtain a new revenue stream. Through these trials we will inform best practice for how DNOs will engage with I&C customers. University of Bath (UoB) will develop a detailed specification for trials e.g. the amount of demand we would want to move and develop the customer engagement strategy and propositions. Working with MKC, customers in the target area will be approached and a commercial agreement negotiated. The energy retailers of customer's choosing to be part of the project will be notified and invited to be more actively involved. Through loading the results of the trials in the SIM, we will understand the effectiveness in terms of time saving, customer service and cost efficiency of the deployment. In addition to the evaluation criteria outlined above, we will find out how attractive the propositions are with I&C and DG customers. The learning from these activities will be shared with other DNOs and the wider industry. The results obtained will be fed into the SIM and further, modified trials will be deployed with final results available in March 2015.

Evidence (9.6)

A commercial agreement will be in place with the University of Bath by March 2012.

A comprehensive specification document detailing Intervention techniques 5 and 6 will be produced i.e. components and locations of each of the trials.

Use cases detailing the learning requirements and outputs from the implementation of the two commercial trials.

Commercial agreements with customers will be signed.

The learning obtained from loading the results of the trials in the SIM and their subsequent analysis will be available and disseminated as per the communications plan.

A specific workshop will be held to present the analysis of the network data by the SIM and the outputs of the trials (Milestone DE4).

9: Succesful delivery reward criteria contd.

Criterion (9.7)

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

An optimised future business plan for the trials area will be developed. We will be able to compare this plan with the results of the updated run of the SIM outlined in criterion 9.4.

We will obtain an understanding of key sensitivities of low carbon uptake rates in a defined area and discuss these with Ofgem to assist in the design of suitable regulatory mechanisms.

As the intervention technique data becomes available, the SIM will be refined with multiple intervention techniques deployments and iterations of the SIM.

We will continue to develop the future low carbon uptake data, taking into account latest developments in government policy and low carbon technology.

The industry data will also continue to be enhanced including the introduction of data smart meter installed in the trials area.

Evidence (9.7)

Improved industry data will be documented and shared with the industry.

An investment plan will be developed and operational manuals for each intervention technique will be developed and available for dissemination.

A final report consolidating the learning and the recommendations from the SIM will be developed and available for dissemination.

Workshops will take place with other DNOs and Government to explore how the SIM can inform network investment and policy (Milestone DE5)

A final report 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.

A final project symposium to share the outputs of the SIM will take place (Milestone DE6) and the findings and the outputs of the whole project will be shared.

Criterion (9.8)

Evidence (9.8)

Section10: List of Appendices

A. Full Submission Spreadsheet

B. Maps and Network Diagrams

C. Technical Overview

D. Project Support Documentation

  a. High Level Plan (Fig 1)

  b. Project Schedule (Fig 2)

  c. Risk Register (Fig 3)

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APPENDICES

Contents

Appendix A - Full Submission Spreadsheet

Full Submission Spreadsheet is attached as a separate document.

Appendix B - Maps and Network Diagrams

The trials area will provide the test bed for proving the practicality and responsiveness of the six techniques. The data gathered from the trails will be used in the SIM.

In order to ensure maximum benefit and robust assessment, the trials area we have chosen for the Project:

- includes a mix of urban, suburban and rural networks;
- includes both overhead and underground linear assets;
- is reasonably geographically contained to minimise travel and implementation costs;
- avoids areas already designated for DCPR5 investment;
- is appropriate for the technique(s) being trialled (e.g. includes open ring circuits, in the case of automated load transfer and mesh networks techniques, has a sufficient density of HV connected customers in the case of the DSM technique);
- has a high probability of becoming constrained in the near future (within 10 years).

The attributes of network that is required for each intervention technique are:

- **Dynamic Asset Rating** – Urban and rural networks including radial, open ring and meshed network types.
- **Automated Load Transfer** – Urban and rural networks with open ring networks
- **Meshed Networks** - Urban and rural networks with open ring networks
- **Storage** - Urban and rural networks including radial, open ring and meshed network types.
- **Distributed Generation** – presence of one or more DGs on the network (this would normally be in an urban area with open ring network)
- **Demand Side Management** - presence of one or more HV customers with flexible demand on the network (this would normally be in an urban area with open ring network).

In deciding on the scale of deployment, we have struck the optimal balance between maximising the statistical validity of the trials and minimising the cost and risk of delivery in order to provide best value-for-money. The Trial area selected for the project is the South East Midlands. We believe this area provides a representative mix of customers and assets. It is mainly constructed of overhead and underground open ring networks with a few radial spurs, together with a number of distributed generators and HV connected customers. The different network configurations and customers in this trial area are representative of over 90% of the national 11 kV network. The other 10% of the existing national HV network comprises of meshed networks and radial 11 kV feeders. All of the techniques being trialled, with the exception of automated load transfer would be applicable to existing meshed networks and radial networks.

Our trial area will comprise six primary substation transformers, namely: Newport Pagnell, Childs Way, Newton Road, Fox Milne, Bletchley Grid and Marlborough Street. These substations supply 80 HV feeders totalling 350 km of linear assets (both overhead and underground). The substations serve 200 secondary substations which, in turn, serve 55,000 customers.

Figure 1 below, shows the location of each of the six primary substations and the area they feed.

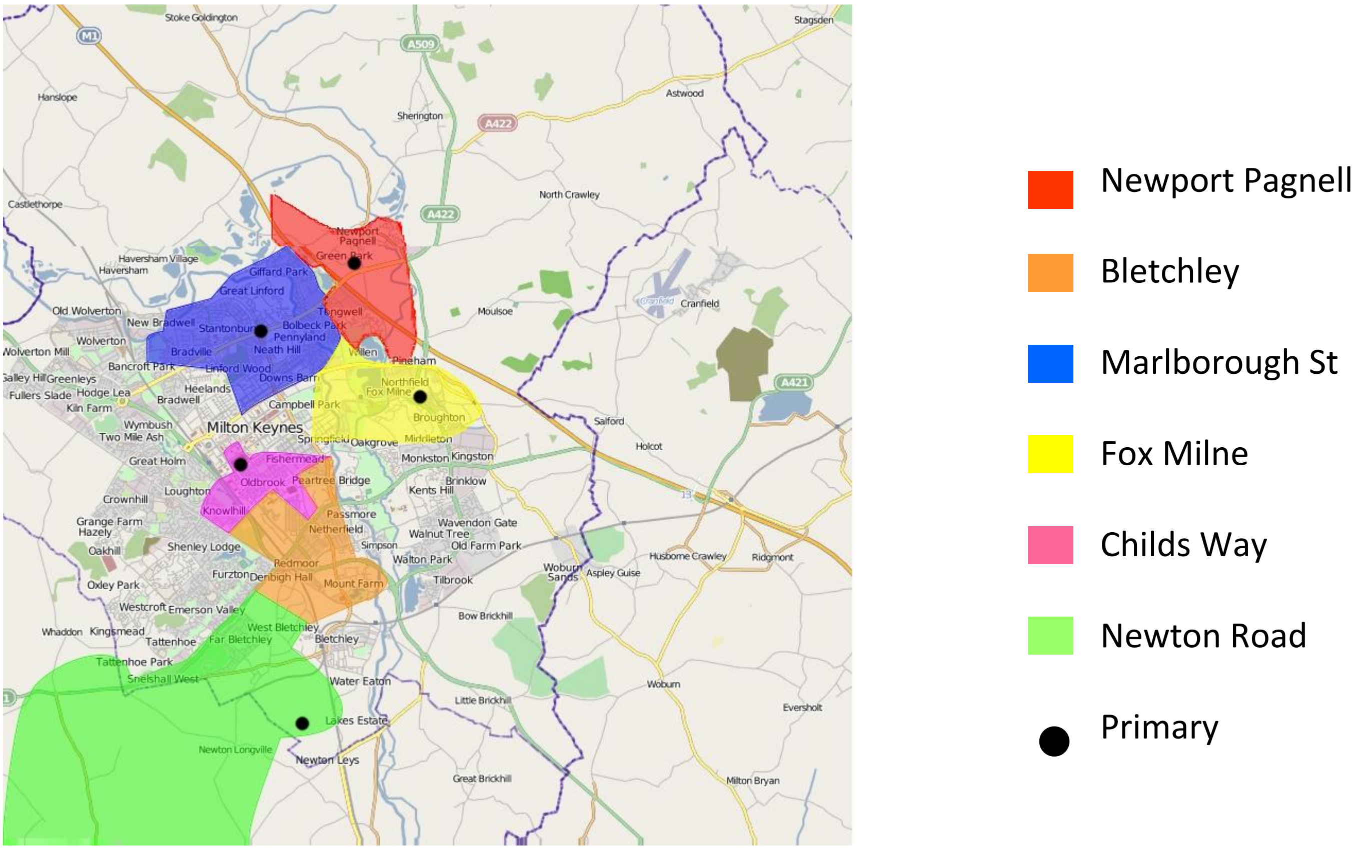
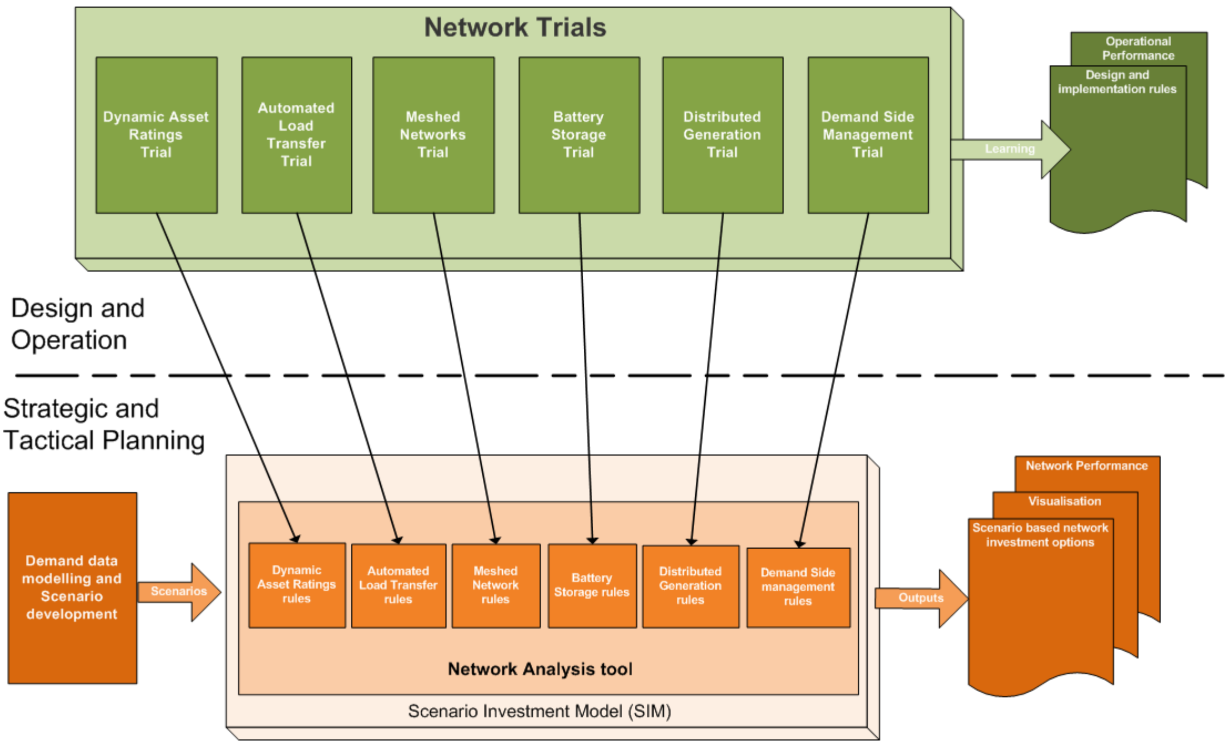


FIGURE 1: Map of the trial area

Figure 2 below is a diagram that represents the trials and now they will inform the SIM and the learning process.

Figure 2 – Major Components of Project FALCON



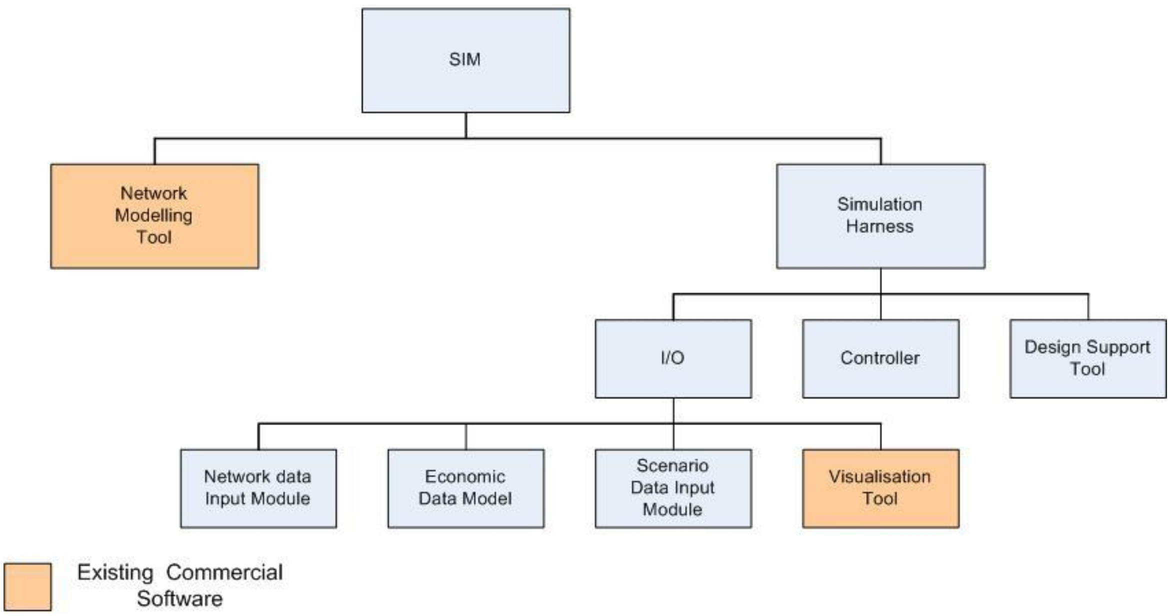
The figure above shows how the Method links both the Network Trials Area and the SIM to maximise learning.
The six intervention techniques are implemented in the trial area and also modelled in the SIM. This parallel interlinked approach maximises the learning and ensures that it is directly applicable to future load scenarios.

Appendix C - Technical Overview

1. SCENARIO INVESTMENT MODEL (SIM)

The SIM provides the modelling required to cope with increasing uncertainty in future demand. A key feature of the SIM is its ability to not only identify current and future network constraints, but also model combinations of different techniques for addressing these constraints to determine the best solution in terms of whole life cost of ownership, duration of implementation, operational network performance, the customer impact and flexibility to cope with future load

The SIM comprises two major components:
A **network modelling tool** within which sections of network can be represented, various network reinforcement techniques modelled and power flows/voltages across the network calculated, highlighting areas of constraint. It will be based on two established network modelling tools, namely: GROND, a tool used extensively within the UK, and a European modelling tool called DPLAN
A **simulation harness** This allows data entry for load scenarios, technique models and network information It will allow multiple solutions comprising different combinations of reinforcement technique and load scenarios to be run in the network modelling tool and evaluating and comparing the results of each to determine the optimal solution.
The individual modules of the SIM are shown in the figure below:



SIM Modules

The Simulation Harness extends the Network Modelling Tool to compare multiple solutions on multiple load scenarios. It will have the ability to combine real measured data from the trials area with multiple predicted load growth scenarios. The simulation harness will be developed by Cranfield IVHM Centre.

It consists of the following modules:
Scenario Data Input Module: This will input predicted load scenarios and measured trial area data. It will have the ability to combine these inputs. This data will be routed to the Network Modelling Tool.
Economic Model: This will contain an NPV whole life cost model of all techniques the output will be used in the Design Support Tool.

Network data Input Module: This will allow the trials area (or any future trials area) parameters to be entered into the Network Modelling tool. It will also input the modelling data of the techniques used in the project.
Design Support Tool: This is the heart of the SIM it will allow multiple runs of the Network Modelling tool to be compared to determine possible solutions. Using the output of the Economic Model is can determine the most effective solutions.
Visualization Tool: This will be based on commercial software and provide a clear presentation of the SIM results.
Controller: This will manage the process of running multiple power flow calculations for:

- a series of time slices along a future network load profile to assess how constraints are likely to develop over time
- a number of revised network models to compare the effectiveness of combinations of intervention techniques

The Controller will also determine the weighting to be applied to the various assessment criteria within the Design Support Tool and Economic Model.

