# DEVELOPING FUTURE POWER NETWORKS


FALCON Commercial Trials

Season 1 - Winter 2013/14

| | | |
|---|---|---|
| Report Title | : | FALCON Commercial Trials<br>Season 1 - Winter 2013/14 |
| Report Status | : | Issued |
| Project Ref | : | WPDT2002 |
| Date | : | 07.07.2014 |

| **Document Control** | | |
|---|---|---|
| | Name | Date |
| Prepared by: | Gary Swandells | 24.06.2014 |
| Reviewed by: | Sanna Atherton | 20.06.2014 |
| | Roger Hey | 26.06.2014 |
| Approved (WPD): | Sanna Atherton | 07.07.2014 |

| **Revision History** | | |
|---|---|---|
| Date | Issue | Status |
| 29.04.2014 | v0.1 | Draft |
| 08.07.2014 | V1 | Final |

# Table of Contents

# 1. Document purpose

This report provides a summary of the learning gained during the Design, Build and Operational phases of Project FALCON's Season 1 Commercial Trials, and covers the period June 2012 to late April 2014.

Having now completed the first of two sets of operational trials, we are able to document and share many of the experiences and early insights into how a Distributed Network Operator could deploy Demand Side Response as a Business as Usual solution.

The report provides a wide range of outputs including:

- High level programme design
- Assumptions and dependencies
- Technical design and development
- Commercial / financial design and development
- Participant and industry engagement
- Trials Operation
- Analysis
- Conclusions
- Proposed modifications
- Business as Usual application

A variety of different methods have been used to develop the Commercial Trials programme which call upon experience from existing Demand Response services and other trials operated previously in relation to a DNO as the service operator. The report aims to provide adequate context to any references that relate to prior programmes or identify external resources where more detailed information can be obtained.

The development of Season 2 Commercial Trials has commenced and will run to June 2015. A subsequent revision of the report will be authored and made available after this date and will detail the full two year results.

# 2. Executive Summary

## 2.1. FALCON Commercial Trials

FALCON (**F**lexible **A**pproaches for **L**ow **C**arbon **O**ptimised **N**etworks) is a project led by Western Power Distribution (WPD) involving a number of partners. The project is partially funded by the energy regulator, OFGEM, via their Low Carbon Networks Fund, which tasks Distribution Network Operators (DNOs), like WPD, to trial ways to provide security of supply at value for money as Great Britain moves to a low carbon future.

The project is £16.19m project and started 1st December 2011. It has five overlapping phases: mobilisation, solution design, solution build, trials implementation, consolidate and share. Project completion date is 30th September 2015.

The ultimate deliverable from FALCON is new prototype software that assists network designers and planners to make choices relating to deploying new techniques and technology as an alternative to conventional reinforcement. The prototype simulation software, the Scenario Investment Model (SIM), has an embedded network modelling tool capable of analysing the network as loads change over time. This will allow expected constraints to be visualised for different time periods over many years. The SIM will simulate the application of the various techniques to solve network constraints so that many potential solutions are considered over a long time frame. It will then allow the user to select optimum solutions that are evaluated against various factors including cost, speed of implementation and impact on network performance and losses. This is particularly important in the development of a smarter more efficient system. When electricity is produced at a power station it needs to travel through the National Grid transmission system then on through the lower voltage distribution network to consumers. As the DNO for the Midlands, South West and Wales, it is WPD's responsibility to ensure that the installed infrastructure meets the needs of homes and businesses.

Conventional reinforcement methods for centralised networks mean that they have been designed and maintained to cope with times of peak consumption, which can commonly be just a few hours on the coldest winter or hottest summer days. This can lead to expense and disruption, as more cables and transformers are laid to create extra capacity that represents less than 1% of actual annual consumption. FALCON is testing smarter alternatives to reduce the need to do this.

FALCON will operate live system trials to test six alternatives to conventional network reinforcement methods, to assess effectiveness, see how they work in practice, establish likely costs and generate new learning about how these can be rolled out across the networks in the future. An innovative new communications network will allow these to be controlled and all the resulting performance data, captured to ensure that our energy models reflect real world performance.

Four of these options are based around engineering approaches that will involve modifications to the network itself:

- Dynamic Asset Ratings
- Meshed Networks
- Automatic Load Transfer
- Storage

The remaining two options are Commercial Techniques, which focus on consumer behaviour. These will provide opportunities for participants in the trial to receive an incentive for changing their behaviour for a short period of time. This is commonly known as a Demand Side Response (DSR). The two approaches to achieving the desired behavioural change are by:

- Reducing load by stopping, or deferring consumption
- Starting or increasing generation reduce load and / or export to the 11kV network

## 2.2. Methodology

The methodology applied in the authoring of the report varies in relation to the stages of the trials development being described. In respect of much of the high level design principles, stakeholders were engaged and sensitivities identified on a consultative basis. The outputs are therefore a reflection of this process and the report seeks to offer a basis for the parameters considered and either justification or reason for any decisions that were made. To a large extent, this was determined by a small number of key factors:

- Budget should be based upon cost no greater than that of an 11kV substation upgrade.
- Both direct and third party engagement should be tested
- Reliability is paramount and performance monitoring is required to reflect this
- Commercial arrangements require to test enduring terms and not just for 'trials' period
- Service should be focussed on 'pre-fault' conditions
- Trials only extends to Half Hourly metered, non-domestic property

As a result, much of the report will be provided in the form of statements, with references to supporting resources that seek to verify the assertions offered.

The 'trials operation' stage offers a great deal of measurable data relating to participant performance against clearly determined objectives, as well as the attitudinal research that was carried out before, during and after. The methodology during this phase is therefore significantly different and the analysis in this area is a combination of statistical and socio-technical reporting.

Overall the report seeks to, not only determine the most critical factors to the operator of a DNO, but also understand how those align to the broader marketplace and any potential participants in commercial intervention techniques in the future.

## 2.3. High Level Learning objectives

Due to the similarity of the impact of the two commercial techniques on the programme operator it can often be assumed that their similarities extend right across the board. Despite this, FALCON has separated demand reduction and generation within the learning and reporting processes in a clear attempt to challenge such assumptions and determine what the potential differences are and potentially how this may alter the design and development of future DSR programmes.

### *2.3.1.* Technique 5 Description – *Load Reduction*

*It is important to note in both this section and that of 2.4.2 that these should be considered in the context of Section 22.1 to 22.7 'Appendices' in order that the principals of DSR are fully understood.*

Load Reduction in this context, refers to a change in behaviour by a customer site in response to an explicit signal triggering a pre agreed action. The action being referred to should be the interruption of a participant's internal electricity consuming processes, either as overall avoidance or, more likely, to defer these to a later time. Typically, this is expected only to yield results from 'non-disruptive' intervention which generally relates to processes that have some latent capacity within them. These often include heating, cooling and pumping as it is generally the case that there is a delay between the commencement of the interruption and any discernable effect within the participant's property. In the majority of cases it is expected that this will generally take the form of a deferment and will be required to still consume a similar total volume, just shifting this to a later period. Conversely, processes such as lighting or industrial processing will generally have a very direct and overt impact, but if the 'real cost' of the interruption is lower than that of the 'service payment,' it may still be considered to be viable.

### *2.3.2.* Technique 6 Description – *Distributed Generation*

Distributed Generation is commonly expected to be stand-by generation which for the majority of its operational life will be idle, with a sole purpose of providing electrical cover for critical supplies in the event of a failure in the primary supply from the 11kV network. While assets of this type do represent a significant proportion of generation within DSR programmes, there are other classifications including combined heat and power installations. Where combined heat and power is encountered, it will often be the case that it is the primary supply, but it either has headroom or, through 'load reduction' it will result in the decrease of demand or increased export.

On receipt of an explicit signal, Distributed Generation sites will carry out a pre agreed action with their embedded generation asset(s). Where the generation is off, it will typically be started and, if already running, it will increase its output to demand ratio.

There are various dependencies relating to such operation, in relation to safe operation within any related constraints such as synchronisation with the mains network and authorised connection permissions. An explanation of these and related considerations are detailed in section 6 - Process Development.

### 2.3.3. Learning Topics and Outcomes

A full record of the learning topics, outcomes and results will be available through the Knowledge Management resources associated with Project FALCON. The full range of learning objectives go into finer levels of detail, including aspects of internal processes which are determined to be of limited value within the context of this report. The more relevant of these to the broader learning outcomes are provided in sections 15.5 – Key Learnings. Learning topics are made up of several learning outcomes which will be a combination of planned (those we set out to learn) and those we have collected on the way.

During the design and build phases and ongoing throughout the first set of trials, we identified over 30 more key learning outcomes at a higher level. Each of these has been documented and recorded in line with the agreed knowledge capture approach and have been combined with the planned learning outcomes.

Captured learning outcomes will continue to grow and be revised as the Project moves forward. Each lower level detail document does carry a version control, so we can retain what we found originally, why we changed something and what the outcome was.

For the commercial trials specifically, as we are carrying out two sets of independent trials, we will be revisiting many of the documents at the next stage of re-design (or refining) and trial as they develop.