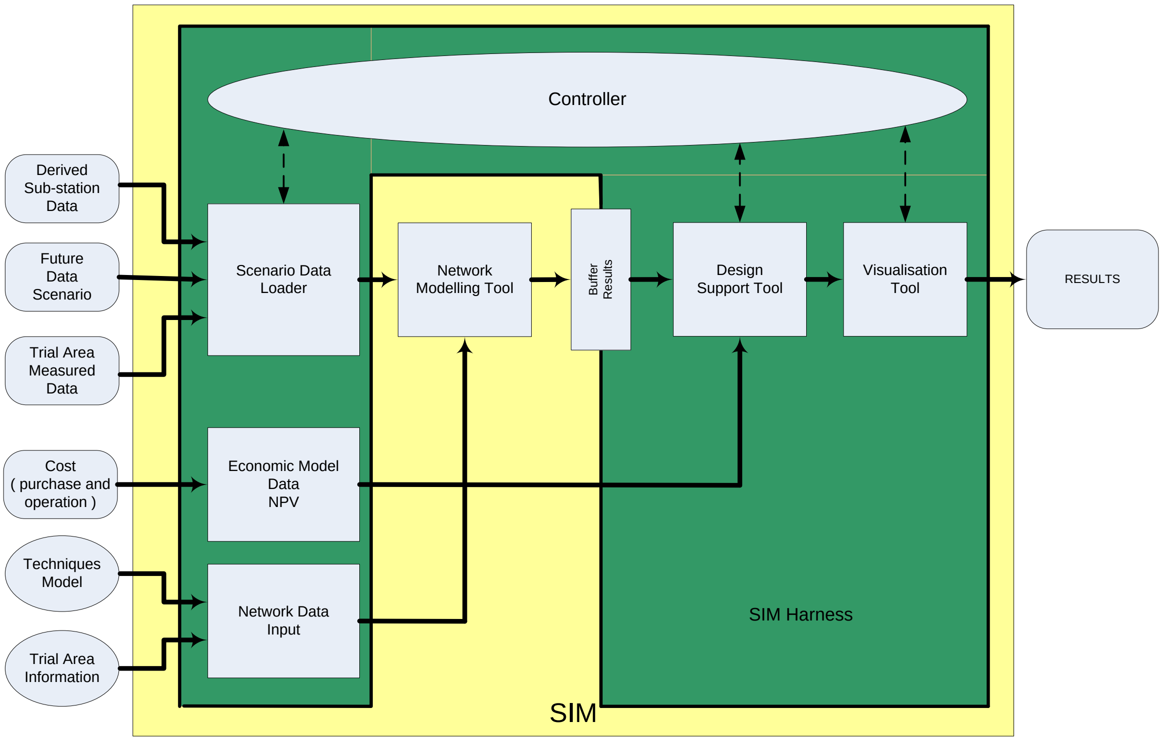
1.1 SIM Operation

The SIM will be validated using aggregated half-hourly load profiles calculated from settlement data. Next the results of physical trials and the measurement obtained from the trials area will be input and compared with those predicted by the validated SIM in order to tune and calibrate the model. After this the SIM will available to assess the impact of combinations of techniques on measured load and future load profiles This provides the ability to determine the best solution for both current and predicted load profiles thus plan the network to enable the installation of future low carbon technology.
The ability to automate the running of multiple calculations for a variety of inputs and to marshal and compare the results from these calculations will allow:

- assess network performance over time against a variety of possible future load profiles including various rates of uptake of low carbon technology
- assess the relative effectiveness of different intervention solutions against a common future load profile
- perform sensitivity analysis on a candidate network solution using a variety of possible future load profiles

It will be possible to use the SIM to analyse any section of 11kV network, simulate interventions and calculate the associated benefits and display then in a graphic form.

The figure below shows how the key modules of the SIM interconnect in operation.



The combinations of load scenarios, techniques to be applied and the weighting of assessment criteria will all be set in the SIM Controller at the start of a run. The Data Buffer will store the outputs of multiple operations of the Network Modelling Tool required to assess various options of load and techniques. The output of the Buffer will then to feed into the Design Support Tool which will compare the results to determine the best candidate network solution in for each area of the Trial Network for the given load Scenarios. The output will be passed to the Visualisation Tool to display.

2. Demand Scenario Data

Data used on the project will be obtained from three sources:

- → Aggregated half-hourly load profiles calculated from settlement data
- → Metered Data obtained from the trials area via Monitoring equipment
- → Estimated future load profiles

The aggregated half-hour load profiles will be used for initial proving of the SIM. The Metered Data will be used to assess the operation and performance of the intervention techniques in addition to determining the validity of the aggregated load profiles. Finally the Estimated future load profiles will be superimposed on the metered data in the SIM to assess and evaluate the robustness and applicability of techniques to future load growth.

2.1 Metered data

For the purposes of assessing the performance of intervention techniques and in parallel determining the accuracy of the estimated half-hourly data actual metered half-hourly data is required. This will be obtained from the trials area via the Cisco communications infrastructure. The data will be routed and stored in a Data Buffer form use in the SIM.

2.2 Aggregated half-hourly load profiles calculated from settlement data

Substation load profile data developed will be used in the initial development and verification of the SIM. DNOs currently have access to both half-hourly and non half-hourly settlement data for each premise attached to their networks. This data is currently aggregated by Elexon by Supplier and GSP Group for settlement purposes. With Elexon's support, we will re-create and modify part of the settlement process in order to aggregate this data by secondary substation. We will then assess its accuracy by comparing it with the corresponding actual load profiles obtained from substation metering to determine whether the existing settlement data provides a viable alternative to installing meters in all secondary substations.

The benefits of using load profile data obtained from settlement is that it is available now, for all DNOs, without the customer interventions and lead time involved in installing secondary substation metering. This raises the prospect of a DNO performing an initial assessment of constraints on their entire 11kV network as an entirely paper-based exercise. Even if this data is found to be have limited accuracy, it may still be sufficient for the purpose of generating an initial hotspot map of constraints within the SIM that could be used by the DNO to target deployment of substation metering in areas of predicted constraint, thus focusing investment in areas where it is most likely to be needed.

We will initially assess the value of settlement data by modelling elements of WPD's South Wales network and utilising metered substation data collected as part of WPD's 2010 LV Network Templates Tier 2 Project. We will then demonstrate the applicability of this technique to other DNO networks by validating the results against WPD's East Midland network once metered substation data becomes available from FALCON.

We believe this new use of existing data is truly innovative in that:

- → it finds a new use for existing data that is available to every DNO;
- → it could be adopted by all DNOs in a very short space of time to inform their 11kV investment strategy;
- → it will generate learning that will be used by ELEXON in assessing the accuracy of their settlement profiles and is, therefore, a clear demonstration of an LCNF project spreading learning beyond DNOs;
- → it will build on previous investment in LCNF by utilising substation metered data from WPD's 2010 LV Network Templates Tier 2 project.

Our partners for this initiative are Elexon (the central industry body responsible for delivering the Balancing and Settlement Code in Great Britain) who will provide the settlement systems required to derive the half-hourly profiles and Logica (designer and developer of these systems) who will make the necessary modifications, run these systems on a quarterly basis to generate the substation profiles and compare the results with the metered substation profiles.

2.3. Aggregated half-hourly load profiles calculated from revised profiles

In addition to obtaining estimated half-hourly substation profiles from existing settlement data, we will experiment with improving these profiles by developing new, more sophisticated customer profiles based on a wide range of additional factors, such as occupation and demographic characteristics. This work will build directly on DECC's National Energy Efficiency Framework initiative. Our partners for this initiative will be ElectraLink and Katalysis. The profiles produced by this exercise will be converted into half-hourly secondary substation load profiles by Logica during the quarterly run of the modified settlement systems.

2.4. Future load scenarios generated for investment planning

The preceding steps enable the final stage of producing a set of future load scenarios for investment planning purposes. New profiles will be used to reflect the low carbon economy (e.g. premises with heat pumps and/or photovoltaics installed, premises with an EV etc.). These profiles will be of use in developing the future load scenarios which model different levels of uptake of low carbon technology. These scenarios, based on current usage, low carbon technology uptake and economic forecasts, will be fed into the simulation harness to identify and evaluate optimal investment strategies.

3. Intervention Techniques

Safety

For all the Intervention techniques described in this section the practical deployment of the proposed trial equipment will follow WPD's existing safety policies and procedures, with the core documents being ESQCR:2002 and the Power Systems Operations Manual. Full risk assessments and method statements will be undertaken for all on-site equipment installation.

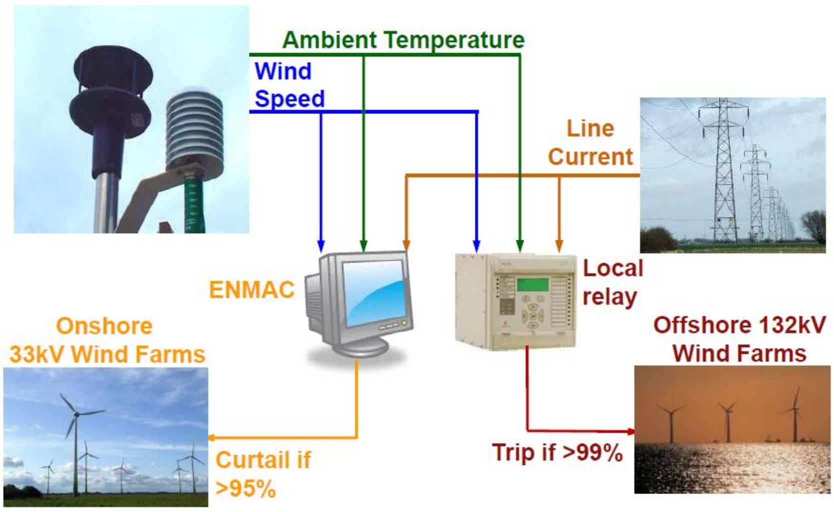
3.1 Technique 1 - Dynamic Asset Ratings

In this technique we will be asking the following questions:

- → How long does a cable take to heat up to its optimum operating temperature when subjected to high load?
- → How long does it take for the cable to cool when the load is reduced?
- → What would be the effect of short term high loading on overhead lines and their sag?
- → Can we create a dynamic load profile and use this information to amend our existing summer/winter ratings?
- → Can the circuits provide a robust alternative for supporting 1st and 2nd circuit fault?

The benefits of this technique include:

- → Utilisation of Spare Capacity,
- → Studying the impact of using dynamic circuit ratings on other equipment,
- → Prediction of long term implications from operating outside design constraints (e.g. lifetime degradation),
- → Dynamic circuit ratings could be used to maintain supply to a greater number of customers during fault conditions,
- → Avoidance of unneeded reinforcement, and
- → Maximise cyclic capacity (eg. Low load cooling times).



Dynamic Assets have previously being trialled and implemented on higher voltage circuits (33kV / 132kV) overhead line circuits to increase the output allowed from Wind Farms without having to replace or reinforce the connected circuits. Similar benefits could be obtained by expanding this technique to encompass points on the network where dynamic circuit ratings may be able to achieve extra utilisation within allowable rating.

The proposed solution is based on the Alstom Grid MiCOM P341 product. This product has been successfully used on a previous trial with WPD for Dynamic Line Rating (DLR) on a 132kV circuit between Boston and Skegness. It has also been used on a trial with Scottish Power to cover Dynamic Cable and Transformer Rating, in addition to DLR.

The ALSTOM MiCOM P341 DLR uses real-time measurements from weather sensors to calculate the real-time ampacity automatically, which is then compared to the actual line current. The sensors are connected to the relay via the current loop inputs (a range of 0-1mA, 0-10mA, 0-20mA or 4-20mA is available). Wind speed and direction, temperatures and solar radiation can all be used as inputs to the relay or a combination of them. Variables not measured can be set using conservative fixed values based on Engineering Recommendation P27. The most significant measurements are the wind speed and the ambient temperature.

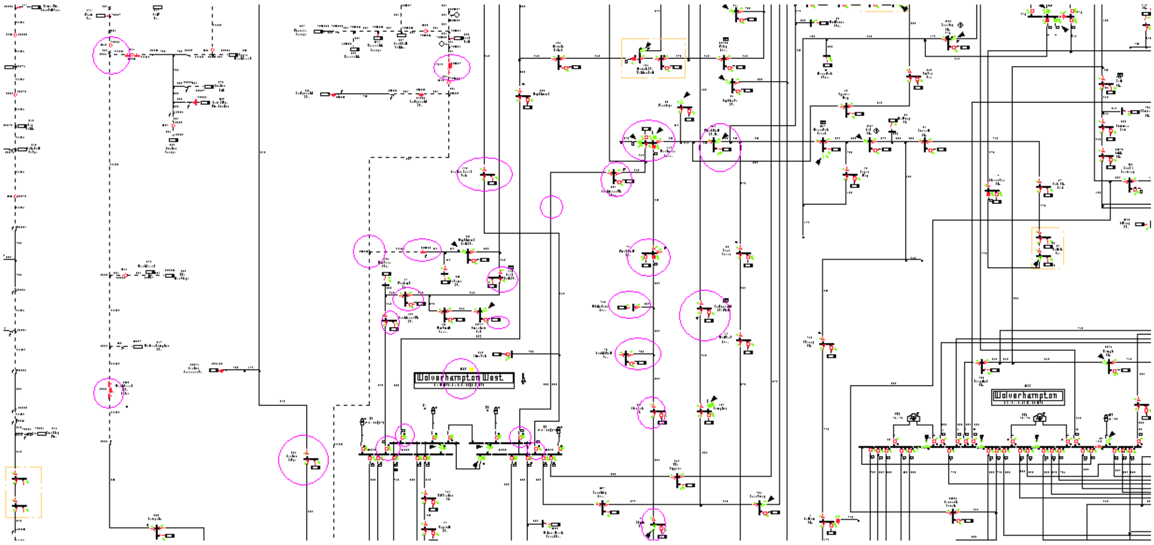
Note that the ampacities calculated in this technique will be used in Technique 2 (Automated Load Transfer) to improve the different switching plans, and make an efficient use of the network.

The trial will include equipment to monitor six Feeders (including Overhead Lines and Underground Cables) and one Distribution Transformer

Whilst on previous implementations parameters have been specifically applicable to overhead lines (e.g. Wind Speed, Solar Energy), for this proposal parameters will also be specifically applicable to the particular items of plant in question (e.g. Output from Plant Temperature Sensors).

Configuration of 132kV Boston-Skegness

Typical Primary Substation/s and 11 kV Feeder arrangement showing location of Dynamic Asset Rating Equipment.



3.2 Technique 2 - Automated Load Transfer

In this technique we will be asking the following questions:

- → How effective is automated load transfer in reducing peak flows?
- → Are voltages on the network improved by load transfers?
- → Is there any significant decrease in losses?
- → What improvements are there to CMLs and CIs?

The benefits of this technique include:

- → Utilisation of Spare Capacity,
- → Automated load transfer at peak times,
- → Voltage Regulation,
- → Even Load Profile of circuits,
- → Extra support for highly loaded primary sites,
- → Real-time transfer of load across feeders and primary sub stations real time, and Real-time transfer of generation across feeders and primary sub stations real time.

Automated Load transfer can be applied to 11kV networks in which secondary substations can be supplied from different HV feeders but are normally only supplied from one at any time normally configured in an open ring configuration.

In the simplest form of open ring network, there are two feeders which supply a ring divided into two sections by an open switch. Each secondary substation has two potential sources of supply (i.e. from either of the two 11kV feeders that make up the ring). Automated load transfer uses this feature to dynamically alter the number of secondary substations that are fed from each of the feeders by closing the open switch and using remotely operated switches between substations to effectively change the length of each 11kV feeder. If one half of the ring has exceptionally high load whilst the other has spare capacity, load can be shifted between the two by shortening the overloaded feeder at the expense of the feeder which has spare capacity.

The proposed load transfer intervention technology will identify feeders with spare capacity present. Load will only be transferred to feeders with appropriate spare capacity available; therefore the N-1 capacity will not be compromised. This intervention will allow the load to be dynamically shifted, however, if an instance arose where the network were to get close to N-1 capacity then the existing network control methodology and procedures would be initiated, which have been derived for static feeders.

To enable automated load transfer the following are required:

1. Knowledge of the power flows and voltages on the network (and possibly predicted flows/voltages over the next few hours)
2. Capacities of the feeders affected (these may need to be dynamically calculated if Technique 1 is being used on the same feeder)
3. Modelling of potential network reconfiguration to confirm resolution of issues and prevent creation of new issues
4. Automated switch gear at the appropriate places to control
5. Algorithms / Systems to make a decision on the reconfiguration and when it needs to be initiated.
6. Potential need to modify protection settings for the revised network configuration

Alstom, our partner for this technique, will provide trial e-terra licences that will cover the 6 primary substations for the 4 year duration of the project. The e-terra licence will cover the following functional areas

- Network View
- Network Analysis
- Network Optimizers
- Load VAr management
- Automated Feeder Reconfiguration

In addition Alstom will provide a Trial PhasorPoint license for 3 substations and 3 Phasor Measurement Units (PMUs) for the trial.