The table below shows the topics we have chosen as key learning topics – parent, for the Commercial Techniques for the duration of Project FALCON:

| Learning Topic – Parent | No. Learning outcomes |
|---|---|
| Develop a dispatch management system for commercial demand side response | 18-20 |
| Targeting, recruiting and signing customers for a DSR scheme through all channels | 15 |
| Identifying the most suitable use, and time for deploying DG in a DSR commercial environment noting any limitations | 5 |
| Monitoring, controlling and responding to events on the customer side and control room side of a commercial DR scheme | 4 |
| Making a comparison to when the service is used direct, or via suppliers and addressing the challenges | 5 |
| Analysing performance and outputs of commercial trials in a DNO environment and drawing conclusions | 10 |
| Creating an automated data, billing and customer communications system for managing a commercial platform | 5 |
| The customer journey and modelling a DSR commercial scheme | 6 |

*Table 1: Commercial Trials Parent Learning Objectives*

## 2.4. Conclusions

The scope of the DSR trials being carried out within FALCON are far more commercially focussed than any previous investigations carried out by DNOs. This has been set against the context of establishing an industry roadmap as to how this could potentially be offered as a 'Business as Usual' (BaU) solution. As such, the conclusions have incorporated the engineering learnings from other projects conducted by WPD and other DNOs. In particular, there were very important lessons learned from the WPD 'Seasonal Generation Deployment' project funded under the LCNF tier 1 scheme in 2011. This project was closed down in 2013 after two concerted, but unsuccessful, attempts to complete the first of two phases; to create a workable commercial framework. The objective of the framework was to offer an attractive proposition to owners of mobile generation assets to store them at constrained points on the 11kV network, and offer ancillary services to DNOs during periods of network constraint. It became apparent that DNOs would encounter major conflicts with a number of other factors in endeavouring to develop an economically viable service offering to compete with more conventional capital reinforcement.

The second phase of this trial intended to utilise existing network generation connected to an adjacent section of 11kV network, which would test the commercial framework and technical elements within a more complex network environment. It was hoped this would provide a platform for commercial arrangements and automated control methodologies which would be further developed. In many respects, the Commercial Techniques trials within Project FALCON has superseded the intentions of the second phase but on a larger scale with an increased range of commercial learning objectives, but without any technical engineering scope.

*More details on the 'Seasonal Generation Deployment' is available in* section 22.7.1

FALCON can be deemed to have achieved a very meaningful set of learning outcomes that have already assisted WPD in increasing both its and the industry's understanding of how commercial techniques may be applied and how they may require to be adapted in order achieve desired efficacy levels. Building on the learning from the first season winter trials, we have altered the scope of the second season trials; these have been submitted and approved via an internal review and change process. The alterations will enable WPD to minimise duplicating learning and continue to achieve fresh learnings beyond the originally proposed scope.

The main highlights of the first year's results and consequential conclusions are as follows:

1) Reliability is critical to DNO deployment of commercial techniques. Under the conditions applied within the trial it is unlikely that a DNO could rely on such services as a viable alternative in order to substantially defer capital investment.
2) The level of funding that a DNO is likely to have to make as operational payments to participants is in conflict with the principal of commercial techniques being a lower cost alternative.
3) Existing DSR programmes and their associated contractual terms create restrictions that require to be addressed if participants are to benefit from multiple programmes. A cost sharing model will need to be developed to reduce cost of operation.
4) Identification of potential participant sites in the correct location and their engagement is a critical aspect of developing a DSR service that can affect specific constraint points. Initially, it is likely that there will only be very limited correlation between network issues and suitable customers to offer load reduction or generation.

5) DSR service participants are heavily biased towards providing service via Technique 6 'Distributed Generation'

6) A non-engineering approach to managing network issues and future design decisions is currently not well aligned with a DNO's existing resources. Major investments in several areas including culture, skills development, recruitment and IT systems will be necessary in order to establish DSR services within the existing BaU options.

***IMPORTANT NOTE***:

In order to fully appreciate the report and its findings in relation to the commercial parameters outcomes it is necessary to have a minimum level of knowledge in relation to many of the complex sensitivities associated with the current and potential future of the DSM / DSR Marketplace. The report therefore includes and extensive summary of the existing and foreseeable services that are likely to be actors within the commercial and operational framework that will potentially influence the DNO use case for DSM / DSR. These resources are contained within the appendices section of the report and it is recommended that if the reader is unfamiliar with context these market conditions create it should be a prerequisite to read the following appendices in advance of the FALCON Commercial Trial report – Winter 2013 /14.

22.1. Definition of DSM / DSR and the Marketplace
22.2. Purpose of DSR
22.3. Current market
22.4. Existing programmes
22.4.1. Triad or TNUoS avoidance (Transmission Network Use of System)
22.4.2. STOR (Short Term Operating Reserve)
22.4.3. FCDM (Frequency Control by Demand Management)
22.4.4. Energy Trading and Fuel Arbitrage
22.5. Further Opportunities
22.5.1. DSBR (Demand Side Balancing Reserve)
22.5.2. Footroom
22.5.3. ToU (Time of Use) Tariffs
22.5.4. DUoS (Distribution Use of System) Charge Avoidance
22.5.5. GDUoS (Generation Distribution Use of System) Charge
22.5.6. PPA - Power Purchase Agreement
22.6. DSR – Carbon and the environment
22.7. Low Carbon Network Funded DSR trials
22.7.1. WPD – Tier1 LCNF Trial – Seasonal Generation Deployment
22.7.2. Thames Valley Vision - Scottish & Southern Energy Power Distribution
22.7.3. SoLa Bristol – Western Power Distribution
22.7.4. Capacity to Customers – Electricity North West Limited
22.7.5. Low Carbon London – UK Power Networks
22.7.6. Customer-Led Network Revolution– Northern Powergrid

## 3. Smarter Networks Challenge

To date the principals that have determined electricity network design and its operation have been predicated on the assumption that generation is likely to be large centralised power stations. This in turn creates a single direction of flow to customers at the opposite end of the network. On this basis the network is assumed to maintain a passive role to accommodate the safe transfer of power from the top to the bottom, or left to right as shown on the diagram below.

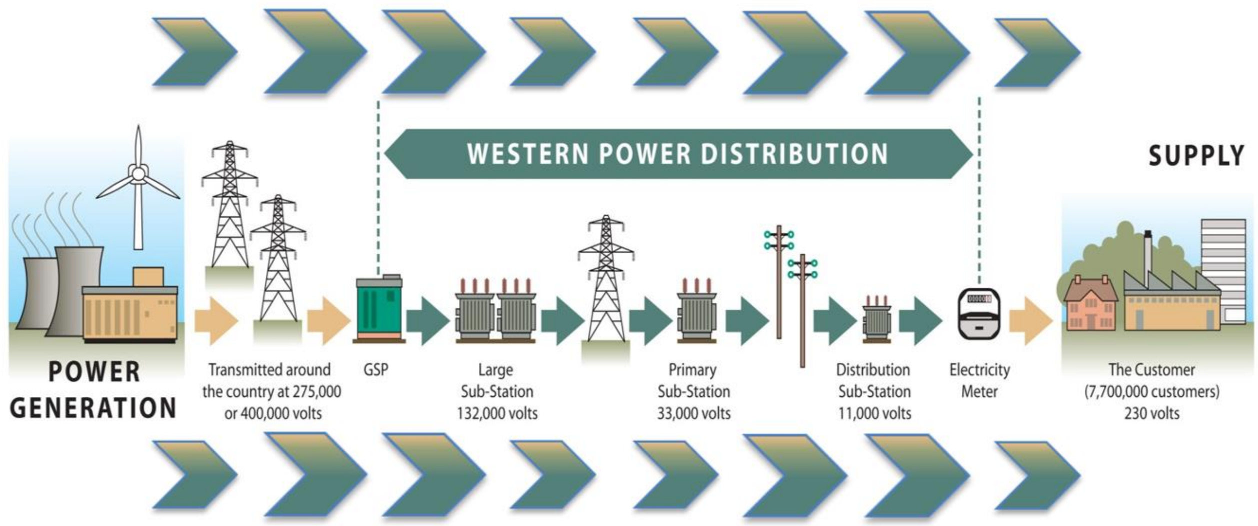



*Diagram 1: The UK's electricity network*

The whole network requires to be designed and constructed with adequate capacity to meet the peak annual demands at every level. For the Distribution Networks which operate from voltages of up to 132kV down to final delivery at around 230 volts it can result in the network being oversized for 99%+ of the year but out with the design ratings for certain periods on just a few days.

Traditionally, any such constraints would be addressed through network reinforcement, which will generally involve the re-specification of the assets that are determined to be limiting the capacity. This often takes time and costs money that results in additional or larger capacity cables, transformers and switches to be installed along with their related ancillary equipment. In some cases this may mean that new street furniture, sub stations and pole mounted equipment is required to be installed.

## 4. FALCON Introduction

FALCON (Flexible Approaches for Low Carbon Optimised Networks) is a project led by Western Power Distribution (WPD) and is partially funded by the energy regulator, OFGEM, via their Low Carbon Networks Fund (LCNF). The LCNF tasks Distribution Network Operators (DNOs), like WPD, to trial ways to provide security of supply for value for money as Great Britain moves to a low carbon future.