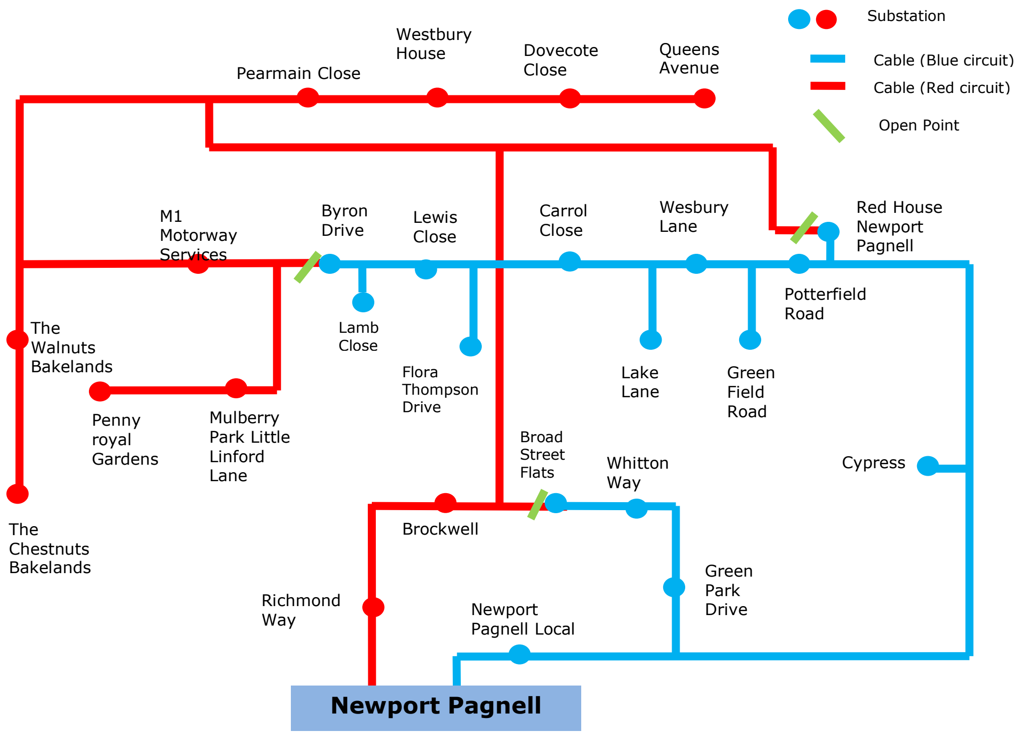
The network will require the appropriate automated switchgear to be installed:

On the overhead system this will involve utilising existing automated pole mounted reclosers and sectionalizing devices and installing new equipment where required. The use of Nulec N12 PMR's and RL27 sectionalisers would be preferred due to their ability to monitor voltage and current and the already proven communications with Poweron.

On the underground system there is existing equipment that is fully automated. There are options of using automated switches or installing CB's to add additional security and protection to the network. Voltage and current analogues can also be utilised on underground equipment.

Shown below is an example of how automated Load Transfer can be configured at two feeders on the Newport Pagnell Primary substation.

Newport Pagnell - Current



An example of how Automated Load Transfer can be configured on these feeders the following actions can be taken:

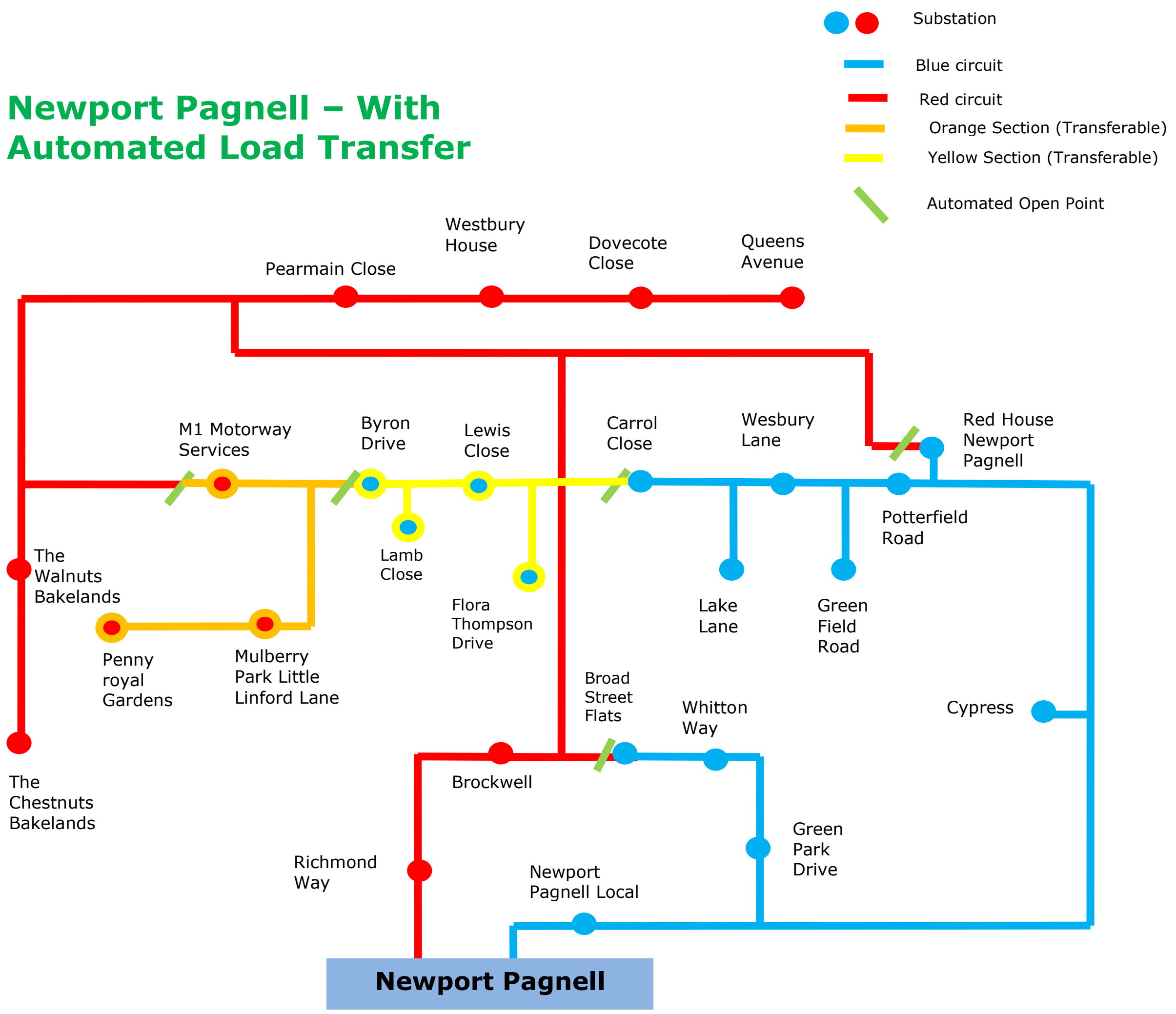
1. Install an Automated Open point at the following locations
    a. M1 Motorway Services (on The Walnuts Bakelands circuit)
    b. Carrol Close (on the Lewis Close circuit)
    c. Byron Drive (on the M1 Motorway Services circuit)
2. Install monitoring equipment and rules to allow operation of the Automated Load Transfer

The new configuration can be seen in the diagram below.

The normal Open point would be at Byron Drive. However if the Automated Load Transfer monitoring equipment detected that the red circuit (which in the normal state also supplies the Orange section) was overloaded and their was spare capacity on the blue circuit then the following actions would occur

1 Close the Open Point at Byron Close
2 Open the Open Point at M1 Motorway services

This essentially transfers the Orange section from the red circuit to the blue circuit. In a similar way the yellow section can be transferred from the blue circuit to the red circuit if the blue circuit was overloaded and there was spare capacity on the red circuit.



3.3 Technique 3 – Meshed Networks

In this technique we will be asking the following questions:

- → How easily can meshed networks be applied on rural/suburban networks?
- → Are different configurations preferable depending on the load density?
- → Are voltages on the network improved?
- → Is there any significant decrease in losses?
- → What improvements are there to CMLs and CIs?
- → What are the protection issues that need to be overcome?

The benefits of this technique include:

- → Enhanced Network Security,
- → Zero Customer impact from circuit fault,
- → Improved Voltage Regulation,
- → Enhanced Distributed Generation Capability,
- → Even Load Profile of circuits,
- → Utilisation of Spare Capacity,
- → Lower Impact to customer and generation for routine maintenance, and
- → Extended Asset Life.

Meshed networks are currently used in the UK in high load density city centre area where high level of security of supply is required. This has a high cost of implementation as it requires more complex protection arrangements and a very high level of automated switchgear.

A hybrid meshed network will be developed for use in suburban and rural areas without the cost of full asset replacement and installation of a pilot cable system for unit protection. The hybrid meshed network will still provide the benefits of an improved security of supply together with the ability to improve utilisation of the network capacity and support larger more volatile loads such as may occur with low carbon technologies. The aim of the technique is to evaluate the cost benefit of meshing networks at 11 kV.

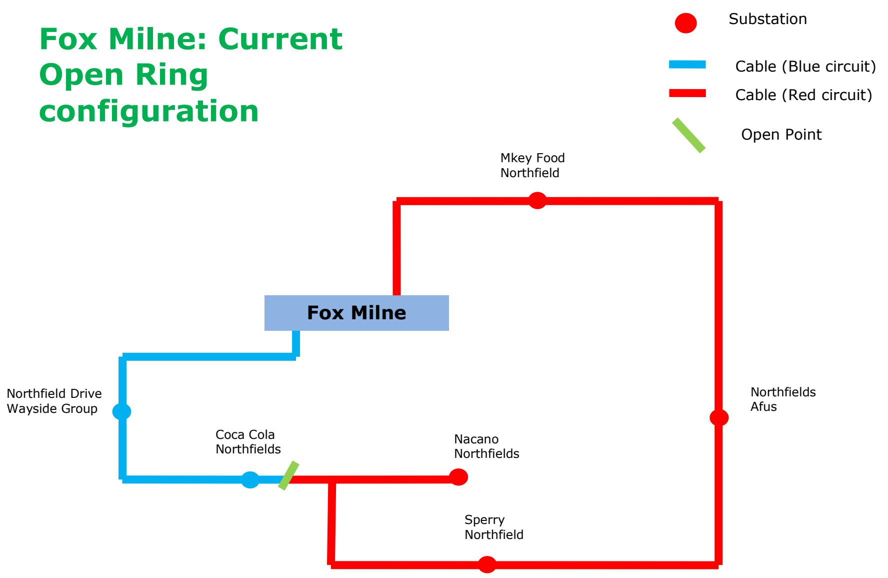
Alstom will be the partner that will provide support for this technique.

Initially a network model of the unmeshed network that may also include embedded generation, using the power system simulation software package will be produced. The intention is to transform this network to a meshed network and then to repeat the network studies (load flow, short circuit fault and voltage stability) in order to:-

→ Evaluate enhanced capacity and impact on losses.
→ Evaluate fault level & protection.
→ Assess costs of meshing.

A study of the identified network will be carried out in order to establish the optimum points on the network to install any new equipment, if necessary.

Distributed generation will be a consideration in the project as the effects on voltages can affect customers. By meshing feeders, voltages can remain stable with even load share, the potential to use generation for extra support can be utilised with minimum impact.The proposed protection solution is based on the Alstom Grid MiCOM P521 product.
The diagrams below show a potential open ring feeder configuration at Fx Milne and how the change to a mesh network

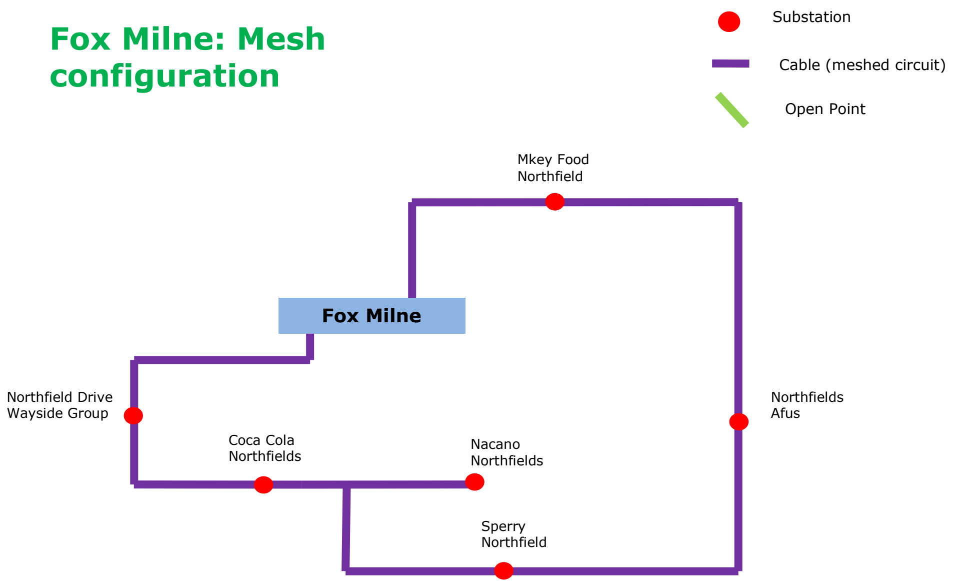


By doing the following actions a simple hybrid mesh network can be created:

1. Closing the Open point switch at Coca Cola Northfields

2. Installing automated switchgear at Coca Cola Northfields and Northfields Afus substations (if not already automated)
3. Create three unit protection zones
    a. Fox Milne to Coca Cola Northfields (via Northfield Drive)
    b. Coca Cola Northfields to Northfields Afus (Via Sperry Northfield)
    c. Northfields Afus to Fox Milne (via Mkey Food)

The following mesh network is created.



3.4 Technique 4 – Battery Storage

Battery storage has the potential to provide a number of services which will all be tested namely:

- Reducing the peak flow within a HV feeder in order to defer reinforcement.
- Phase balancing
- Voltage support

Batteries will be installed at 5 Secondary substation sites within the trial area and these will include both rural and urban networks. The batteries planned to be used are GE Durathon which are based on Sodium Metal Halide technology compact units and have previously been used in the transport sector.

The Durathon Battery technology provides a longer life-span than traditional storage, offering a life-cycle of up to two decades, whilst delivering and maintaining a round trip efficiency of 82%. Each battery unit delivers 21kWh of energy with dimensions 320 x 510 x 930 mm. GE's specification is based on an 80% depth of discharge (DOD). The DOD can be varied to suit, changing the performance and life-span of the battery. Increasing the DOD will increase its kWh performance with an obvious reduction in life-cycle.

An installation at each substation will compose of a number of batteries and a Power Conditioning Unit (PCU) which will manage the charge /discharge cycles. The batteries will be installed and connected to the LV side at the secondary substation and will typically be sized to have an output of around 10% of the secondary substation transformer capacity. With an output of around 10 kW per battery, a secondary substation with a 500 kVA transformer would have a number batteries installed which would deliver the required output of over a 2 hour period.

When selecting the specific locations on the network for using it for peak lopping/load shifting then the shape of the load curve is an important consideration. The load curve must have the following attributes

- peaks that need to be reduced to the required level (taking into consideration any modified level as a result of technique 1 – Dynamic Asset rating)
- energy delivering requirements
- sufficient spare network capacity between peaks to recharge the batteries

3.5 Technique 5 / 6– Distributed Generation/ Demand Side Management

The same process is expected to used for both Distributed Generation and Demand Side Management

The key elements to the trialling of these techniques are:

1. Identifying the potential customers which have the ability to participate
2. Developing a Commercial Agreements Proforma
3. Develop the DG/DSM Operational Decision Tool
4. Agree individual parameters and sign Commercial Agreements with each customer
5. Establishing Communications methods and processes
6. Install monitoring/metering equipment

Element 1 has already commenced with a number of HV Demand and Distributed Generator customers within the Trial area already contacted and agreeing in principle to participate in the trial. (There are around 90 HV connected customers in the Trial area)

A key part of the project is to develop a Commercial Agreements Proforma. The development of this proforma will be in association with the customers who have initially indicated an interest in participating in the trial and will contain the following:

1. Response time (minimum notice the customer requires to act on a request for support)
2. Level of support (the maximum support that can be provided)
3. Duration of support (how long support can be provided)
4. Frequency of support (How often the support can be requested in a given period)
5. Available periods for the support (Specification of when support is available (e.g. between 8:00 to 18:00 hours weekdays))
6. Payments (This is expected to be split into an "availability" payment, "usage" payment and possibly penalties for not proving support when requested.)
7. Monitoring equipment
8. Communications process (requests / confirmation for support)

This is not a comprehensive list and these will be developed with the participating HV customers.

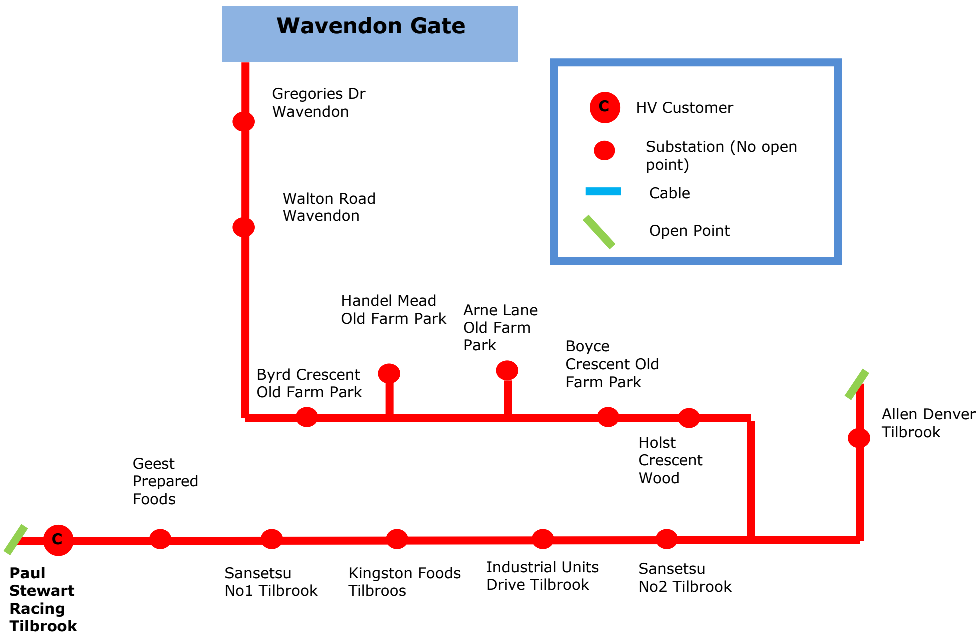
To enable WPD to request support, an Operation Decision Tool will be developed. The Operational Decision tool will forecast the demand profile for the following assessment period for each element of the HV system that is influenced by each DG/DSM support Unit and by comparison to the asset rating (which in the later trial period will include any Dynamic Asset Rating calculated using Technique 1) will determine if any support is required and if so the volume, time and period for the support. The assessment period will be driven by the response time (see point 1 of the proforma above). The trial expects that different response periods will be trialled (e.g. 2hr (immediate), 8hr (today) and 24hr (next day))

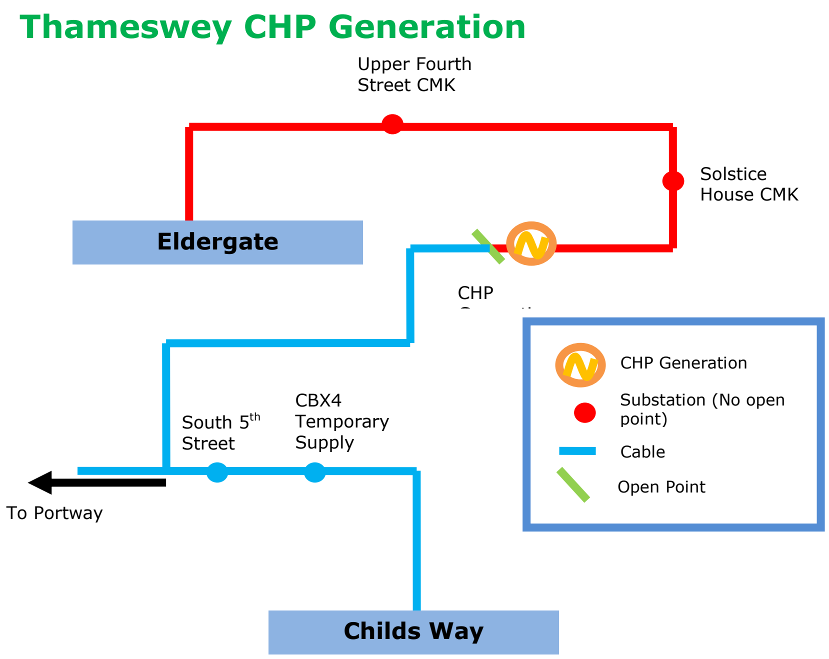
The forecasting element of the Operational Decision Tool will initially be based on the typical historic load profiles of the HV circuits supply the DSM/DG support unit. During the project, this will be developed further using the learning from the SIM demand profile development to determine whether this provides a more accurate forecasting mechanism.

The trial is primarily concerned with the development to the commercial agreements, the trialling of the Operational Decision Tool, and the responsiveness to participants to requests for support and their effect on the HV network. As such no special communication/control mechanism is planned to be installed. The exact communication method will be agreed with each customer separately and this partially be dependent on the response time agreed. Initially telephone, email and text messages will be offered, with a business process that will include confirmation of receipt and possibly commencement of the requested support.

Shown below are simplified network diagrams showing the connection of a Generation Customer and a Demand Side Management customer who are interested in participating in the trial.

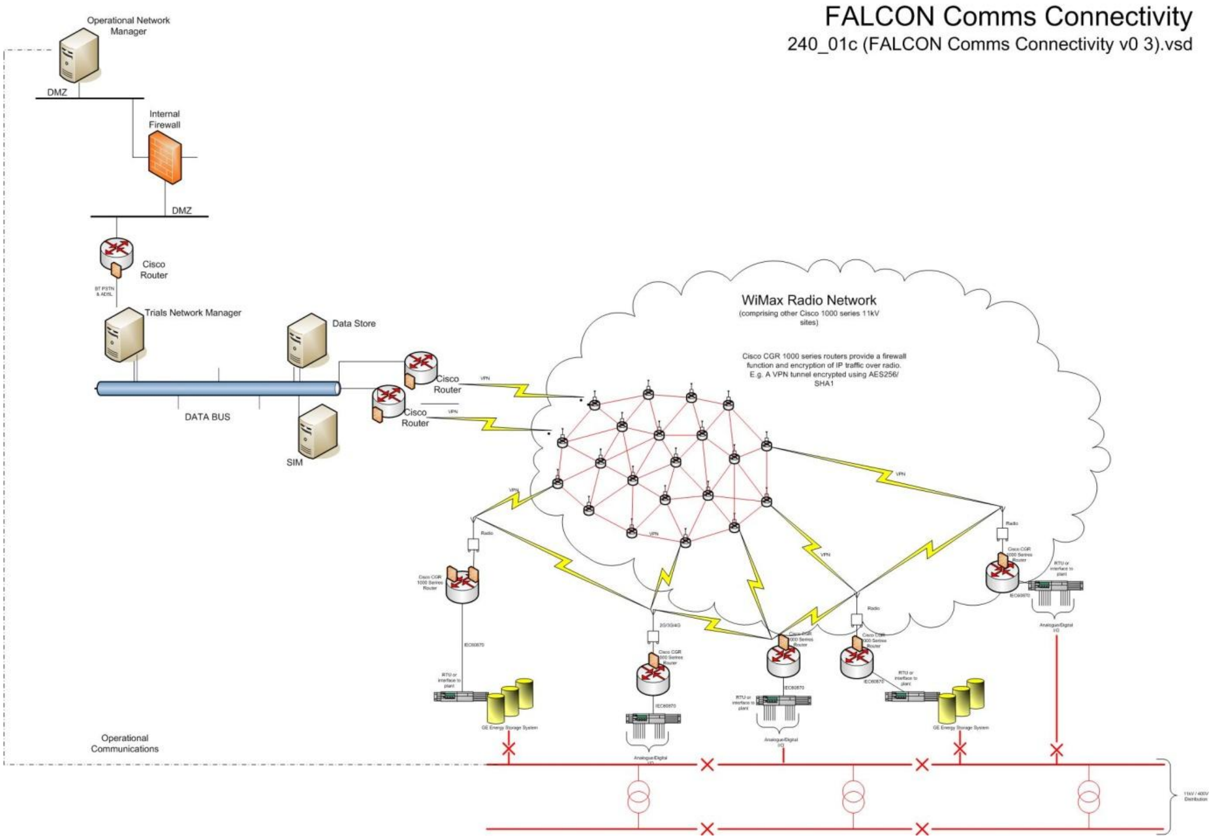
An example of a HV Customer





4. Communications Structure

The communications infrastructure for FALCON will link the 200 sub-stations within the trail area with the Trials Network Manager and Data Storage. It is design using open standards. The transport layer will be realised using WiMAX technology (IEEE 802.16). This will provide resilience via the provision of a full mesh interconnecting all the sub-stations. The traffic will be routed over this layer between Cisco CGR 1000 Connected Grid routers installed at each sub-station using IPv4. Data from the monitoring devices and relays at each sub-station will be connected to the router via a mini-RTU (for analogues) or directly via Ethernet.



A pair of Cisco CGR1000 will be used to interface the network data to the Data Bus. This bus will connect the following:

- Trials Network Manager
- Data Store
- SIM

The Data Store will be used to collect and store the ½ hour monitored data from the sub-stations. This data will then to feed into the SIM when required.

The Trials Network Manager will be used to control and monitor the techniques installed in the trial area. A connection from the Operational Network Manager to the Trials Network Manager will allow the Operational Network to override the trial so that any impact on customers can be reduced and to allow the management of fault conditions.

Cyber-Security is key to the operation of the communications infrastructure. The Cisco CGR 1000 has built in firewall functionality and encryption of the IP traffic. It should be noted that the trials network will be a private IP network with no direct connection to any public networks. A part of the project the network will be independently tested to determine its resilience to cyber attack.

Appendix D - Project Support Documentation

Figure 1 - High Level Plan

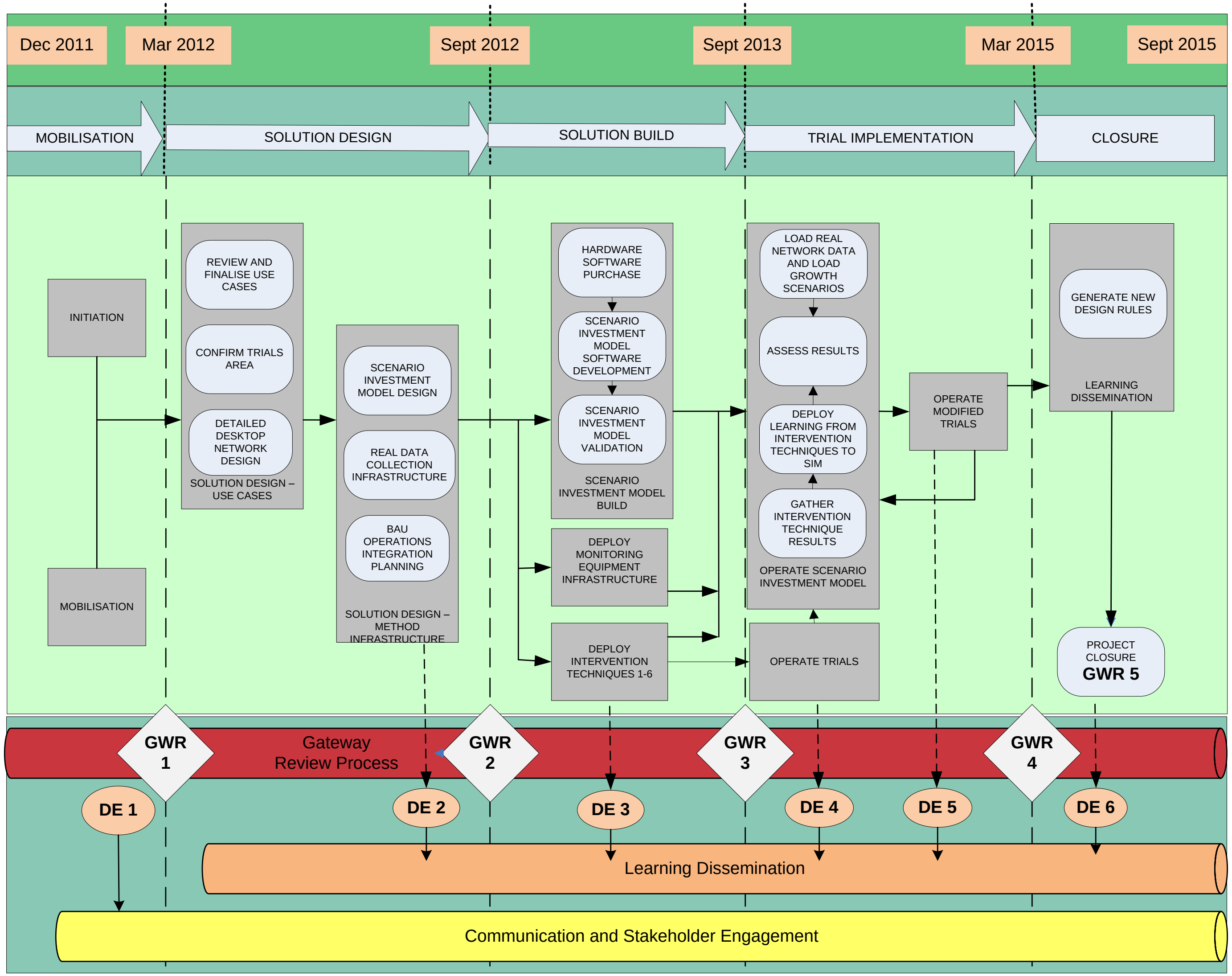


Figure 2 - Project Schedule

ID	Task Name	Start	Finish
1	**Key Milestones**	**Mon 28/11/11**	**Mon 28/11/11**
3	**Project Management**	Mon 28/11/11	Wed 30/09/15
4	**Communication and Stakeholder Engagement**	Fri 02/03/12	Wed 30/09/15
5	**Funding award**	Mon 28/11/11	Mon 28/11/11
6	Project Direction received	Mon 28/11/11	Mon 28/11/11
7	**Project Initiation**	**Mon 28/11/11**	**Mon 23/01/12**
8	**Consolidation into exisiting governance structure**	**Mon 28/11/11**	**Tue 29/11/11**
11	**Initial Meeting with Senior Management**	**Wed 30/11/11**	**Tue 06/12/11**
14	**Review Bid**	**Mon 05/12/11**	**Tue 17/01/12**
19	Appoint Project Team members	Wed 18/01/12	Wed 18/01/12
20	Identify Project Team location	Mon 16/01/12	Fri 20/01/12
21	**Senior Management meeting**	**Wed 18/01/12**	**Mon 23/01/12**
22	Confirm Project Team location	Mon 23/01/12	Mon 23/01/12
23	Confirm Project Team members	Thu 19/01/12	Thu 19/01/12
24	Sign off Project Initiation Document	Wed 18/01/12	Wed 18/01/12
25	**Mobilisation**	**Thu 19/01/12**	**Wed 07/03/12**
26	Project Team Kick Off Meeting	Thu 19/01/12	Fri 20/01/12
27	Update RAID log - manage on an ongoing basis until project closure	Fri 20/01/12	Thu 26/01/12
28	Identify and order long lead time items	Fri 20/01/12	Fri 27/01/12
29	Set up separate bank account	Fri 20/01/12	Tue 24/01/12
30	**Partner mobilisation**	**Fri 20/01/12**	**Tue 06/03/12**
31	**Formalise relationship with Logica**	**Fri 20/01/12**	**Wed 01/02/12**
35	**Formalise relationship with Cisco**	**Fri 20/01/12**	**Mon 30/01/12**
39	**Formalise relationship with GE**	**Fri 20/01/12**	**Fri 03/02/12**
43	**Formalise relationship with ElectraLink**	**Fri 20/01/12**	**Fri 03/02/12**
47	**Formalise relationship with Alstom**	**Fri 20/01/12**	**Tue 28/02/12**
51	**Formalise relationship with Cranfield University**	**Fri 20/01/12**	**Thu 09/02/12**
55	**Formalise relationship with University of Bath**	**Fri 20/01/12**	**Tue 06/03/12**
60	**Formalise relationship with Aston University and Birmingham University**	**Fri 20/01/12**	**Mon 13/02/12**
64	Conclude partner internal governance processes	Tue 06/03/12	Tue 06/03/12
65	**Project Forum**	**Thu 19/01/12**	**Thu 26/01/12**
68	**GWR1 - Mobilisation to Solution Design gateway review**	Tue 06/03/12	Wed 07/03/12
69	**Reporting**	**Tue 13/12/11**	**Fri 18/09/15**
70	Create Status report for Senior Management - produce and update weekly	Tue 13/12/11	Fri 18/09/15
71	**Ofgem reporting**	**Mon 03/06/13**	**Mon 03/11/14**
72	Create and submit Ofgem report	Mon 03/06/13	Mon 03/06/13
73	Create and submit Ofgem report	Mon 04/11/13	Mon 04/11/13
74	Create and submit Ofgem report	Mon 02/06/14	Mon 02/06/14
75	Create and submit Ofgem report	Mon 03/11/14	Mon 03/11/14
76	**Project team meetings**	**Fri 20/01/12**	**Fri 11/09/15**
121	**Senior Management meetings**	**Mon 23/01/12**	**Fri 11/09/15**
166	**Project Forum meetings**	**Mon 05/12/11**	**Tue 23/06/15**
181	**Phase 1 - Solution design**	**Tue 06/03/12**	**Fri 28/09/12**
182	**Solution Design - Use Cases**	**Tue 06/03/12**	**Fri 21/09/12**
219	**Solution Design - Method infrastructure**	**Tue 06/03/12**	**Thu 27/09/12**
220	**Scenario Investment Model Design**	**Tue 06/03/12**	**Fri 14/09/12**
236	**Real data collection infrastructure**	**Tue 06/03/12**	**Thu 16/08/12**
244	**BAU Operations Integration Planning**	**Thu 16/08/12**	**Thu 27/09/12**
247	**GWR2- Deployment readiness gateway review**	Thu 27/09/12	Fri 28/09/12
248	**Phase 2 - Solution Build**	**Thu 26/01/12**	**Fri 27/09/13**
249	**Solution Build**	**Thu 26/01/12**	**Fri 27/09/13**
250	**Scenario Investment Model Build**	**Fri 28/09/12**	**Fri 27/09/13**
271	**Deploy monitoring equipment infrastructure**	**Thu 26/01/12**	**Fri 28/06/13**
285	**Deploy intervention techniques**	**Fri 28/09/12**	**Fri 20/09/13**
312	**GWR3 - Solution Build completion gateway review**	Fri 20/09/13	Mon 23/09/13
313	**Phase 3 - Trial Implementation**	**Fri 20/09/13**	**Mon 23/03/15**
314	**Operate trials**	**Fri 20/09/13**	**Fri 22/08/14**
321	**Operate Scenario Investment Model**	**Fri 22/08/14**	**Fri 05/12/14**
350	**Operate modified trials**	**Fri 28/11/14**	**Fri 20/03/15**
374	**GWR4 - Trial Implementation Review**	Fri 20/03/15	Mon 23/03/15
375	**Phase 4 - Learning dissemination**	**Sun 01/01/12**	**Thu 31/12/15**
376	**Market research with stakeholders**	**Tue 06/03/12**	**Thu 31/05/12**
380	**Electronic media**	**Tue 06/03/12**	**Thu 31/12/15**
403	**Workshops / seminars**	**Tue 06/03/12**	**Wed 30/09/15**
413	**FALCON Dissemination conferences**	**Mon 02/07/12**	**Tue 30/06/15**
418	**Academic dissemination**	**Fri 08/06/12**	**Thu 31/12/15**
425	**Other media**	**Sun 01/01/12**	**Tue 01/09/15**
459	**Reports**	**Sun 01/04/12**	**Tue 01/12/15**
476	**Training**	**Tue 01/04/14**	**Wed 30/09/15**
481	Generate new design rules	Fri 20/03/15	Fri 12/06/15
482	**Project Closure**	**Tue 15/09/15**	**Wed 30/09/15**