The cost and limited flexibility of conventional approaches to 11kV network reinforcement threatens to constrain the uptake of low carbon technologies. FALCON aims to gain an understanding of the dynamic nature of the utilisation and demands placed on this part of the network and assess a number of alternative solutions to the existing reinforcement technique currently used. In addition, it aims to obtain telecommunications and ICT insights to identify 'top down' investment needs.

The £16.2m project, based in Milton Keynes, started 1st December 2011. It has five overlapping phases: mobilisation, solution design, solution build, trials implementation, consolidate and share and will complete on 30th September 2015. The following sections outline the deliverables of each project area and the organisations involved.

**The Scenario Investment Model**

The ultimate deliverable from FALCON is new prototype software that assists network designers and planners to make choices relating to deploying new techniques and technology as an alternative to conventional reinforcement. The prototype simulation software, the Scenario Investment Model (SIM), is essentially two main components: a predictive engine and a results analysis tool.

The predictive engine takes network and regulatory data with load profiles from our energy model and looks at the area of the network being interrogated, to identify how and when it may become overloaded in the future. The SIM has an embedded network modelling tool, which is capable of analysing the network as loads change over time. Expected constraints can, therefore, be visualised for different time periods over many years.

The SIM will simulate the application of the various techniques to solve network constraints so that many potential solutions are considered over a long time frame. It will then allow the user to select optimum solutions which are evaluated against various factors including cost, speed of implementation and impact on network performance and losses. It will provide the user information to support a planning decision to defer, or even remove the requirement for reinforcement. The diagram below shows a pictorial representation of Project FALCON.

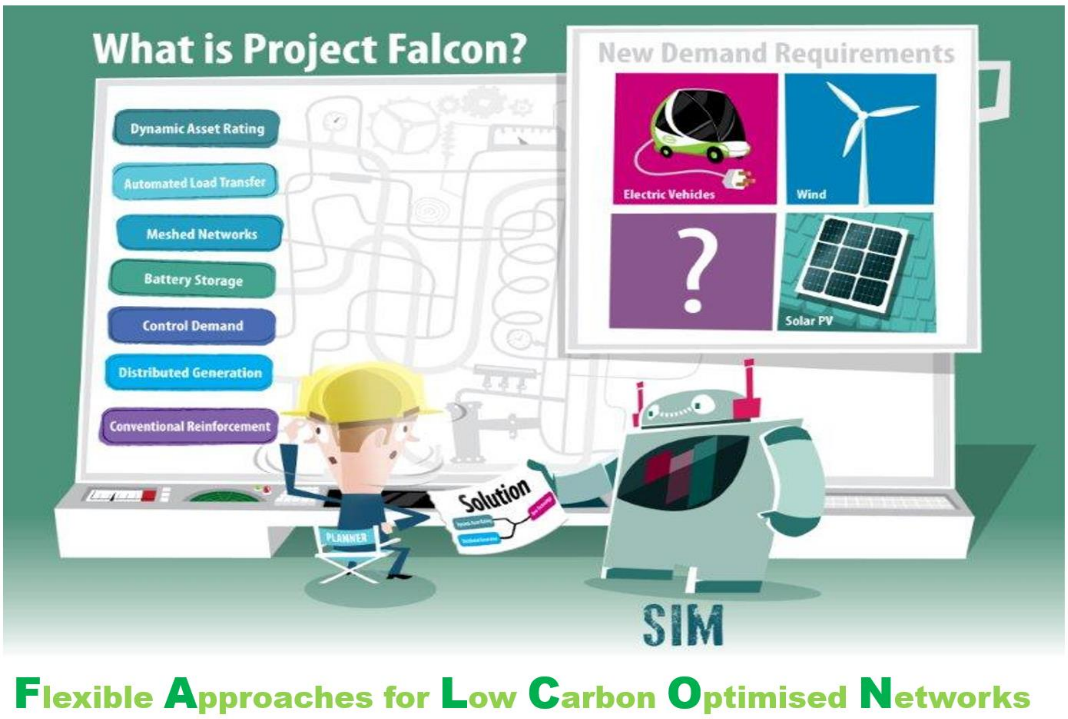



*Diagram 2: Pictorial Representation of Project FALCON*

**The Energy Model**

To support the forecasting component of the SIM, we are developing an energy model.

The Energy Model is a tool that is used to predict the load at distribution substations. It estimates the average load for a half hourly period during the day and distinguishes between weekdays, Saturdays, Sundays for the five seasons that are used by Elexon. It also creates estimates for "extreme" days where we might expect the most onerous network conditions reflecting peak load, either from winter heating or summer cooling, or from peak PV generation. To support the long term analysis of the SIM, the energy model also suggests how the load profiles will change over the years to 2050. The changes in load reflect user specified assumptions, such as the level of take up of electric vehicles, heat pumps, PV panels, energy efficient appliances etc. A complete set of assumptions defines a Scenario and the Energy Model will allow us to create as many scenarios as we want to consider, though we expect to focus on just four which we will try to match as closely as possible to scenarios that have already been used in the industry.

As well as estimating the total load, the Energy Model estimates how much of the load relates to different uses such as washing, heating, lighting, refrigeration etc. This is necessary to support the analysis of future changes, for example how much load might change due to energy efficient lighting, but also when considering the potential for demand side management, where some types of load offer more opportunities.

The Energy model makes use of a good deal of existing experience and data incorporating:

1) A model for water and space heating energy requirements for different building types developed by University College London
2) Energy Savings Trust's propensity matrix method to allocate the adoption of new technologies across customers in a realistic way
3) Energy Savings Trust analysis of energy use by type from their Home Analytics Survey
4) Matching of WPD customers to Energy Savings Trust's Health Economics Evaluation Database (HEED) to determine the type of home and known data about energy efficiency measures already undertaken.

Initial comparisons between the predicted and measured loads are encouraging and we may be able to improve the model further by adjusting the values used. So for example, we might find that we can improve the accuracy of the energy model estimates by adjusting the assumptions about whether a customer is at home or elsewhere.

**The Intervention Techniques**

FALCON will operate live system trials to test six alternatives to conventional network reinforcement methods, to assess effectiveness, see how they work in practice, establish likely costs and generate new learning about how these can be rolled out across the networks in the future. An innovative new communications network will allow these to be controlled and all the resulting performance data, captured to ensure that our energy models reflect real world performance.

Four of these options are based around engineering approaches that will involve modifications to the network itself:
- Dynamic Asset Rating (running the substation hotter i.e. making existing assets work harder)
- Automated Load Transfer (transferring power flow across the network using equipment installed in substations)
- Meshed networks (transferring power flow across the network by closing circuits)
- Energy Storage (substation batteries)

The remaining two options are Commercial Techniques, which focus on consumer behaviour. These will provide opportunities for participants in the trial to receive an incentive for changing their behaviour for a short period of time. This is commonly known as a Demand Side Response (DSR). The two approaches to achieving the desired behavioural change are by:
- Reducing load by stopping, or deferring consumption
- Starting or increasing generation reduce load and / or export to the 11kV network

**Telecoms**

FALCON will also inform WPD’s telecoms strategy. The primary role of the FALCON communications network is to allow monitoring of the six techniques enabling accurate data to be gathered for the modified PowerOn Fusion Distribution Management System (DMS). The data traffic needed includes monitoring and control data, so data speed is an important component in the telecoms design. The 1.4 & 3.5 Ghz frequencies are currently vacant and reserved for use by the MoD. They have granted the use of it for the period of the project and it’s being trialled to assess whether it’s a suitable frequency for all network operators in the UK. Where practical, other use cases have been developed and built into the architecture design. This ensures that we are deriving maximum learning from the project.

**Our partners**

FALCON has a series of partners and suppliers that support the overall delivery. Partners typically contribute financially into the project and, as such, have a vested interest in its success. On FALCON the partners involved and their responsibilities are briefly as follows:

- Cisco are responsible for the provision of the equipment to support the telecommunications infrastructure. The solution is a WiMAX solution, the first implementation of such in the UK Utilities industry and therefore it has a significant amount of strategic interest across the industry and even globally.

- Alstom are providing the switchgear and network protection for the engineering trials.

- Aston University are undertaking research and analysis related to the engineering trials to validate outputs as well analysing the data from the trials in order to validate outputs of the SIM.

- Cranfield University, IVHM Centre are developing the Scenario Investment Model in conjunction with WPD's 11KV planners.

- CGI, having supported WPD through the bid phase transitioned into delivery and are providing technical and project management expertise.

Suppliers are those organisations who provide specific deliverables to the project without making a contribution and may interact with the project only once, or throughout the project. Suppliers on FALCON include:

- TNEI who are providing the Network Modelling Tool as part of the overall SIM solution.

- The Energy Savings Trust, working with University College London, are creating and developing the FALCON Energy Model

- Airspan who are providing the card within the routers to enable the WiMAX network.

- GE who are providing the batteries for the storage trials as well as developing the Trials Distribution Management System.

- Smart Grid Consultancy who are providing industry expertise to design, deliver and manage the commercial trials as well as providing knowledge management expertise across the whole project.

## 5. DSR (Demand Side Response) Introduction

It is important in establishing the context of the commercial techniques scope within the overall FALCON trials to take a step back and clarify what the definition of the term DSR represents within the UK Electricity Industry.

Ofgem recently published a consultation entitled 'Creating the right environment for demand-side response' *(June 2013)* in which the following definition was offered.