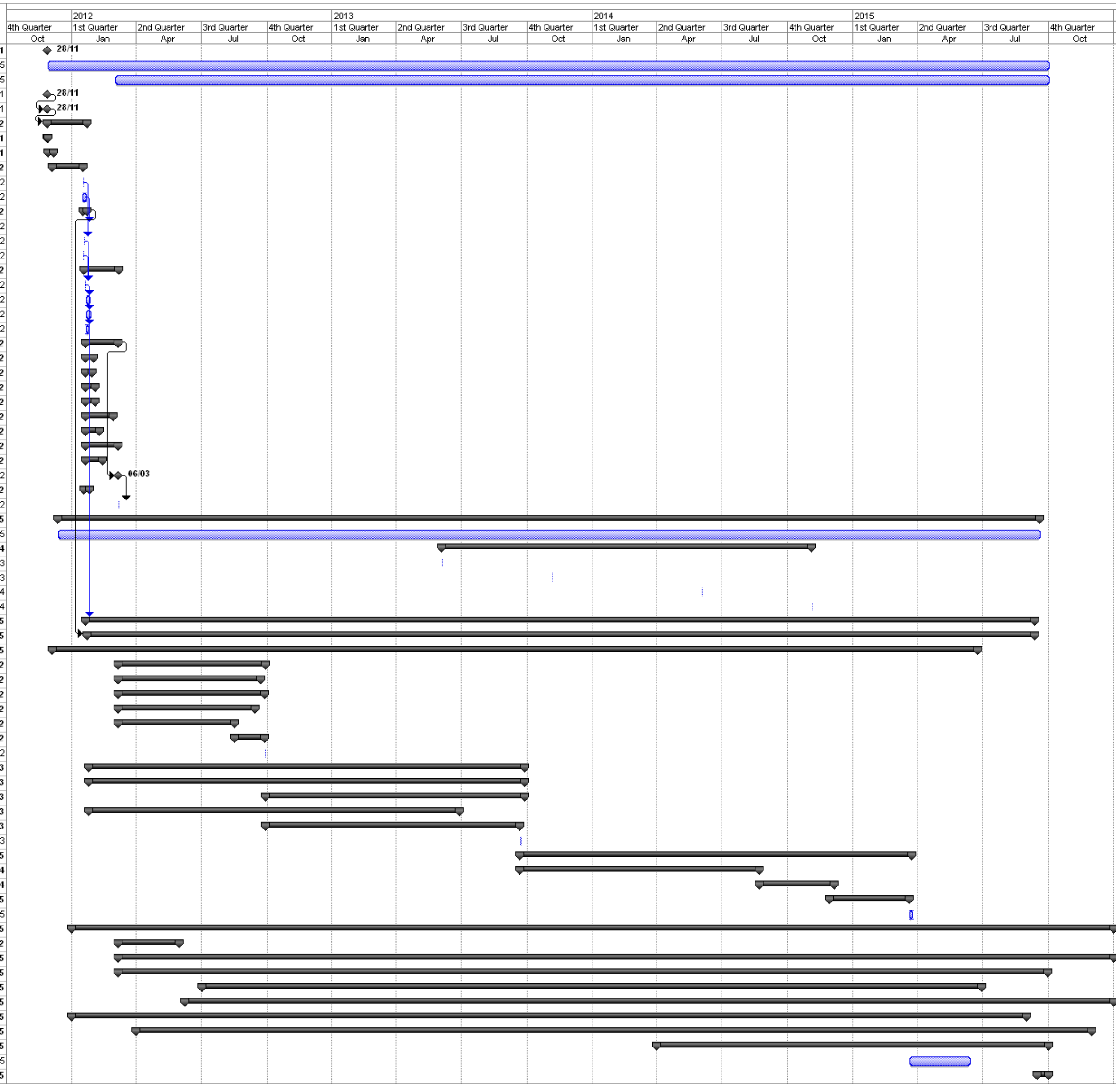


Figure 3 - Risk Log:

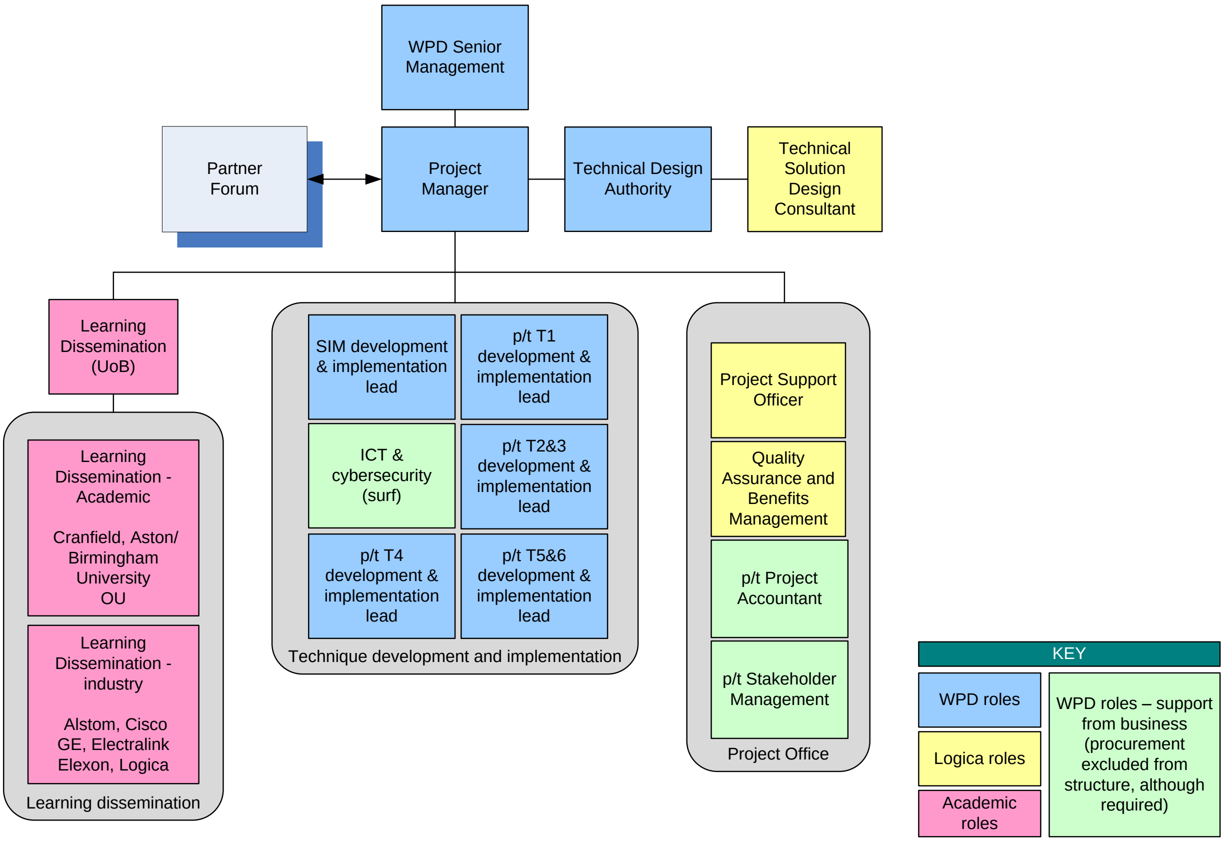
Figure 1 below is a snapshot of out Project Risk Log. We will be happy to provide the full document upon request.

Risk Register			**Last updated**													
			Project Name: FALCON													
				High Level Definition										**Cause**	**Effect**	
Risk Ref. No.	**Risk Status**	**Owner**	**"There is a risk that..."**	**Impact**	**Probability**	**Proximity**	**Rating**	**Movement**	**Raised by**	**Raised on**	**Target Date**	**Last Updated**	**"...because of..."**	**"...leading to..."**	**Mitigation Action Plan**	**Issue ID**
Next No.	Dropdown list	Responsible for mgmnt	Details of the Risk	See Table below Score 1-5	See Table below Score 1-5	See Table below Score 1-5	Auto Calculated	If risk has changed to a higher / lower priority	Who raised the Risk?	when was it raised?	Target Date for Resolution	Late date the risk was updated	What will Trigger the Risk?	What will happen if it occurs?	How will this Risk be avoided?	ID of Issue Risk has transferred to
FAL001	Raised	WPD	The Project Team cannot be effectively resourced	3	1	2	**6**			pre bid submission	01/12/11	16/08/11	Other significant or higher priority actvities running in parallel might impact WPD ability to resource FALCON	A significant delay in the project start date, milestones or deliverables	Early checking, monitoring and identification of other projects which may impact on this project. Impact analysis process in place	
FAL002	Raised	WPD	The Project Delivery Team does not have the knowledge required to deliver the project	5	3	5	**75**			pre bid submission	01/12/11	16/08/11	the legacy Bid team being made redundant	A gap in the project delivery knowledge	Detailed documentation of technical solution, key members of the bid team seconded to the project team	
FAL003	Raised	WPD	The overall Project scope and cost could creep	4	2	3	**24**			pre bid submission	01/09/12	16/08/11	poor control, underestimation of costs at bid stage, changes in technical scope, partner uncertain of their scope	increased cost, delays in project shcedule, dissemination outputs are of poor quality	Early planning RFI process, and Project Accountant role identified to keep a handle on project costs	
FAL004	Raised	WPD	Partner perceptions on their project scope may change as we move from MoU to signing a formal contract.	4	2	5	**40**			pre bid submission	06/03/12	16/08/11	Lack of clarity in discussions during the bid stages	Cost increase, funding contribution decreasing, lack of partner resource availability	Engagement with partners has been ongoing for some months. MoU describing scope is in place and agreed	
FAL005	Raised	WPD	A Partner may withdraw from project or have oversold their solution	5	2	4	**40**			pre bid submission	06/03/12	16/08/11	Misunderstood technical requirements, misrepresentation of solution	Delay in schedule, inability to achieve successful delivery reward criteria	Consider if activity is critical (at that stage in the project), Understand if activity can be picked up by exsiting partners/suppliers or seek new partner	
FAL006	Raised	WPD	Logica unable to resource the Project Office, Independent Technical Design Consultant and Quality Assurance and Benefits Management roles	5	1	1	**5**			pre bid submission	01/12/11	16/08/11	Lack of understanding of the requirements	inability to undertake the project	WPD will find resource internally if necessary. Continual dialogue and planning will have mitigated this risk sufficiently.	
FAL007	Raised	WPD	The SIM software cannot be designed within the required timescales	4	1	4	**16**			pre bid submission	01/09/12	16/08/11	Cranfield University do not have the appropriate resource to develop it	Poor quality of SIM operation and outputs. Delays in project schedule, increase in cost (apply more resource), early learning delayed	Early and detailed discussions with Cranfield to ensure scope is understood. Formal contract will contain significant technical requirements and required deliverables.	
FAL008	Raised	WPD	Aston University, together with Birmingham University are unable to deliver against their scope	2	2	4	**16**			pre bid submission	01/09/12	16/08/11	Lack of understanding of scope during bid phases	Increased costs, delay in timescales	Early and detailed discussions with Aston/Birmingham to ensure scope is understood.Consider whether other academic partners could pick up the work	

Figure 3(b) - Definition of Ratings as recorded in Risk Register

Rating	Impact	Probability	Proximity
5	Inability to deliver, business case/ objective not	Certain	Imminent (Award - Mobilisation)
4	Substantial Delay, key deliverables not met,	More likely to occur than not	Likely to be near future (<1year)
3	Delay, increased cost in excess of tolerance	50/50 chance of occurring	Mid to short term (1-2 years)
2	Small Delay, small increased cost but absorbable	Less likely to occur	Mid to long term (2-3 years)
1	Insignificant changes, re-planning may be required	Very unlikely to occur	Far in the future (4 years)

Figure 4 - Project Organogram



Roles and Responsibilities

Role	Brief description
Project Manager	Responsible for the day to day delivery of the project scope within the agreed budget and timescales. Will be responsible for presenting all changes, risk actions and progress reports for the approval of the Sponsor, undertaking the agreed actions in line with governance model.
Project Support Officer (Logica)	Providing supports and information to the Project Manager as required, ensuring that all Project Management Office operational systems and processes are managed and maintained, this includes managing the configuration plan, the project file, reporting and admin as well as finance, procurement and facilities.
Quality Assurance and Benefits Management (Logica)	Reviews the outputs from individual techniques and project phases to monitor and confirm that the overall project outcomes (benefits) will be realised. They will also scan environmental factors external to the project to determine if these will impact the project benefits. All risks to the project benefits will be included in the risk register and managed by the Project Manager.
Project Accountant	Responsible for qualitative analysis of risks in the RAID log. Ensures that all aspects of project financial control are implemented and adhered to throughout the project life cycle. This will include control of budgets, invoicing and monthly reporting. Any deviation from the project earnt value will be reported to the Project Manager.
Stakeholder Management	Ensures that the project has a comprehensive communication plan in place and then monitors and maintains the plan. Provides reports on activities and issues to the Project Manager. Responsible for engagement with key project FALCON stakeholders.
Technical Design Authority	Accountable for the overall solution design and implementation of the Scenario Investment Model and Intervention techniques 1-6. Overall responsibility for partner or supplier technical input.
Technical Design Consultant (Logica)	Provides assurance that technical standards are maintained throughout solution design and trial implementation, Supports the Technical Design Authority by auditing the overall solution design and implementation.
SIM development & implementation lead	Responsible for the development of the Scenario Investment Model, defining the detailed scope of the relevant partner(s) involvement. Supports the Technical Design Authority in developing the relevant documentation for solution design and any gateway reviews. Provides progress updates to the Project Manager as agreed.

Role	Brief description
T1 development & implementation lead	Responsible for the development and implementation of the Technique 1 –Dynamic Asset Rating, including defining the detailed scope of partner/supplier involvement, liaising with procurement and WPD operational staff as required/directed by the Project Manager or Technical Design Authority
T2&3 development & implementation lead	Responsible for the development and implementation of the Technique 2 – Automatic Load Transfer and 3- Meshed Networks, including defining the detailed scope of partner/supplier involvement, liaising with procurement and WPD operational staff
T4 development & implementation lead	Responsible for the development and implementation of the Technique 4 – Storage, including defining the detailed scope of partner/supplier involvement, liaising with procurement and WPD operational staff
T5&6 development & implementation lead	Responsible for the development and implementation of Technique 5 – Distributed Generation and 6- Demand Side Management. This includes , including defining the detailed scope of partner/supplier involvement, liaising with procurement and WPD operational staff as required, retailers and customers.
ICT and Cyber-security	Responsible for the overall design and implementation of the telecommunications structure and relationship with Cisco, Westica JRC. Ensuring that the overall architecture has been cybersecuirty tested and the results are passed to the Project Manager for onward dissemination.
Learning Dissemination (University of Bath)	Responsible for coordinating the learning dissemination activities of all parties but focusing on the management of academic institutions.

Appendix E - Partner Details

Partner Engagement Model

Below we have summarised their individual roles and responsibilities and their individual attributes that shows what we believe they will bring to the project.

Organisation:	Logica
Role Summary	Logica will be providing Project Office support to the Project as well as specialist skills as required, for example, Independent Technical Design Authority, Benefits Management and Quality Assurance roles.

Logica has helped WPD to shape FALCON throughout the 2011 LCNF Tier 2 bidding process. We have gained an excellent insight into the technical and delivery-related aspects of the project and are committed to providing ongoing programme management and technical support to WPD throughout the project lifecycle.

What does Logica bring to FALCON?

Sustainability is one of Logica's three global strategic themes. In the UK, we are focusing on helping DNOs extract the maximum learning and value from Ofgem's LCNF. We can add significant value to the WPD project in key areas:

Track Record: Logica has a recognised delivery capability within the utilities industry. With respect to LCNF, we are currently helping UKPN to deliver Low Carbon London.

Project Understanding: our role on the FALCON bid has given us a unique understanding of the objectives and challenges of the project. This insight will enable to a seamless transition from bid to project delivery.

Partner Engagement: during formulation of the bid, we have developed strong relationships with the other partners based on clearly articulated roles and responsibilities.

Industry Knowledge: Logica has been involved at the heart of every significant industry transformation in GB (e.g. the Pool, 1998, NETA, BETTA, smart metering etc.). Having designed, built and operated the central market settlement systems for ELEXON for the past ten years, we are uniquely qualified to help WPD with their planned innovative use of settlement data. Having implemented DPLAN in Portugal's InovGrid programme, we also have unique capabilities to assist with production of the SIM.

We believe that the combination of a proven track record in delivering complex utility programmes, existing LCNF programme management experience, deep industry knowledge, a profound understanding of FALCON gained through helping to shape the bid and established relationships with all key partners will enable us to manage a seamless transition from bid to project delivery, enabling a timely start to the project and early benefits realisation.

Organisation:	Aston University
Role Summary	Lead partner on network modelling and simulation of the impact of the four intervention methods.

Aston University will undertake initial definition of the network incorporating 200 substations and the four specified technical intervention methods.

What do Aston University bring to FALCON?

This work will provide the base data on the characteristics of the defined 11kV network, its responsiveness to each of the technical implementation methods and an indication of how the network modelling system and the simulator can be applied to other network configurations. The Partners will bring their prior experience and knowledge of

developing and using power system modelling software to inform project development and to achieve successful outcomes.

Organisation:	Cranfield University (Boeing IVHM Centre)
Role Summary	A simulation model will be developed by Cranfield's IVHM Centre using the provided domain knowledge and the learning from some earlier works done at the University. The project mainly includes three major steps: development of simulation model, analysis of future scenarios, and analysis of actions to be taken for the scenarios.

Cranfield University through its IVHM Centre will lead the first phase of the project, which involves building a computer simulation of the 11kV system and its visualisation. The IVHM Centre has the ability, expertise, and experience to analyse, simulate and visualise the systems. A simulation will be developed by IVHM Centre and Cranfield CSRC (Cranfield Complex Systems Research Centre) building on previous expertise from the CASCADE project (described below) and using the provided domain knowledge.

What do Cranfield University bring to FALCON?

Prior relevant projects:
1) Setting up the consortium for the Cranfield IVHM Centre (£9.5m): Core Partners: Boeing; Rolls-Royce; BAE Systems; Thales; Meggitt. Members: MoD; Alstom
2)FLAVIIR(£6.5m): BAE Systems/EPSRC funded University Partnership to build and fly a UCAV, involving a total on 10 UK universities led by Cranfield University demonstrates the university's ability to lead and manage diverse consortia and deliver outstanding results.

Organisation:	University of Bath
Role Summary	Project dissemination, leading Methods 0,5 and 6, management of academic participants

The University of Bath will lead on the knowledge capture , dissemination and customer engagement. This will be led by Dr Ian Walker. The University has significant experience in engaging DNOs and the power sector in a variety of power and low carbon related projects e.g. Transition Pathways to a Low Carbon Economy, LV templates, LRIC pricing methodology. Bath will also bring together dissemination of FALCON with its roles in Project BRISTOL and LV networks project (funded last year through LCNF). The dissemination will be undertaken chiefly in conjunction with the Open University but with input from all partners. Bath will also support the evaluation framework of techniques 5 and 6 on distributed generation and demand side management.

What do University of Bath bring to FALCON?
The University of Bath has been involved in a significant number of relevant large projects across the power networks landscape in the 132kV, 33kV, 11kV and LV networks including

The evaluation work on techniques 5 and 6 will be led by Dr Furong Li who is lead academic for Bath with input into the LV Network Templates project and whose work on flexible charging methodologies has been endorsed by Ofgem and taken up by three DNO's.

Organisation:	Cisco Systems
Role Summary	Communications equipment provider

The communication components are specifically designed for the substation environment and are IEC 61850 compliant. These devices provide the communications routing network over a variety of communications media and the data traffic routing capability. Cisco has worked with several utilities optimising the substation communications architectures.

What do Cisco bring to FALCON?

Cisco has worked with several lighthouse utility customers and equipment providers on both substation automation and smart meter integration to develop a standards based, secure and scalable architecture. This includes working on the various communications standards that may be used within this project and driving the standardisation of proprietary ones. This architecture has defined the capabilities of the products that will be used and gives the project a Cisco validated design as well as example use cases that can be built upon.

Organisation:	Milton Keynes Council
Role Summary	Supporter of the project , assisting in end customer contact and local interest stimulation

It is our belief that by involving a major Borough within the WPD region demonstrates the local commitment to FALCON and furthermore demonstrates the Council's commitment to their carbon reduction programme. This is evidenced by their Low Carbon Living Programme and their ambition to be an exemplar to their community.

a. Other initiatives that MKC have been involved in are:

b. One of the first awarded plugged in places schemes in the UK

c. Development of a city energy partnership with E.ON. The principal objective of the relationship between E.ON and MKC is as follows:

- Develop infrastructure solutions that safeguard energy security for companies and citizens
- To reduce City wide energy consumption / carbon footprint / energy costs
- To increase energy efficiency through smart initiatives / technologies
- To seek continuous improvement through an agreed regular communications and partnership working programme
- To deliver additional benefits to the community through education, training, job creation and community engagement
- To deliver services to the highest standards of quality.

d. Developing and implementing a Smart Homes demonstrator.

Organisation:	Elexon Limited
Role Summary	Elexon will provide access to the systems required to process and aggregate this data to specific substations/HV feeders

Elexon will assist in obtaining the customer settlement data to be used to build substation load profiles for modelling purposes. They will also provide access to the systems required to process and aggregate this data to specific substations/HV feeders

What do Elexon bring to FALCON?

Elexon delivers the Balancing and Settlement Code (BSC) and the services that underpin the successful operation of Great Britain's electricity trading arrangements. The BSC requires each customer site to be assigned to a profile class dependent on the type of customer. It then creates demand profile for each profile class for each day dependent on a number of factors and then these are then aggregated for all the customers of a supplier. A similar process will be created in FALCON but instead of aggregating up to a Supplier this will be aggregated to a substation to which the customer is connected.

Elexon will also have a keen interest in the revised profile creation process which is being trialled in FALCON. If this is proven to provide significantly more accurate profiles for customers then the new process may influence changes to the BSC.

Organisation:	ElectraLink Limited
Role Summary	Modelling Consumer demand under various low carbon interventions using a range of datasets including consumption.
Project Role:	

Develop and maintain a model of substation 11kV load. This will be based on physical and demographic characteristics of residential and non-domestic properties attached to the metered test substations and using MPAN consumption from industry data.

What do ElectraLink bring to FALCON?

The team brings extensive and directly relevant experience of this type of data usage and modelling. ElectraLink has managed data transfer in the electricity retail market in GB since 1998. ElectraLink's subcontractor has very extensive background in the data sources needed for this model and the development of forecasting tools. Most recently, the team has supported DECC in the development of its National Energy Efficiency Data Framework of all properties, their physical and occupant characteristics and their gas and electricity consumption history over five years. The members are acknowledged experts in this field and are also familiar with the analysis and presentation tools needed to make the project a success.

Organisation:	GE Digital Energy
Role Summary	Provider of the storage batteries for Technique 4.

GE proposes to demonstrate an Energy Storage System (ESS) that is based upon the DurathonTM battery technology and a closed loop liquid cooled power conversion system with state-of-the art controls specific to utility applications. GE's role is therefore limited to the provision of batteries that form one of the techniques being trialled.

What do GE Digital Energy bring to FALCON?

GE have an innovative battery technology that offers benefits within the 11kV network,. Specifically at distribution substations. They have also developed a control mechanism for their batteries that will link directly to the network management platform to allow the batteries to be used as an integrated storage medium to address peak constraint issues within the network.

Organisation:	The Open University
Role Summary	Supporter of the project , assisting in the dissemination of learnings via various media

The Open University will support elements of the project, specifically those concerned with customer satisfaction and engagement .Specifically these would be:

Stakeholder Engagement:

- Market and customer segmentation
- Support the development of a customer engagement plan
- Development of innovative engagement solutions, web portals, social networking, audio/video media

Customer Feedback:

- Development of customer satisfaction measuring techniques
- Gathering and analysis of data on customer satisfaction

Learning Dissemination

- Delivery of internal and external dissemination programme (short courses, web based learning, secure data access portal)

What do Open University bring to FALCON?

They will be drawing upon and building on, for example, the existing work conducted as part of the OU's contribution to the Milton Keynes Low Carbon Living Programme and, in particular, the current Plugged in Places electric vehicle project.

Eventually the website will include a wide range of interactive tools for people to find information, learn and explore. For example, one likely tool would be for people to model the impact of different combinations of technologies on their own house or small business, what tariff systems are involved and how to take advantage of the Governments feed-in-tariff for distribution connected generation.

Appendix F - Base Case Method / Cost

Base Case Costs
FALCON provides a method of providing an optimum strategy with a prioritised evaluated set of options to develop the HV network using a number of growth scenarios. The base case cost for the development of the HV network has been taken from the Imperial College / ENA report (Benefits of Advanced Smart Metering for Demand Response based Control of Distribution Networks, Summary Report V2.0).

Table 6.1 of the report identifies a range of scenarios and the investment required in the HV network using currently applied techniques for a range of low carbon uptake scenarios from a 0%-100% penetration. These investment costs range between £ 0.7 -4.5 bn depending on the penetration scenario adopted. For the purpose of this project the Base Case cost is using the 50% penetration scenario (by 2030) which indicates an investment on the HV network using current techniques of £3.7 bn.

The trial area for FALCON constitutes the following six primary substations in the South Midlands - Newport Pagnell, Childs Way, Newton Road, Fox Milne, Bletchley Grid and Marlborough Street. There are 55,000 connected customers in these six primary substations. The total number of connected customers in the United Kingdom is 28.7 m. The Base Case Cost for the selected trial area is therefore:

$$£3{,}700m * \frac{55{,}000}{28{,}700{,}000} = £7\ m$$

Method Costs
THE SIM will support the identification of the optimum solution for reinforcement using either the existing techniques or one of the new techniques being trialled and modelled under FALCON.
The process of identifying the saving by applying one of the new techniques is as follows:

1. Identify the expected level for which the new techniques and the existing technique for reinforcement would be used.
2. For each new technique for where it is used the average savings over the existing technique
3. The effectiveness of the new technique compared to the effectiveness over the existing technique (e.g. would it solve the issue for the same period of time as or is it for a shorter period of time)

In addition an assessment of the saving of time to implement a new technique compared to that of traditional reinforcement has been assessed. This provides a measure of the benefit of being able to respond more quickly to the changing demands of customers as may occur when new low carbon technologies are taken up.
The values and rationale for these assumptions are given below. Traditional reinforcement techniques will continue to be a cost effective mechanism for meeting the increased capacity. As a conservative estimate it is expected that the new techniques being trialled under FALCON will replace traditional reinforcement for only 50% of the cost. This is supported by the Imperial College study where for the 50% penetration scenario that the smart grid solution would require £1.8bn of investment (Table 6.2) against a £3.7bn for traditional reinforcement (Table 6.1).

When assessing the percentage take up of each new technique it is recognised that more than one technique may be used simultaneously. The percentages are therefore greater than 100% but the cost savings have then be normalised by dividing by the total percentage uptake. Based on the assumptions of costs savings, effectiveness, uptake for each technique (as set out in the table below) the expected national saving on the HV reinforcement is £659 m (see below for calculation).

The Method Based Costs for the selected trial area is therefore:-

$$£(3{,}700 - 659)\text{m} * \frac{55{,}000}{28{,}700{,}000} = £5.8\ \text{m}$$

National Savings on HV reinforcement

The calculation of the national savings on HV reinforcement costs is based on the following:

1. 50% of alternative techniques would be used instead of traditional reinforcement
2. The total cost of 11kV reinforcement is £3.7 bn based on the 50% low carbon technology penetration scenario in the ENA/Imperial College paper.
3. The estimated % uptake, % effectiveness and % cost saving for each alternative intervention technique as set out in the table F-1 below.

For each alternative technique a gross % saving is calculated as the product of the % uptake, % effectiveness and % cost saving. This gives the following values :

Alternative to Traditional Reinforcement	% uptake	% Effectiveness	% cost savings	% Gross Savings
1. Dynamic Asset ratings	60%	50%	80%	24%
2. Automated Load Transfer	20%	100%	50%	10%
3. Meshed Networks	5%	100%	30%	2%
4. Battery	10%	100%	10%	1%
5. DG	5%	50%	50%	1%
6. DSM	20%	50%	50%	5%
Total	120%			43%

In order to normalise the % gross savings, the aggregate of the % Gross savings is then divided by the aggregate of the % uptakes. This gives an overall gross savings for all the alternative techniques of 35.625%

Finally this overall gross savings value is multiplied by the % of reinforcements for which these alternative techniques would be used (50%) and the total costs of reinforcement under the 50% penetration scenario (£3.7 bn) i.e.

35.625% * 50% * £3700m = £ 659m

The % uptake, % effectiveness and % cost saving values used in this process are WPD estimates. The rationales behind these estimates are set out in the table F-1 below. The value of these estimates will be validated in FALCON during the trialling of each intervention technique. When assessing the percentage take up of each new technique it is recognised that more than one technique may be used simultaneously. The percentages are therefore greater than 100% but the cost savings have then be normalised by dividing by the total.

TABLE F-1
The table below sets out the assumptions we have used in developing our Method cost calculations.

The table shows, for each of the techniques being trialled, the percentage we have assumed against four criteria; uptake, effectiveness, cost saving and time implementation savings. This table supports the spider diagram shown at the end of Section 3 of the main pro-forma.