***What is demand-side response?***

*For the purposes of this document, we define demand-side response as actions by customers to change the amount of electricity they take off the grid at particular times in response to a signal. As such, we refer specifically to 'transactable' demand-side response, where a customer chooses to change the way they consume energy. This could include choosing to change their behaviour and habits to alter their energy consumption, or choosing to let somebody else help them manage or control their energy consumption. These examples differ from ('non- transactable') system management activities that cause no discernable change in the quality of electricity supply and in which a customer has played no part. Transactable demand-side response differs from interruptions to customers' electricity supply that they have not chosen to incur.*

Furthermore the Introduction section of the consultation document provided the following justification for the regulator's interest in gaining a greater understanding of the current environment for DSR provision.

***Why is demand-side response important?***

*Customers have always had the potential to shift their demand. Now this potential is increasing for a number of reasons, as set out below. As it does so, new potential competitive opportunities materialise, offering an avenue for innovation and new products.*

- ***The electricity system is being upgraded****. Ofgem has estimated that due to plant closures and the need to replace and upgrade the UK's electricity infrastructure, over the next decade the UK electricity sector could need around £110 billion of capital investment. Demand-side response provides one way to reduce or delay some of these investment costs, which will ultimately be passed through to customers' bills. Furthermore, demand-side response may be a valuable tool, alongside others, for managing the increasing contribution that intermittent generation is expected to make to the generation mix.*
- ***We are changing the way we use electricity.*** *As more heating and transport is electrified over time, overall electricity consumption is expected to rise, as well as consumption at peak times. The technologies behind this electrification, such as heat pumps and electric vehicles, could make it easier for customers to be more flexible about how and when they consume electricity.*
- ***Smart meters will open up opportunities.*** *Larger non-domestic customers already have advanced metering, which can help to lower the cost of monitoring and verifying demand-side response. The Government's ambition is for all households and other small energy customers to have smart meters installed by their energy suppliers by 2019. Smart meters will provide new opportunities for domestic customers to improve their understanding of their energy consumption, by giving them better information about their consumption, in a more accessible form. Half-hourly consumption data from smart metering could make contracting for demand-side response easier by providing a means to verify changes in consumption. Furthermore, a combination of two-way communication and potential load-switching functionality provided by smart metering could provide opportunities for customers to negotiate new types of contract, for example to limit their load in some way.*

Full details of the consultation and published responses can be accessed at https://www.ofgem.gov.uk/publications-and-updates/creating-right-environment-demand-side-response

Please note, FALCON limits the scope of the trials for Commercial Techniques to non-domestic properties with Half Hourly metered supplies.

# 6. FALCON DSR Design Approach

A recent development within the UK energy sector has been that the energy regulator, Ofgem, (Office of Gas and Electricity Markets) has made changes to the structure of the framework and incentive criteria by which DNOs are funded.

Over the next decade, DNOs face an unprecedented challenge of securing significant investment to maintain a reliable and secure network.

Ofgem, as the regulator, must ensure that DNOs deliver this at a fair price for consumers. To help achieve this, they developed a new performance based model for setting the network companies' price controls which will last eight years. The model is called RIIO: Revenue=Incentives+Innovation+Outputs.

RIIO is designed to encourage network companies to put stakeholders and customers at the heart of their decision making process, invest efficiently to ensure continued safe and reliable services and innovate to reduce network costs for current and future consumers. DNOs will need to play a full role in delivering a low carbon economy and wider environmental objectives.

As part of the transition to the new RIIO-ED1 price control Ofgem created the Low Carbon Network Fund. The LCN Fund allows up to £500m to support projects sponsored by the DNOs to trial new technology, operating and commercial arrangements. The aim of the fund is to help all DNOs understand how they can provide security of supply for value for money as Britain moves to a low carbon economy.

There are three tiers of funding under the LCN Fund. The first tier allows DNOs to recover a proportion of expenditure incurred on small scale projects. Under the second tier of the LCN Fund, an annual competition for an allocation of up to £64 million to help fund a small number of flagship projects is held. The third tier is the discretionary reward mechanism, by which DNO's can apply for a reward at the end of the project. The amount that can be applied for is capped at the amount the DNO contributed towards the project.

In LCNF projects, DNOs explore how networks can facilitate the take up of low carbon and energy saving initiatives such as electric vehicles, heat pumps, micro and local generation and demand side management. They also investigate the opportunities that smart meter roll out provide to network companies. As such, the LCN Fund should provide valuable learning for the wider energy industry and other parties. The LCN Fund is replaced at the end of the transitional period by the Network Innovation Allowance, NIA. The NIA is a set allowance each RIIO network licensee receives as part of their price control allowance to limit funding to RIIO network licensees. Its purpose is to fund smaller technical, commercial, or operational projects directly related to the licensees network that have the potential to deliver financial benefits to the licensee and its customers

There are other funding mechanisms available for Smart Grid initiatives through European programmes, research councils and organisations such as the Technology Strategy Board. These, however, are not typically used for the development of DSR services.

As the LCN Fund and IFI (Innovation Funding Incentive) have been the primary mechanism by which DSR programmes have been investigated by DNOs, a list of some the current trials is provided in the remainder of section 7.1. A full list is available via the Energy Network Association, Smart Networks Portal http://www.smarternetworks.org/Index.aspx?Site=ed

Many of these are unlikely to be adopted as business as usual propositions without significant commercial and technical development. As part of the LCN Funding governance, the DNOs are obliged to share the learning and experience of their trials with the industry that will result in 'best practice' developments and changes to the codes under which they are regulated. One such development, directly relating to DSR is a working group that reports to Energy Network Futures Group, ENFG, and includes the System Operator, (SO) and all DNOs. It was recognised that the current markets and commercial frameworks would act as a barrier to create unnecessary competition in the marketplace that would ultimately be borne by consumers. As a result there was a clear objective to create a shared services model to allow multiple programme operators to have access to a DSR participant rather than the current restrictions resulting from their exclusive arrangements. Further information on the scope and expected outcomes from this group are provided in Section 18

Some aspects of research from preceding LCNF trials have assisted the scope creation for FALCON's commercial trials and duplication of already established factors have been avoided. Also, through publication of the FALCON learning outputs, it is hoped that a far greater value will be achieved across the industry by the research than just satisfying the core requirement of providing real results data to the SIM.

## 6.1. Programme Conflicts

An important learning outcome achieved during the Seasonal Generation Deployment project carried out previously by WPD was that outside of the trials environment, there could be conflicts with participants' other priorities.

A great deal of work has been commenced into looking at the flexibility of different load types and identify where latency can be leveraged as flexibility to be sold as DSR. As well as with generators having to consider the core purpose of their asset, particularly in the case of standby power, research has determined positive correlations between reliability and regular use of the asset. This is generally down to a number of factors that relate to having a comprehensive testing regime for intermittently used generation. As with the average diesel car, it is more likely to be in a 'ready' state if regularly used and serviced, than if left for prolonged periods of inactivity. With generators there are a number of aspects that can be argued to reflect a good quality test regime. Regular running 'on load' simulates actual usage and test all critical components, such as:

- Battery charge;
- Engine and switchgear settings;
- Mechanical components;
- Fuel delivery & quality. (supports manufacturers' recommended fuel management strategy); and
- Identify any faults during 'non-critical' operation.

Despite the largely technical benefits of regular usage in conjunction with commercial opportunities, there has been little analysis into conflicts between different DSR/DSM programmes and their operational benefits, cost savings and revenue. Below are the typical programme operator requirement 'use cases' and aspects that could be determined to act as barriers to BaU (Business as Usual) operations.

FALCON is not the only, or even first LCNF trial to include DSR as a key aspect of their trials in attempt to establish whether it is functional enough to be considered a viable alternative to conventional or new engineering methods of network operation. Much of the learning achieved from these to date has been included within the FALCON commercial trials to avoid unnecessary duplication of basic testing and establish the more advanced challenges including comparative analysis of reliability and commercial impact in a BaU environment.

Details of the preceding trials that have been carried out with LCNF funding are included within the appendix section of the report.

### 6.1.1. The SO – (System Operator)

As outlined within section 22.4, there are several programmes operated by National Grid in its joint capacity as System and Transmission operator. For demand side participants, the SO service is most commonly the 'Balancing or Reserve Service' STOR, but an increasing number of sites either offer, or are considering the potential of Frequency and Footroom services as aggregators develop offerings to harness the potential of multiple smaller sites.

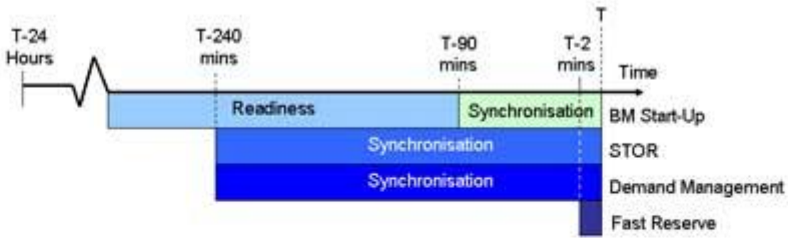



*Diagram 3: DSR operational service timeline*

The diagram above which was sourced from the National Grid, 'reserve services' page (http://www2.nationalgrid.com/uk/services/balancing-services/reserve-services/) and shows how the range of services are used in relation to 'real-time' as represented by the letter 'T'. Demand side providers do not currently offer either BM Start-Up or Fast Reserve. For responses quicker than those offered by 'Reserve services', Frequency services are contracted by National Grid which can either be dynamic and constantly changing to reflect National System Frequency or triggered by at a specific set point with response times as rapid as less than 1 second.