	% Uptake	% Effectiveness	% Cost Saving	% Time Implementation Saving
Dynamic Asset Rating	**60%**	**50%**	**80%**	**75%**
	There is no material barrier to the installation of this on transformers and overhead line. The reason that this is not 100% is an assumption that this technique cannot be cost effectively applied to all cables. This is due to the limitation on measuring all the factors created by variable soil and ducting conditions.	When installed the assumption is that Dynamic Asset rating will handle the peak load for 50% of the normal asset life without the need for any additional re-enforcement. This can be translated into an average delay to re-enforcement of 20 years.	The cost for instigation of dynamic asset management will be the installation of monitoring IED, associated communications and algorithms in the network management platform. It will save an estimated 80% over traditional re-enforcement materials and outage risk management.	Dynamic Asset Ratings require some monitoring equipment to be installed and changes in operation procedures. Implementation effort is contained within the substation site or on the Overhead circuits with no impact on planning consents /Traffic Management Act requirements
Automated Load Transfer	**20%**	**100%**	**50%**	**50%**
	The network configuration will require feeders to be in proximity that can benefit from the automatic load transfer. This will be governed by demographics and existing network configurations. The view from initial studies is that this technique can be applied to 20% of the HV network.	If automated load transfer is install it will reduce the need for any re-enforcement over the normal asset lifecycle of 40 years.	The cost for instigation of automated load transfer will be the installation of automated switchgear, associated communications and algorithms in the network management platform. It will save an estimated 50% over traditional re-enforcement materials and outage risk management.	Automated Load Transfer may require the installation of new switchgear within substations. Implementation effort is contained within the substation site with no impact on planning consents /Traffic Management Act requirements

	% Uptake	% Effectiveness	% Cost Saving	% Time Implementation Saving
Meshed Networks	**5%**	**100%**	**30%**	**50%**
	The load configurations that will allow mesh network to deliver benefits will be limited. These will occur in mainly urban areas. A conservative estimate is that mesh networks will deliver benefit in 5% of the network.	If the feeders are meshed it will reduce the need for any re-enforcement over the normal asset lifecycle of 40 years.	The cost for instigation of a mesh will be the installation of automated switchgear, protection, associated communications and algorithms in the network management platform. It will save an estimated 30% over traditional re-enforcement materials and outage risk management.	Meshed Networks will require the installation of new switchgear within substations and new protection arrangements for the mesh. Implementation effort is contained within the substation site with no impact on planning consents /Traffic Management Act requirements
Battery Storage	**10%**	**100%**	**10%**	**75%**
	The uptake of batteries will be limited to some degree to areas where they are cost effective compared with traditional re-enforcement. We have again used a conservative estimate. As battery take up increases the volume of production will lead to a reduction in unit price and increase the relative uptake. The project will determine unit prices and their implementation on the relative uptake of the solution.	When a battery is installed the assumption is that it will reduce the need for any re-enforcement over the normal asset lifecycle of 40 years.	The cost for instigation of a battery in a distribution substation, associated communications and algorithms in the network management platform. It will save an estimated 10% over traditional re-enforcement materials and outage risk management. This is due to the high cost of battery technology. If the volume of battery production increases then the costs will reduced.	The Batteries being trialled will be sited within substations. They are intended to be easily connected to the LV board teed into a feeder within the substation site. Implementation effort is contained within the substation site with no impact on planning consents /Traffic Management Act requirements

	% Uptake	% Effectiveness	% Cost Saving	% Time Implementation Saving
Distributed Generation	**5%**	**50%**	**50%**	**25%**
	This is limited to 5% as it only addresses DG connected directly to the 11kV network.	When instigated the assumption is that DG active management will handle the peak load for 50% of the normal asset life without the need for any additional re-enforcement. This can be translated into an average delay to re-enforcement of 20 years.	The cost of DG management will be the commercial agreements required with the suppliers plus the additional communications infrastructure required and algorithms for the network management platform. It will save an estimated 50% over traditional re-enforcement materials and outage risk management.	Standard Commercial Pro-forma will have already been developed. It is expected that detailed contract negotiation will take some time although implementation once agreement is made can be done swiftly as the base requirements of monitoring and communications equipment can be easily deployed
Demand Side Management	**20%**	**50%**	**50%**	**25%**
	This is limited to 20% as it an estimation of the percentage of controllable demand connected directly to the 11kV network.	Where DSM is used in the network it is assumed that it will reduce the peak load for 50% of the normal asset life to a level that does not need any additional re-enforcement. This can be translated into an average delay to re-enforcement of 20years.	The cost of DSM will be the commercial agreements required with the industrial and commercial consumers plus the additional communications infrastructure required and algorithms for the network management platform. It will save an estimated 50% over traditional re-enforcement materials and outage risk management.	Standard Commercial Pro-forma will have already been developed. It is expected that detailed contract negotiation will take some time although implementation once agreement is made can be done swiftly as the base requirements of monitoring and communications equipment can be easily deployed.

Appendix G - Knowledge Dissemination

Background
FALCON's aim is to address the constraints on the 11kV network hindering uptake of low carbon technologies.
The Project delivers new knowledge in the form of a long-term investment model consisting planning guidelines for determining the best individual and combination of technical and commercial techniques for solving constraints in a wide range of different current and future 11kV network scenarios. The outputs will be delivered to key stakeholders as a robust and enduring framework for assessing future innovative approaches.

The need for knowledge capture and transfer
Knowledge capture and transfer are vital as the issues concern the whole of the UK. DNOs not directly involved in FALCON need to be able to learn from the project and effectively employ its methods and insights in the planning and development of their own 11 kV network. Due to the multidisciplinary nature of the Project, there must be co-ordinated learning across all the partners, to allow the project's outputs to be captured and shared. Equally, the knowledge transfer must reflect the multi-stakeholder perspective of the future network grid and recognise that stakeholder needs are different consequently the style of dissemination and level/type of knowledge transferred must be tailored to meet audience needs. This co-ordination approach will be managed by the University of Bath.

Knowledge transfer as a tool
People and organizations are not passive recipients of information – rather, new information often causes changes in beliefs, attitudes and behaviour. The process of sharing knowledge from FALCON will be a tool to influence the uptake of future low-carbon technologies and thereby influence the future demand on the 11 kV network.

Systems and processes for knowledge capture
The knowledge captured during the Project is centred on the (SIM). This assesses six intervention techniques, each consisting of a technical solution linked to a benefits case which will be investigated and validated.
The assessment of each intervention technique involves several project partners, and the new knowledge that emerges from these partners and their outputs must be captured, stored, analysed, protected and ultimately transferred to the other stakeholders. The knowledge will need to be captured in multiple ways. There will also be early agreement and sign off of a communications plan so that all partners understand their roles and responsibilities in disseminating knowledge. The means for capturing knowledge will be:

- Technical reports, reviews and specifications
- Models and related training manuals
- Notes and minutes from project team meetings
- Progress and final reports
- Patents and IPR
- Academic and journal papers
- A secure server which holds:
    - A research database for reports and papers
    - A wiki on which reports and notes can be collaboratively assembled and multi-partner discussions maintained outside of formalised meetings
    - An email archive; all emails concerning the Project can be copied to this server where they will be archived in a searchable format
- Interviews and surveys. This will be a key knowledge capture tool for this part of the project and will be one of the core roles for the researcher employed at the University of Bath. This researcher will visit key people involved in the FALCON project at various stages of the project and, using pre-arranged interview protocols as well as free-flowing conversations, will record the conclusions that emerge about each method, as well as the decision processes by which these are reached

- Logs of lessons learned, maintained throughout the project by the Project Manager and project support
- Post-implementation review.

A two-way dialogue is required with Stakeholders to maximise the impact of the project. In addition to capturing knowledge from the project and its team, there is the need to capture knowledge and feedback obtained from external stakeholders engaged by the project in its knowledge dissemination activities. These will include:

- Market research and interviews with DNOs, other LCNF projects, other key stakeholders and the general public
- Recording of feedback and discussion sessions at workshops and seminars
- Feedback given by stakeholders through the website portal.

Systems and processes for engagement
The key recipients of knowledge output will be the UK DNOs, energy retailers, UK Government (DECC, BIS), equipment manufacturers and Energy Networks Association. Although these bodies are likely to have some interest in the raw information from the knowledge capture process– they are more interested in processed information, in which all our learning is synthesised to simple rules, concrete conclusions, recommendations and action plans. We envisage a variety of methods for providing members of this audience with such outputs, including:

- Representation on the Project Forum occurring on a six-monthly basis to allow knowledge sharing between LCNF projects and to other ongoing initiatives funded by Government and other bodies, e.g., SmartGrid GB
- Early-stage market research to understand the expectations of the Project from the audience and to ensure that the proposed communication plan and methods is appropriate to, and meets the needs of, these stakeholders
- Regular stakeholder/team meetings
- Workshops and symposia, including an early workshop to elucidate links and learning opportunities between the various LCNF projects in which these partners are involved (Project FALCON, Project BRISTOL, Customer Led Network Revolution, Low Carbon London, etc.) Some of these can be undertaken virtually to permit the widest participation using the Open University's Elluminate platform
- Technical operational guide manuals for the SIM
- Outputs from the project can be structured for DNOs, energy retailers and other stakeholders to be delivered as online podcasts and web-delivered CPD training materials
- Provision of access to the secure project wiki
- Regular e-newsletters
- A LinkedIn group, facilitating contact between interested people
- Technical reports
- Academic papers
- The technical face of the FALCON website
- Articles for in-house newsletters and industry magazines
- Press releases.

The second key group of recipients of the knowledge generated will be industrial and commercial customers. In addition to some of the methods listed above, specific mechanisms for engaging these stakeholders include:

- Customer recruitment campaign – information packs, site visits and generation contracts
- Information leaflets with their bills
- Customer focus groups
- Focussed workshops.

Academics will also be recipients of the knowledge disseminated by the project. The outputs, knowledge and insights from the project would be used to inform teaching of the next generation of engineers and provide opportunities for the development of further research projects. This group will be engaged specifically through:

- Journal and conference papers, posters and presentations
- The development of joint research projects related to the Project
- The outputs of, and insights from, the project will be developed jointly by Bath, Aston, Cranfield and Open universities into course materials for undergraduate, postgraduate and CPD teaching
- Teaching materials can be further developed to allow science teachers to integrate information on low carbon technologies and behaviours into their lessons.

The final group to be engaged are the end-users of the network. The members of this group are important as ultimately it will be their uptake of low-carbon technologies that will determine the demand on the 11 kV network. Dissemination will allow end-users to learn about how FALCON and low carbon technologies could benefit them. There will be a range of one- and two-way engagement processes including:

- Press releases and briefings, focusing on both national and local angles to the Project
- Surveys to improve our understanding of attitudes, perceptions and behaviours related to energy use, low-carbon technologies and network grid demand issues
- Leaflets (e.g., delivered with energy bills)
- Notices on energy companies' customer websites
- Newsletters and Public displays e.g. at libraries, supermarkets or suitable public events
- A public and non-technical face to the website providing interactive information and tools through which users can learn about energy, networks and low carbon technologies. This would be linked to social media.
- Notices on energy companies' websites, with links to project's public facing website
- YouTube programmes and podcasts.

These activities will be informed by public engagement research, drawing on the experience of Bath and the Open University.

Systems and processes to evaluate knowledge capture and customer engagement

Over the course of this project, it will be important to check that the above knowledge capture and engagement processes are working. This process breaks down into various areas: auditing the knowledge capture process regarding the SIM and Intervention Techniques and then auditing the knowledge transfer process for this information.

Knowledge capture audit

We will be gathering a considerable amount of information about methods and technologies for managing the 11 kV network. To audit the extent to which the knowledge capture methods properly record the learning from the project, we propose to have core materials (technical reports, models, training manuals, meeting minutes) periodically audited by impartial experts. The auditors' reports will allow project members to check that everything that should have been captured has been recorded, in a form that could be used by DNOs or other intended stakeholders. In other circumstances, for example with surveys of key stakeholders and the public, we cannot know objectively what the results should look like, the above form of audit is not feasible. The method for assuring the quality of these data will not come from our data collection and analysis methodology, and from using power analyses, where applicable, to ensure that sufficient people are tested at various stages of the project.

Knowledge Dissemination audit
Information on network management methods will be provided to interested parties through a variety of methods, as outlined above. The success of these efforts might be evaluated through methods including:

- Before-and-after surveys of key people to assess the extent to which core messages have been successfully received
- In-depth interviews in which the lessons taken from knowledge dissemination efforts are investigated. Such interviews will allow more detailed information to be gathered than the survey, for example they can explore the extent to which a person is able to employ one of FALCON's models to make decisions and feedback lessons learned from this.

Track record for each partner

The University of Bath
The University of Bath has an extensive track record of knowledge capture, dissemination and engagement with stakeholders in the power industry, as well as in many other branches of industry and government. The University of Bath, which shared a Nobel Prize for climate change work, is involved in flagship projects across the energy sector which will help shape the UK's future energy system, including the EON / EPSRC funded Transition Pathways to a Low Carbon Economy, SUPERGEN FlexNET and the LCNF Tier 2 funded LV Customer Templates project.

The University is also the chosen delivery partner by The Goldsmiths for a Sustainable Energy course delivered to secondary school teachers on an annual basis (http://www.bath.ac.uk/news/2011/07/26/summer-school/).

The Open University
The Open University is internationally renowned as a distance learning university. It is constantly ranked in the top three UK universities for the quality of teaching and also has a strong research reputation. The OU has been working with the MKC on activities for the MKC Low Carbon Living programme. This is drawing upon both the Open University's expertise for public engagement through mass and web-based media and its specific experience in the engagement of users of low carbon domestic technologies. For example the OU has hosted user workshops in connection with the MKC Electric Vehicle plugged in places programme, produced an e-newsletter and supported the programme's website and data repository development.

The University's environment and energy programmes are supported by its award-winning public engagement internet operations, which include:

- *OpenLearn* website (http://openlearn.open.ac.uk/) which links to many of the OU/BBC co-produced programmes and includes online discussion forum on subject areas. This site won the ICT Initiative of the Year Award at the Times Higher Leadership & Management Awards ceremony in June 2010
- Open Learn includes the Creative Climate section, which includes downloads and interactive tools on home energy issues
- Podcasts (http://podcast.open.ac.uk/) and also available through YouTube
- OU's iTunesU pages (the first university worldwide to hit 20 million downloads)
- OUverte: the new Open University Online Community for environmental, social and economic sustainability.

Cranfield University
The Cranfield IVHM Centre has world leading expertise and experience in the analysis, simulation and visualisation of systems. IVHM will support the dissemination strategy

through the sole and joint publication of academic and conference papers, links to its website / related project websites and in conjunction with the other academic partners facilitate dissemination / technology transfer through IVHM's training and educational offerings such as short courses and the newly launched IVHM MSc. IVHM's extensive track record in dissemination is demonstrated by its participation in a number of high profiles network related projects:

- EEDA funded project (Cranfield and University of Central MK) - End to end demonstrator development - from point of generation to end consumers.

CASCADE a complexity science based investigation into the concepts of the smart grid – this project has developed an agent-based modeling framework.

Aston University
Aston University has an excellent track record of engagement with the power industry and with the proposed FALCON partners. Current research includes a project on meshed networks (the outputs of which will input to FALCON) with WPD and a further CASE Award with Alstom Grid. Aston is currently leads or is involved in a number of flagship EPSRC SUPERGEN projects. In conjunction with the other academic partners particularly the Power Engineering research groups at Birmingham and Bath, Aston will disseminate findings through journal and conference papers but also seek to develop future research projects with these institutions. In conjunction with Bath, Open and Cranfield, Aston will seek to develop the outputs of the project into teaching materials that can be used in undergraduate, postgraduate and CPD training with the power industry.

Alstom
Alstom is a global leader in transport, power generation and power transmission and have considerable knowledge and experience gained over many years in Power Systems Infrastructure. Alstom have been heavily involved in the areas of Dynamic Asset Management and Meshed Networks and have successfully developed, designed, manufactured, installed, tested and commissioned working solutions for a number of industry partners.
Alstom have established protocols for knowledge capture and data management. In terms of knowledge transfer Alstom could provide support to the FALCON project dissemination activities through the co-authorship of journal and conference papers in conjunction with the academic partners, through their Alstom Web TV, Twitter, Facebook and YouTube presences as well as through attendance at project dissemination events.

ElectraLink
In relation to ensuring knowledge capture, ElectraLink's Quality Management System is certified to meet the requirements of ISO 9001:2008. Electralink will support the dissemination of the project through attendance at workshops, presentations in relation to the technological forecasting / scenario modelling aspects of the project. In addition, Electralink publish a quarterly electronic newsletter which is widely disseminated within industry providing an important dissemination route to publicise FALCON and its findings.

Cisco
Cisco's knowledge capture will be based on its Business Management System which is made up of two parts; the Quality Management System and the Environmental Management System. Cisco will support knowledge dissemination through co-authoring papers with the academic partners, engagement within project dissemination events and authoring of technical reports

Appendix H – Extracts from our Letters of Support

The following list of Partners, Suppliers and Supporters has written to confirm their roles and support of the Project. Full copies are available on request.

"Logica has supported WPD throughout the 2011 LCNF bidding process and have contributed to the development of the project concepts and trial designs.

We are delighted to be the Project Partner and are fully committed to working with WPD to ensure a successful conclusion to the project. "
Tara McGeehan Utilities Director

"...to enable successful delivery of the project, WPD has communicated the intentions to establish a forum for project partners; Cranfield University agrees on the creation of such a forum as a mechanism to ensure that the objectives of the FALCON project are met and welcome the opportunity to be an active participant. Consequently, we at Cranfield University are in full support of the FALCON project."

Clifford Friend, Deputy Vice Chancellor

Alstom Grid is grateful for the opportunity to contribute its expertise and global experience in smart grid control rooms and distribution automation technologies towards the FALCON project. We recognise the benefits that increased network flexibility will bring to a low carbon transition and consider that the objectives set for the project will help make this a reality. As the Leading Industrial partner, Alstom Grid will develop and deploy innovative technical solutions for the intervention techniques to be trialed. Including; utilisation of dynamic asset ratings, automatic load transfer between feeders, implementation and operation of meshed networks, control of distributed generation and demand.

Robert Weston SMART Grid Director

The FALCON project provides the University with a significant opportunity to demonstrate the benefits of our research at the real world scale. T he University is strongly committed to working with industry partners to enhance the outreach and socioeconomic impact.
Professor Jane Millar Pro-Vice-Chancellor (Research

"The Council has supported WPD in the development of the FALCON bid and is fully committed to being an active partner in its implementation. We will integrate the project within our overall programme in order to strengthen the impact and maximise learning.

We would be delighted to explain further why we have such a belief in the value of this project and its close fit with our community's ambitions to be a low carbon living exemplar.