The SO services of these types are on the most part contracted and dispatched on a non-geographic basis, but due to the criticality of the services, they are typically 'exclusive' and cannot be operated in conjunction with any other commercial programmes. A premium is paid for capacity by the SO in the form of an 'availability' payment and where appropriate a further 'utilisation' payment for volume delivered when called upon. Most significantly, the exclusive nature of the contracts means that if being paid for STOR, a site should not operate any other ancillary services or cost avoidance schemes that require the same capacity capability. This currently prevents multi-functionality from even multiple SO programmes simultaneously. It is however feasible that a site that can meet the technical requirements for Frequency Services can declare itself available for the faster response service during any periods where STOR availability hasn't been committed.

The SO does contract STOR services under two different contractual conditions, known as committed and flexible. As the name suggests, the flexible service conditions to allow for a limited amount of adjustability around availability, but under normal circumstances will still require to declare exclusivity on a week ahead basis. Such firm contractual conditions results in reserve services generally being in conflict with any other commercially driven operation during STOR availability windows.

### 6.1.2. The TNO - (Transmission Network Operator)

National Grid also has the responsibility for Transmission Network Operation. Within the TNO's charging methodology for TNUoS (Transmission Network Use of System), it is possible to change consumption and/or generation behaviour to avoid annual costs for electricity transit through the transmission network. The commercial principles of this methodology are highlighted in section 22.4.1.

Triad avoidance is normally operated around one of two methods, Triad Management or Triad Warnings. Depending on which mechanism is used, the methods can be considered as DSR or DSM. This highlights an interesting anomaly within the overall service.

Most electricity suppliers can offer triad warnings to their clients which range in timing and frequency, from weekly through to daily, typically being issued either day ahead or in the morning for that specific day. There are also a small number of specialist energy management consultants who can offer a daily service based on either a success fee or annual subscription charge. These will typically be of greater accuracy as they will base their analysis on consideration of several supplier alerts, as well as their own internal working. When operating with warnings, a site is generally making the decision to operate in advance of real-time by enough time that it is more likely to be considered as DSM.

Reliability of 'warning services' for each source can partially be assessed by looking at their historical attainment for hitting all three triads, but also critically it is necessary to consider the number of warnings that they issued in order to achieve their performance record.

This, however, is only part of the picture as, due to changes in the way the overall energy market operates and responds to triad alerts, the changes can, and will, affect the reliability of warnings. There are three main factors that affect reliability and both are related to activity that takes place at the distributed level of the network:

1. With an increasing volume of participation in triad avoidance, the warnings offered by the large suppliers have a direct impact on the likelihood of a triad being realised. Using the same principal as the combined impact of many consumers reducing their consumption, the increasing volume of participation will flatten many of the peaks. This results in increased numbers of calls requiring to be issued;

2. As the winter period experiences a flattening of many of the peaks, it is also increasingly likely that the failure of any of the big suppliers to issue a warning will, as has historically been demonstrated, create enough of a peak to make that day one of the three triads. The consumers who subscribe to that particular suppliers Triad warnings will therefore also fail to hit all three triads.

3. Increasing levels of distributed generation is connecting to the system at a Distribution level and is therefore not subject to TNUoS calculation. The most significant element of this is the rapid growth in renewables, in particular. If the wind output is either lower or higher than predicted it will have a direct impact on either increasing or reducing the volumes supplied through the transmission network. It is widely recognised that wind prediction is notoriously difficult and assessing how much may be delivered around a suspected triad peak, either several hours or days in advance, is a significant variable to consider amongst the other influences currently considered.

Triad Management is provided by aggregators by virtue of their technical infrastructure they have developed in order to meet response times and metering conditions set out by other schemes such as services from the SO. Due to their technical infrastructure, aggregators often have the capability to communicate directly on a machine to machine basis with assets on participating sites to either start / increase generation or reduce demand. This creates an advantage of not having to make a decision until closer to the time when a triad may or may not occur. During this time, aggregators may have the benefit of having received and assessed the impact of all the large supplier triad warnings in addition to those of any other subscriber services. They also have access to, and can monitor, the national system demand profiles that show consumption levels and generation outputs. These are updated on a 30 minute basis.

Armed with this more accurate information and the ability to remotely start / stop generation and reduce demand, aggregators can more prudently respond to ensure that all triads are avoided but have a risk profile that will avoid excessive number of calls and shorter runs, and thus reduce the costs associated with the operation. When operated in this dynamic manner, where notice periods are significantly shorter and potentially full responsibility for running reassigned to a third party, the operation of the service can be classified as DSR.

As avoidance simply requires a site to maximise their load reduction and increase generation in order to benefit, there can sometimes be correlation with other schemes which have a high propensity to be used during periods of high demand. This can sometimes result in the SO, TNO, supplier and DNO issuing a dispatch call during periods that eventually become classified as one of the three 'triad' periods, resulting in multiple benefits. This is, however, only a loose correlation and, if contracting to one of the other services, may force a site to reject triad warnings in favour of a previously contracted position. As triads are so lucrative it is common for sites to opt out of other programmes during afternoon / evenings of the winter period (November to February) to enable triad as the prime mover in DSM/DSR decisions.

### 6.1.3. Energy Suppliers

It is not yet clear as to what form the Energy Suppliers impact will be on the provisions of I&C (Industrial and Commercial), DSR services. In many respects suppliers are already a major influence in DSM, and ToU variable tariffs can be a contributory factor in industrial and commercial processes.

Currently many I&C energy users will purchase energy on a flexible contr act or against an expected profile with an allowable variance. If the site therefore deviates significantly from their procured energy, by either consuming more or less than expected, it is feasible that their supplier can apply a penalty to reflect any imbalance in the supplier's trading regardless of whether or not the an actual penalty for imbalance occurred. It is therefore important that a site shifting or changing their total consumption or profile for DSM/DSR opportunities takes into consideration any negative costs that occur as a result.

Some energy suppliers already allow some of their larger and more sophisticated customers to take a more active role in self balancing and trading and this is likely to grow in time. Out of this we can expect to see more bespoke and detailed conditions applied that will either restrict sites ability to work with other external programme providers. Or, potentially they will seek to develop their own aggregation capability to assume a more strategic role in the optimisation of participants' behaviour for commercial benefits to the parties who offer the greatest incentives, but minimise risk.

Where the I&C customer has flexibility within their processes, most likely by means of on-site generation, then we are also likely to see an increase in consumers entering into trading and arbitrage behaviours. This already occurs within a very small portion of businesses who have assets that enable them to achieve sufficient volumes to merit the relatively complex analysis. They have sufficient capacity to justify the additional risk that results from seeking to profit from adopting changing positions in relation to purchasing fuels, energy and then ensuring that final processes reflect this in real time.

More typically we find that the common role for an energy supplier in the current DSR market is as an energy purchaser, or ‘off-taker’ who purchases any exported power from a participant site through a PPA, (Power Purchase Agreement)

# 7. Process Development

The overall scope of the trials required the development of several processes in order to facilitate the commercial trials. The trials would culminate in an operational phase to test DSR within live network conditions. It was therefore necessary that each element of the trials had a repeatable process that could be adopted into BaU effectively in the event of a successful outcome.

The required processes that needed to be designed are listed below:

- Payment model assessment;
- Network assessment for potential participants;
- External engagement / site acquisition;
- Contractual;
- Event Operation;
    - Control Room / Usage criteria
    - Dispatch / Cease
    - Data collection
    - Billing / Settlement
    - Account management and
- Impact assessment (operational and financial).

# 8. Technical Requirements

Technical requirements that needed to be considered and addressed within the scope of a DSR trial or BaU service development can be categorised into a few key areas:

- Use Case / Impact;
- Communications;
- Monitoring;
- Operation and
- Safety.

The context behind and the rationale of each of these categories is described in the following sections.

## 8.1. Use Case / Impact

The purpose of a DNO procuring DSR services is ultimately to address a technical requirement relating to the operation of the network. This will typically be to alleviate constraints within the network as a ‘pre-fault’ or ‘post-fault action’.

### 8.1.1. Pre-Fault Scenario

Within this use case it is most likely that the requirement for DSR is either as a temporary or permanent alternative to capital works to a portion of network that has a reasonable likelihood of experiencing a brief fault during periods of high demand. As the potential of the fault is only likely to happen on a limited number of occasions, it may the case that by employing DSR to reduce the constraints to within an acceptable margin then capital reinforcement costs could be avoided or deferred. The deferment option could help DNOs, in particular where the long term expectation is that the issue is ephemeral or where capital works are delayed by unavoidable factors.

This mode of use does mean that a realistic potential exists that failure of DSR provision could result in critical network conditions leading to post-fault and ultimately, interruption of supply to the customers on that affected network.

It is potentially the case that the applicability of a DSR solution will be able to be measured using three key metrics, outlined below.

**Capacity / Delta Reduction**

The reduction necessary within the network can be no greater than the 90% of the available DSR capacity available downstream from the congested point of the network.

**Duration / Frequency**

The event duration can be no longer that the participating DSR sites can comfortably offer. This may relate to the industrial / commercial process to be affected or availability of fuel to a generator.

**Cost of Operation**

The payment for the predicted annual use of the DSR facility should be equal to or lower than the alternative methods for addressing the constraint. More detail regarding the financial calculation relating to DSR provision is available in Section 13.1

The diagram overleaf demonstrates the assumed load profile of overloaded substation that would be suited to DSR intervention.

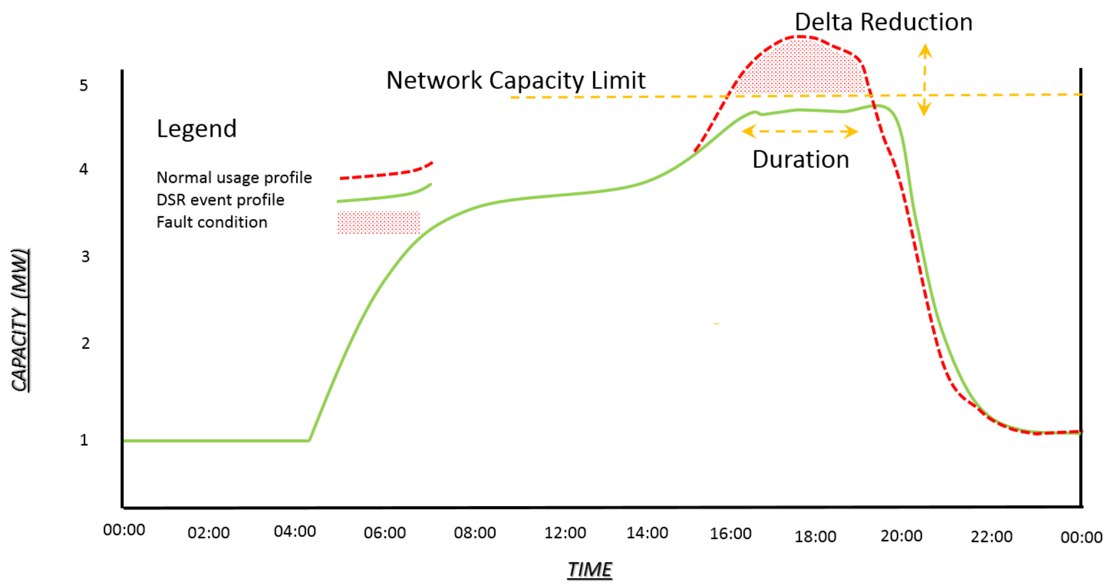



*Diagram 4: Load Profile of Constrained Substation*

This is applied on the basis that the annual occurrence of the fault conditions is limited to a relatively small number of days, combined with the accrual of payments being more economical than other management methods.

It is also assumed at this stage that impact on the network assets has a direct correlation with the site behavioural change, as shown in the following diagram.

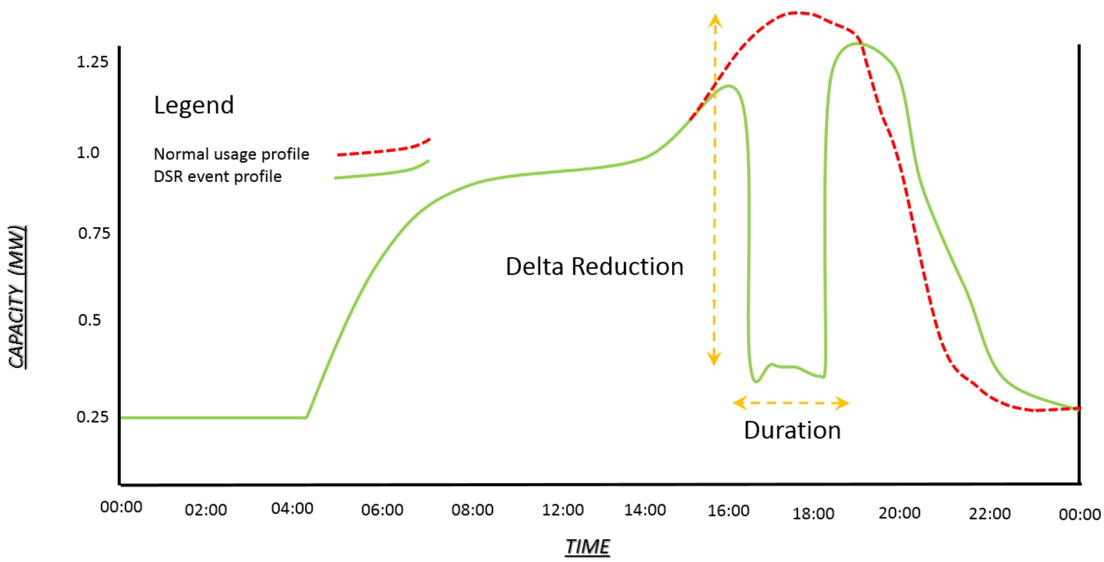



*Diagram 5: Load Profile of DSR Participant Site*

#### 8.1.2. Post-Fault Scenario

The case for DSR to be used in a scheme where the purpose is directly following a fault being identified can have varying impacts depending on the nature of the fault and the actual status of the network at that time.

It can be the case that even after a fault has occurred the network may still be operable, just with increased likelihood or risk that a supply interruption may follow. In such circumstances it could be possible to lessen or avoid the loss of supply through reduction in demand on that particular portion of the distribution network.

If a fault results in supply failure, the DSR action at a site(s) connected to the affected area of network may facilitate or assist in return of supplies sooner than expected or improve the stability of the network when primary supply is resumed. DNOs are subject to Guaranteed Standards set by Ofgem that apply to individual customers and involve penalty payments if they do not meet set guidelines. Further information is available on the Ofgem web site.

The criticality of DSR in the initial post fault period if supplies are not immediately disrupted, the reliability requirement for DNO use is comparable with pre-fault requirements, as any deficiency in DSR delivery may result in further deterioration or loss of supply. However, after post-fault scenarios have led to interruption it is arguable that load reduction is of little value. It is also likely that within such circumstances a site with generation will wish to operate this as their own primary supply for business continuity reasons and unlikely to require further incentive from the network operator to operate it.

Within Project FALCON we have designed the trials to test the principals of using DSR as method with which to address potential technical issues, but much of the assessment relates to its financial impact and suitability in terms of reliability and availability. The scope of the trials is therefore limited to predictable economic factors such as planned network and we are therefore restricting the cost and performance analysis to a pre-fault use.

## 8.2. Communications

The communications requirements within the trial separate into several categories in relation to the technical requirements of operating the trials. This does not include corporate communications or the recruitment of participants to DNO DSR programmes, as this is covered in section 12.

Technical communications requirements within this section relate to:

- Dispatch and Cease of events; and
- Metering / Monitoring and data collection.

#### 8.2.1. Event Dispatch and Cease

TSO operated DSR schemes will generally prefer a dispatch and cease arrangement that is administered through communications that are capable of M2M (machine to machine) communications. By operating on a M2M basis it is expected that any programme operations will benefit from:

- Avoidance of human error;
- Improved reliability;
- Increased speed; and

- Reduced cost of operations.

As part of the final trials report, incorporating the results of the 2014/5 trials we will seek to determine a clear requirement and detailed use case that establishes a suitable standard for the DSR control communications. This will be suited to the requirements of the service rather than adopted from alternative DSR programmes that may have differing requirements for speed, reliability and operating costs.

Within the Season 1 trials DSR was not planned to be used for critical operations or to support live network operations, in order for the trials to remain under the full control of the project. It was therefore unnecessary to incur the expense of a M2M system to signal the beginning and end of the DSR events. We therefore opted to centrally control the notices to participants via a phone call, and manually log the start and stop times.

It was considered that upon receipt of the notifications, an aggregator acting as intermediary on behalf of the site, would use more advanced means, such as automation, to control the event. If low latency, M2M or automated dispatch is required, there is significant prior knowledge regarding this than can be sourced from the aggregator without the necessity to include within the FALCON commercial trials.

### 8.2.2. Monitoring / Data Collection

In respect of the trials operation, communications requirements for the asset performance monitoring, it was not necessary to monitor the reductions or generator outputs live. It was, however, important that for two factors were accounted for within the operations processes.

The first is to ensure the trial operations do not negatively impact the normal, safe operations of the network. It was therefore necessary that whoever operated the trial events remains in contact with the control room and participating sites throughout the full duration of each DSR occurrence and ensures that network conditions are maintained within acceptable standards. It was also important to ensure that assistance is available to the participants in the event that they experience any issues with DSR delivery and can report and problems that may occur.

On the following day after the event, all sites were required to provide a copy of the data for the prior 24 hour period. This presented challenges, as the back office software was hosted within the highly secure environment of WPD’s core systems. In order to maintain the optimal level of security within the system architecture, there are no direct interfaces with the external world via the internet or other perceivably insecure mechanisms. It was therefore necessary to work closely with the internal WPD IR (Information Resource) team to create a new secure file transfer route to receive, scan for threats and store files in a data repository for processing.