" **David Hill, Chief Executive**

" ElectraLink will develop and maintain a model of substation 11kV load based on physical and demographic characteristics of residential and non-domestic properties attached to the metered test substations and using MPAN consumption from industry data. This is a vital input to the rest of the project, allowing it to examine the operation of the network under many economic and usage scenarios, including take-up of renewables and for future horizons. The Project FALCON partner forum will help maximise the outputs of the project. We are pleased to confirm our interest in attending this."

Owen Turrell, Business Development Manager

"...the Open University is strongly committed to project FALCON and we are confident that we can make a significant contribution to its success."

Professor Alan Bassindale, Pro-Vice Chancellor

"Cisco is pleased to be selected as one of the partners to work with WPD on the LCNF project. This project will enable WPD to assess many of the benefits of a true SmartGrid infrastructure combining both theoretical and practical studies to assess the impact of various grid reinforcement methods. Cisco is excited to be working with WPD and its partners on this project to supply the communications hardware and to ensure a reliable, robust and security communications infrastructure is design using Cisco SmartGrid Service."

Andrew Longyear, Business Development

JRC would like to express support for Western Power Distribution's FALCON project being considered under the Low Carbon Network Fund initiative. JRC would see the Project as providing valuable insights into the communications needs for the Smart Grid at distribution voltage levels.

Adrian Grilli
Managing Director

GE Digital Energy is fully committed to supporting Western Power Distribution's LCNF Falcon bid and in addition to the above benefits we also believe the network challenges and opportunities identified within the aims of the project are representative of what can be expected across the United Kingdom during the transition to a low carbon future."

Keith Redfearn, Regional General Manager

Appendix I - Summary of Customer Communications for FALCON project

Stakeholder group	Knowledge / Project outputs	Communication tools	Use of data	Target start date
Other DNOs, Ofgem, Other LCNF projects, National Grid	• Use Cases • Final intervention technique hypotheses • Data analysis tool • Model scenarios based on the intervention techniques • SIM design documentation • Load Growth Scenarios • Economic simulator model • Final simulator design	• Intervention technique and combined hypotheses • Software models • Technical training manuals for models produced • Progress reports • Technical reports • Press releases • Training sessions / courses to provide training on models and gather feedback for further development • Face-to-face meetings • Participation on Partner Forum	• Feedback from training courses will be fed back to Aston, Cranfield, Alstom and GE to feed into iterations of Intervention Techniques 1-4 • Feedback from workshops will be fed to all partners involved in the SIM and Intervention techniques • Data from surveys and market research will be captured and utilised by Bath is refining the stakeholder engagement, knowledge capture and communication plans. • Information regarding outline commercial agreements will be fed back to Bath / WPD • MPAN databases used to link substations/ feeders to meter data	Q1 2012 Q1 2015 Q1 2015 Q1 2012 - onwards Q1 2012 – onwards Q1 2012 - onwards Q2 2014, Q1 2015, Q3 2015 Q1 2012 onwards Q1 2012 onwards
	• SIM code • Developed visualisation tool • Algorithms for technical management platform • Outline commercial agreements • Outputs of simulator operation • Final SIM • Outputs of Superimposed Load Growth profiles on SIM	• technical and public website and Project newsletter • Surveys • Workshops/events to communicate learning and gather feedback • Access to research database architecture • Contract (including information on data use; terms and conditions) for techniques 5 and 6 • Market research • Annual LCNF conference • Annual FALCON conference		Q1 2012 onwards Q1 2012, Q3 2015 Q1 2012 onwards Q2 2012 onwards Q2 2014 Q1+2 2012 Q3 2012 annually Q2 2012 annually
Energy Retailers, DECC, Government / Local	• Final intervention technique hypotheses • Data analysis tool • Model scenarios based on the intervention techniques	• Intervention techniques and combined hypotheses • Face-to-face meetings • Participation on Project Forum • Public and technical website and	• Feedback from workshops will be fed to all partners involved in the SIM andIntervention techniques • Data from surveys and	Q1 2012 Q1 2012 onwards Q1 2012 onwards

Stakeholder group	Knowledge / Project outputs	Communication tools	Use of data	Target start date
Government, OEMs, Energy Networks Association, NGOs	• Load Growth Scenarios • Economic simulator model • Final simulator design • Developed visualisation tool • Algorithms for technical management platform • Outline commercial agreements • Outputs of simulator operation • Outputs of Superimposed Load Growth profiles on the SIM	newsletter • Progress reports • Technical reports • Press releases • Surveys • Workshops/events to communicate learning and gather feedback • Market research • Articles in industrial press / in-house magazines of GE / Alstom • Annual LCNF conference • Annual FALCON conference	market research will be captured and utilised by Bath is refining the stakeholder engagement, knowledge capture and communication plans. • Information regarding outline commercial agreements will be fed back to Bath / WPD	Q1 2012 onwards Q1 2012 onwards Q1 2012 onwards Q1 2012, Q3 2015 Q1 2012 onwards Q1+2 2012 Q1 2012 onwards Q3 2012 annually Q2 2012 annually
Industrial and commercial customers, potential power generators	• Model scenarios based on the intervention techniques • Economic simulator model • Outline commercial agreements • Information derived from outputs of economic and network models showing potential benefits of adopting DG and DSM	• Customer recruitment campaign. Details of this TBC but might include: - information packs (digital and print) - telephone calls/site visits • Information leaflets with their bills • Press releases • Face-to-face meetings • Letter with results of feasibility study • Customer focus groups • Contract (including information on data use; terms and conditions) for techniques 5 and 6	• Contact and contract details of clients will be stored securely by WPD. Contact details will be passed to Bath. • Information regarding outline commercial agreements will be fed back to Bath / WPD	Q1 2012 Q1 2012 – annually Q1 2012 – onwards Q1 2012 - onwards Q3 2012 Q2 2012 – annually Q1 2013
		• FALCON project public and technical website and FALCON project newsletter • Surveys		Q1 2012 – onwards Q1 2012, Q3 2015
		• Workshops/events to communicate learning and gather feedback • Market research		Q1 2012 onwards Q1+2 2012

Stakeholder group	Knowledge / Project outputs	Communication tools	Use of data	Target start date
		• Annual LCNF conference • Annual FALCON conference		Q3 2012 annually Q2 2012 annually
Academic institutions	• Final intervention technique hypotheses • Data analysis tool • Model scenarios based on the intervention techniques • Load Growth Scenarios • Economic simulator model • Final simulator design • Outline commercial agreements • Outputs of simulator operation • Final SIM • Outputs of Superimposed Load Growth profiles on SIM	• Annual LCNF conference • Annual FALCON conference • Journal papers within publications such as IEEE Proceedings • Conference papers at suitable academic conferences • Project academic institutions to meet in academic team meetings • Joint research projects • Teaching materials • TV / Youtube programmes • Podcasts • Project FALCON technical website and newsletter	• All papers and conference proceedings to be made freely available	Q3 2012 annually Q2 2012 annually Q3 2012 onwards Q4 2012 onwards Q1 2012 onwards Q1 2013 onwards Q1 2014 onwards Q1 2012 onwards Q1 2012 onwards Q1 2012 onwards
General public, Schools	Outputs distilled from the knowledge gathered by project FALCON tailored to provide more general knowledge on the network/low carbon technologies	• Information provided with Utility bill • Social media • Newsletters/ public information displays • Articles in local press	• Feedback from surveys and data collected fed back to Bath • Any personal data / views to be held securely by Bath and destroyed at the end of the project	Q1 2012 Q1 2012 onwards Q1 2012 onwards Q1 2012 onwards
		• Engagement of schools with curriculum suitable materials in conjunction with Project B.R.I.S.T.O.L		Q1 2013 onwards
		• Surveys		Q1 2012
		• Workshops		Q1 2012 onwards
		• Project FALCON public website and newsletter		Q1 2012 onwards
		• TV / Youtube programmes		Q1 2012 onwards
		• Podcasts		Q1 2012 onwards

Appendix J- Benefits

Direct Benefits

We do not expect the project to deliver significant Direct Benefits during the course of the project as there is to be no change to the existing DR5 business plan; that is to say there is to be no asset deferment or life-cycle increase availability through this project's time line.

Throughout the project there will be elements that decrease and elements that increase the network losses. Existing standard asset ratings of equipment are often the "worst case" scenario, through real-time measurement the expectation is that a greater power delivery from the existing asset can be achieved. Therefore, the use of real-time asset ratings will produce an increase in network losses, due to the I^2R effect on the network. Using DG and DSM to alleviate pinch points, i.e. reducing load on the network at critical times, will have the effect of reducing network losses, again due to the I^2R effect on the network. The LV energy storage is expected to utilise the high level of LV generation currently on the network, at times of low load to charge, therefore reducing some of the distribution losses generally experienced. These losses are typically 3% at 11kV and 7% at LV. However, there are losses associated with the efficiency of the storage devices, which have an expected round trip efficiency of 82%. Utilising the storage over an area of 11kV network should mean that the net losses due to battery installation remain largely unchanged. Through the utilisation of all these methods on the 11kV network, there is likely to be a nil effect on network losses.

The minimal Direct Benefits for this project will come, primarily, through the reduction in customer minutes lost (CML) and customer incidents (CI), driven by increases in network security through meshing and automation inclusion. Providing 11kV load transfer and meshing shall significantly increase the level of automation seen on the network. Calculations derived by WPD indicate that installing automation on to an 11kV circuit has a corresponding effect of reducing the CML's by 0.015 and the CI's by 0.015. By maximising the benefits through automatic load transfers and network meshing, the network security delivered to the end customer should see a tangible increase. Direct Benefits have been calculated on the value associated with the IIS improvement, based on 5 effected circuits in 2011/12, 10 effected in 2012/13, 15 effected in 2013/14 and 2014/15. The IIS value has been calculated on a 0.015 CML and 0.015 CI improvement per circuit, borne by load transfer and meshing, where 1 CML has a value of £420k and 1 CI £120k.

Carbon Benefits

Assumptions and Data Sources for calculating Carbon benefits

A study was carried out by Logica, looking at the impact of the national rollout of the FALCON method. This study concluded that the national rollout would give rise to a reduction of 680 thousand tonnes of CO_2 emissions as compared with the Ofgem LENS Report "Big Transmission and Distribution" scenario. In order to estimate the potential savings in CO_2 emissions, a series of assumptions have been made. This appendix details all these assumptions.

Average annual electricity demand for project benefits is taken from an average of 2005 and 2006 consumption for the WPD Midlands area, these being recent years for which good data was available. Going forward and looking at Great Britain as a whole, the projections for annual electricity demand have been taken from the Ofgem LENS Report "Big Transmission and Distribution" scenario.

The ***savings estimates*** are based on data from WPD Midlands, much of which has formed the basis for previous regulatory submissions to Ofgem.

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 current levels of **reinforcement** across the CN network have been taken from two Excel spreadsheets supplied by WPD: "CN West NADPR Workbook" and "CN East NADPR Workbook". Figures from 2010 were used as this was a year that could be taken as typical of the current approach.

Data on the carbon cost of reinforcement has been taken from Jones, C.I., McManus, M.C., "Life-cycle assessment of 11 kV electrical overhead lines and underground cables", J Clean Prod (2010), doi:10.1016/j.jclepro.2010.05.008. The "Inventory of Energy and Carbon" produced by the Sustainable Energy Research Team at Bath University (Inventory of Carbon & Energy (ICE) Version 2.0 Prof. Geoff Hammond & Craig Jones Sustainable Energy Research Team (SERT) Department of Mechanical Engineering University of Bath, UK, http://www.bath.ac.uk/mech-eng/sert/embodied/) was used to obtain values for embodies carbon.

To obtain a conservative estimate of the carbon benefit of **reduced reinforcement**, a number of assumptions were made. Firstly, only overhead lines and underground cables were considered. Then, the Network Investment Model 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 savings.

Carbon savings from reduced reinforcement come from the savings in embodied carbon of the different materials which would otherwise have been used in the avoided reinforcement. Carbon savings do not scale directly with cost. The basis of the assumption, that we can achieve a 40% saving, is on the accumulated expertise of the wider project team taking into account the attributes of Project FALCON and taking previous project experiences into account. This we believe is a conservative view and will be verified during the course of the Project and made available as new learning.

The value obtained for the CN network was scaled to Great Britain in proportion to annual demand. Cumulative figures for 2016 to 2050 were calculated by assuming that reinforcement requirements would remain approximately the same and that therefore the same carbon saving could be achieved every year. This gives an underestimate as it is likely that reinforcement needs will increase and so the carbon savings from applying the FALCON method would also increase.

Carbon Emission Factors for grid electricity for the present day have been taken from: http://www.defra.gov.uk/environment/business/reporting/pdf/100805-guidelines-ghg-conversion-factors.pdf. For future carbon emissions factors for grid electricity, we have used the Ofgem LENS Report "Big Transmission and Distribution" scenario.

Carbon Valuation has been undertaken using the DECC non-traded shadow carbon prices, taken from:
http://www.decc.gov.uk/assets/decc/what%20we%20do/a%20low%20carbon%20uk/carbon%20valuation/1_20090901160357_e_@@_carbonvaluesbriefguide.pdf

FALCON Addendum

REF: Ofgem Expert Panel Issue: Cost/Benefit of Intervention Technique 4-Storage

At the Ofgem Evaluation Panel presentation on 3rd October 2011 the cost of battery storage was questioned in light of the learning that will be gained in comparison with the other intervention techniques.

The Panel suggested we review the overall cost of Intervention Technique 4-Storage in order to strengthen Project FALCON's business case.

We have detailed our assumptions on the benefits of storage within the core bid documentation and, following a further review, stand by these assertions. Being able to accurately model storage within the SIM remains a fundamental requirement of FALCON.

We shared the panel's feedback with our battery supplier and specifically asked them to evaluate all possibilities to make the overall cost of the Intervention Technique 4-Storage more acceptable to the Panel without compromising the learning. Options were discussed as outlined below.

Option 1: Battery supplier to reduce the unit cost of storage for 10 sites

Option 2: Provide costs for 5, rather than 10 sites

We will explore options to maximise the value for money associated with battery storage.

The table below highlights the updates made in the revised bid submission:

Document Section	Page	Description of Update	Ofgem Clarification Addressed
Pro-Forma			
Section 1.4	1	The values for the Second Tier Funding and External Funding have changed to reflect the impact of reduction in the storage scope	Expert Panel Issue 3/10
Section 2	2	The words describing changes since the ISP submission have been updated to reflect the latest position	n/a
Section 2.2	7	Scope of storage installations reduced from 40 devices over ten sites to 30 devices over 5 sites.	Expert Panel Issue 3/10

Section 9.5	51	Criteria updated to reflect change in scope of storage trial. Five sites rather than ten	Expert Panel Issue 3/10
Section 4(b)	20	Text of 4 (b) updated to explain further WPD's direct input to the source of the investment costs taken from the ENA/ICL paper.	Q1
Section 4(b)	20	Corrected typo - the word "investment" was omitted from the end of the last paragraph.	n/a
Section 6	36	Words included to address Q13 around the probability assigned to the risk of being able to resource this project.	Q13
Section 7	41 and 43	Section 7 has been revised to provide clarity and consistency. WPD is seeking £125k protection against IIS penalties. The value given for the number of customers has been corrected from 2000 to 10,000. We have included the table which shows how the protection value has been calculated	Q6
Section 8	44 - 45	Section 8 has been updated to reflect the correct values used in the calculation of CI's and to be consistent with other sections. The statement claiming protection against IIS is not required has been deleted.	Q8
Section 8.3	46	Section updated to clarify the process of managing new connections in the trial area during the trial period.	Q16
Section 9	49 - 52	Section 9 updated to reflect a revised set of Successful Delivery Reward Criteria.	Q17
Appendices			
Appendix C		Section numbering has been updated	n/a

Appendix C	9	Appendix updated to confirm the position regarding safety criteria during the deployment of the intervention methods. All deployments will comply with WPD safety policies and procedures.	Q10
Appendix C	12	For the Automated Load Transfer technique we have added words to show that we will not compromise the N-1 capacity situation with regard to capacity on feeders.	Q11
Appendix D	24	Updated to include definitions of the ratings used in the risk register	Q12
Appendix F	33 - 34	Appendix updated to show the calculations from which the £659m is derived.	Q2
Appendix J	47 - 48	Appendix update to further clarify the 40% assumption used in our calculations.	Q15
Spreadsheet			
Whole Project Costs tab		The "Whole Project Costs" tab has been updated in line with Q4. Cells AC7 to DV59 have been completed in Version 6 of the spreadsheet	Q4
		Version 7 of the spreadsheet has been updated to reflect customer payment request.	Q5
Direct Benefits tab		The spreadsheet Version 7 has been updated to remove the Direct Benefits of £283,500. The calculation error has also been corrected.	Q7
Whole Project Costs tab		The spreadsheet version 7 includes information in the column 'Unit cost/total person days/payment per user/expected length of contract'.	Q9
Whole Project costs tab		Reduction in overall project funding	Expert Panel Issue 3/10