Sites contracted via third party aggregators had their data collected by the aggregator, and pushed the files by secure FTP where each has a storage folder designated to their group of participant sites. It was designed that directly contracted sites, would not have an independent intermediary to meter and manage the data transfer process. Therefore, for the single direct participant site involved in the first season of trials, an additional smart meter would be installed at their site by WPD’s Smart Metering division. This would be reconfigured to collect data at 1 min intervals and the data collector will dial this and download the daily files, before using the same FTP access to upload the data for processing.

## 8.3. Monitoring

Many parallels exist between the technical requirements for a DNO to monitor DSR events and the event dispatch requirements. As with the dispatch and cease communications, within the FALCON trials we were able to reference the prior and extensive knowledge already developed in relation to remote asset monitoring.

It was, however, very important to the trials that we were able to gain a detailed insight to both the performance of participating sites and their impact on the network during DSR events. It was therefore necessary for the trial to include metering that enabled a clear assessment of any detectable impact on the network. Metering at all sites had been set at a minimum standard of 1 minute intervals in order that we ensure that, not only an appropriate volume of capacity is reduced or generated, but that it does so in the appropriate way as to satisfy the DSR requirement set out by the DNO. This is a very important point of note in relation to both TSO and DNO requirements on the most part. When DSR is procured for such purposes as system balancing or constraint management, the payments offered by the programme operator are not for the purchase of energy. This is a subtle, but very important, factor in understanding how DSR operates and its role within the broader market mechanics.

When a DNO or SO uses DSR they will, in most cases, see this as a demand reduction unless it is significant enough in capacity to reverse the power flow at the 11kV primary substation. Under this circumstance, the DNO would likely regard it differently. When an event is triggered, the programme operator is not the consumer of the electricity commodity or the owner of it at any stage. The operator is purchasing the impact of that effect which will generally be a behavioural change that reduces an imbalance or shortage of capacity. It is therefore essential that the profile of that delivery meets the requirement for addressing the imbalance or shortage. Generally, this will be subject to two factors; capacity and duration rather than a volume which would be more commonly associated with a commodity purchase and typically only measured to a 30 minute settlement period.

The diagram below shows an example profile for a DSR event that is reducing the demand over the period of an evening peak. In this instance, a dispatch is issued at 15:15 with a 30 minute response. The baseline is established from the average in the preceding five minutes, from which the site will drop an agreed delta measurement and maintain this reduced demand level until a cease instruction allows them to return to normal operations at 18:15. By measuring this at 1 min intervals we can see a detailed shape of the site’s performance against the reduced level for maximum demand, shown with a solid green line.

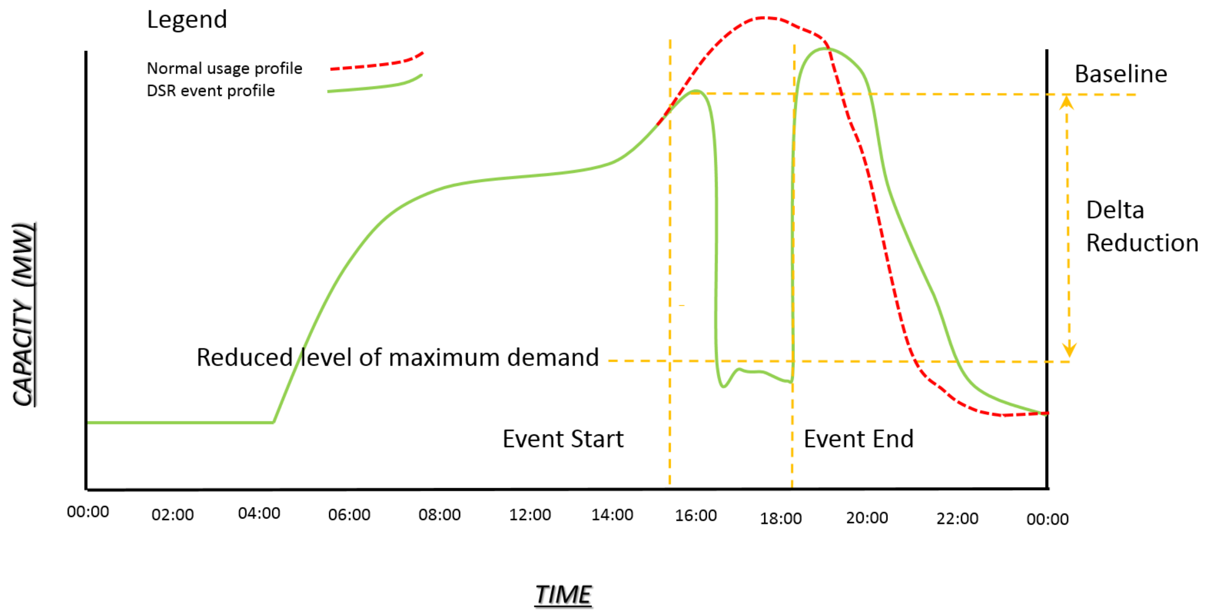



*Diagram 6: Example Profile for a DSR Event*

This compared to the next diagram, in which the half hourly consumption periods reflect the volumes of energy consumed by the site in blue blocks, consistent with metering that would normally be used for settlement. The green line that reflects the accurate 1 minute consumption during the course of day demonstrates how during periods such that between 15:30 to 16:00 (Period 31) and 17:30 to 18:00 (period 35) there can appear to be a disparity with that of the volume measurement. This is particularly obvious at the beginning and end of each 30 minute period as the volume will offer an average value of the granular 1 minute intervals.

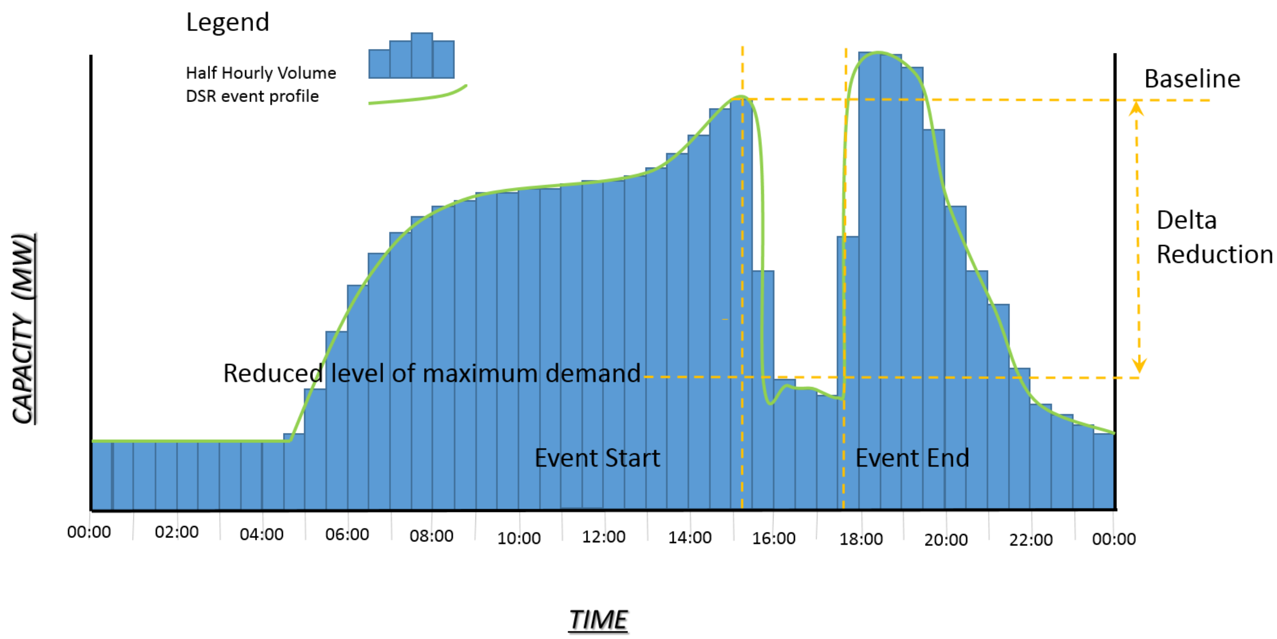



*Diagram 7: Half Hourly averaging vs real-time consumption*

The third and final diagram in this section highlights how it is possible, without the adequate granularity , that a site being measured with standard half hourly settlement metering, could appear to be achieving a consistent reduced maximum demand. However, the blue volume measurement would be the same for both the green and red dotted profile lines. If the theoretic profile was the actual consumption of the site, then it would not have provided the network with the necessary reduction and could contribute to a capacity shortage for brief periods and potentially result in fault conditions.

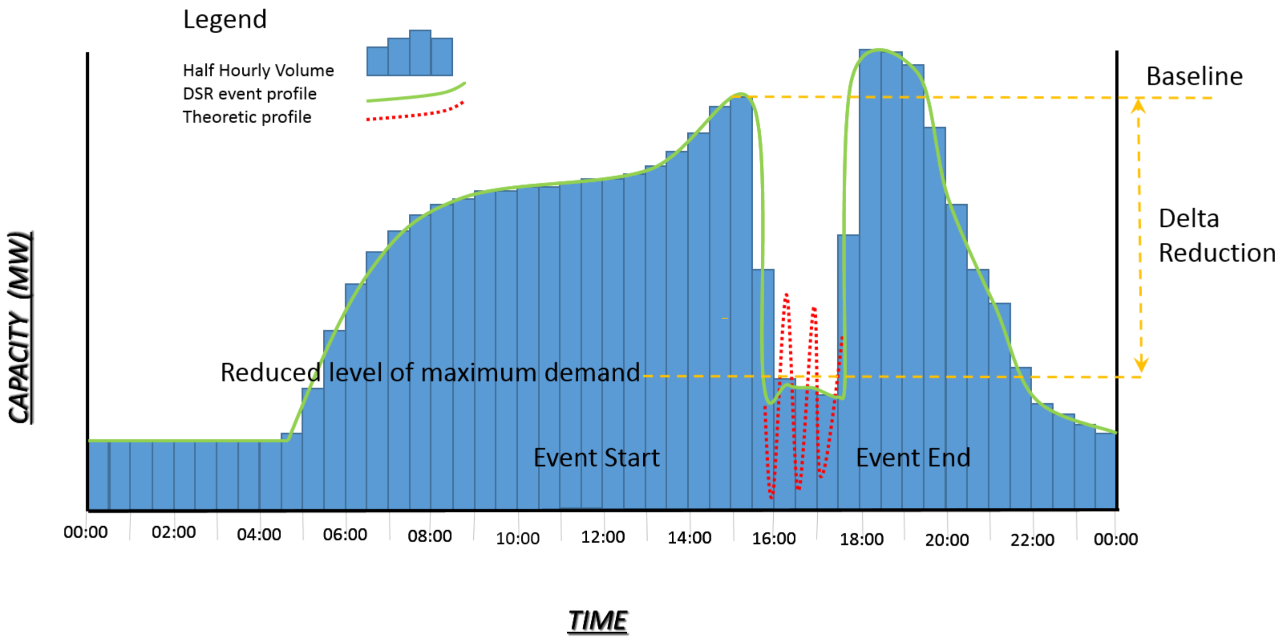



*Diagram 8: Theoretical Possibility of variance between real-time and half hourly consumption*

Another important aspect of the monitoring was to establish if there were any clear correlations between the demand reduction action at a consumer site and the network impact. Also, whether there were any other factors that result in either a consistent or unpredictable variance. During this assessment it was desired that the trials determine if there are any other contributory factors that may result in a difference between capacities that a DNO would need to contract in order to achieve the impact on the network from the site.

It has previously been assumed that this impact will be the same and, if a 1MW DSR delta in consumption is carried out, either by load reduction or generation this would be the same measurement experienced at the 11kV substation. Also within this, it was important to identify if there was any lag in the time it takes to detect the impact of a reduction on the network. Both of these factors were important in developing the DNO DSR requirement and establishing policies relating to when and how best to utilise DSR to manage future constraints.

To assist in the assessment of both of the true impact on the network, Project FALCON installed supplemental network metering on 11kV substations serving participant sites, which were capable of accurately measuring the demand at 1 min intervals. This would facilitate the ability to compare the site and network data at a variety of different times and conditions to establish if any rules may be apparent.

In the Season 2 winter trials we will further these investigations and repeat the trials at different sites and substations to replicate the outcomes or determine additional factors.

## 8.4. Operation

The technical requirements of the commercial trials were largely confined to metering of the events, as described in the previous section, and the associated processing of the gathered data. The scope was focussed on being able to deliver key learning in the following areas:

- Determining the impact on the network;
- Assessing the reliability of participant performance;
    - Speed of response
    - Duration
    - Capacity
- Measuring of the sites against expected volume; and
- Accurately settling customer payments.

One of the major deliverables for the project is therefore, a back office software system that assesses the performance and meets the accounting requirements of generating customer statements including payment calculations. The trial software was required to demonstrate the functional principles expected within a full blown, enterprise software solution developed for managing a larger volume of customers, but at a scale that is appropriate to the trial, so as to minimise costs. As DNO's do not have existing systems similar to those of suppliers who already have large enterprise software deployments to manage customer contact and billing, the developed solution needed to be standalone and not just a concomitant module to a legacy structure. Furthermore, given that there will be a requirement within the industry for such software in future, every attempt has been made to ensure that a scalable solution is established.. This will contribute to the ongoing development of a BaU capability for all DNO's to meet their new necessity to directly, performance contracts with connected sites.

## 8.5. Connections

A very important aspect of the commercial technique 6, where the reduction of demand is facilitated by the sites ability to meet demand with its own embedded generation, is to connect to the network in a safe manner that allows the site to manage the transition between supplies without interruption. With almost all participant sites, particularly those that have invested heavily in the purchase and maintenance of a stand-by asset, it is vital that any DSR scheme does not negatively impact on their business continuity arrangements. Much of the ability to achieve this is incumbent on having the correct connection permissions from the DNO, as well the appropriate controls and switchgear installed.

The design, operation and permissions were based on the assumption that the site will run predominantly in one of two modes. These are 'Islanded' and 'Synchronised'. There are, however, different ways of achieving and operating particularly under 'island mode' and these will affect the potential risk to continuity of a site with generation. These different modes are described further in sections 8.5.1 and 8.5.2

An overview of the Load Transfer procedure is contained within sections 8.5.3 and engineering recommendations for protection is outlined in 8.5.4.

For more detailed information regarding connections and protection please visit the Energy Networks Association website:
http://www.energynetworks.org/electricity/engineering/distributed-generation/distributed-generation.html

### 8.5.1. Island Mode

When in 'island mode' a generator will provide its output to support the local network only. This can be more easily explained with the assistance of the simple, single-line network schematic below:

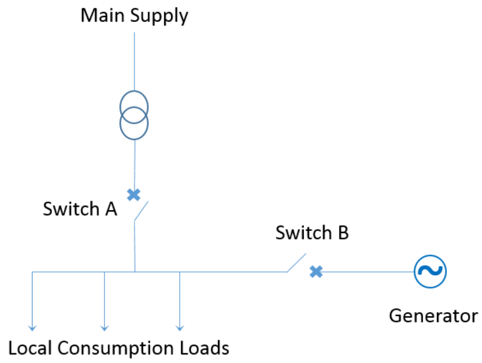



*Diagram 8: Simple Network Schematic*

Under normal operating conditions where the primary electricity supply comes from the DNO (main supply) then 'Switch A' would be in the closed position, allowing the flow of power to the local consumption loads via the bus bar. During this normal mode, 'Switch B' would be open, and therefore preventing the local generator from supplying the bus bar concurrently with the mains supply.

In order to operate in local 'island mode' with power from the generator, the switch positions would require to be reversed so that the main supply is isolated while the local generation is operating. In order to maintain this, it is necessary that the generator is sized appropriately to meet the local consumption loads, but not oversized by a significant margin as it is unable to export excess power due to the open position of 'Switch A'

### 8.5.2. Synchronised

When a generator is operating in a 'synchronised' arrangement then both 'Switch A' & 'Switch B' are closed at the same time. This offers greater levels of functionality and resilience as if either the main or local supply fails, the other should remain present, maintaining the continuity of supply, assuming the generator is adequately sized to carry the full load present at the time of mains loss.

By maintain the continuous synchronisation with the mains, it is possible to either continue to import power for any shortfall or export excess electricity from the generator if there is imbalance between the local load and available generation.

This does however increase both risk to the network and local site in the event of a fault condition and there are some compromises that result, generally in relation to the cost and conditions applied to the granting of a permission to synchronise over and above those of island mode.

It must also be noted that even when permitted to full synchronise local generation with the main supply, it is often the case that there will still exist restrictions over the import and export capacity allowed.

### 8.5.3. Load Transfer

The connection permissions that are granted are often as important for the brief period during which loads are transferred from mains to local or vice versa than for the extended duration it may operate for once running.

Unless permissions have been given expressly by the DNO, then under no circumstances should the site allow main supply and local generation to be interconnected together on the same bus bar. This is a relatively common configuration, particularly with emergency back-up assets which are only expected to run in the event that mains is unavailable anyway. However when mains supply has been restored, the site will require to carry out a 'break transfer' in order to switch back to the normal primary supply. This transfer mode, sometimes otherwise known as 'break before make' does limit the ability to test the generator regularly without interruption to the site and a 2nd interruption is necessary when returning to mains following a critical supply event.

To avoid the secondary interruption and improve the ability to test the generator regularly without incurring a loss of supply the most common option is to gain a STP (Short Term Parallel) connection permission. This offers a compromise between the total exclusion of any synchronisation and the typically more expensive alternative of full or long term synchronisation as described in section 8.5.2.

With STP it is accepted by the DNO that a brief period of synchronisation, where both main supply and local generation are concurrent, will generally be of a lower acceptable risk than maintaining over an extended period. It is therefore possible to allow a site to apply the principal for a period of around five to ten minutes in order to start local generation, synchronise and stabilise the supply before enacting a controlled disconnection of the mains, thus avoiding interruptions. This can also be applied in a reversed sequence to allow the site to return to a primary mains supply without negatively impacting the concatenation of the two sources.

### 8.5.4. Engineering Recommendations for Protection

The proper title is ER G59 or Engineering Recommendation G59. G59 is a generic term, G59-1 is the original standard authored in 1998 and revised to G59-2 in 2010. It has seen further review and updating resulting in the current G59-3 being applied in 2014. This report section refers to the recommendations and guidelines for connecting embedded generation to utility supplies for long and short term duration.

Government policy, environmental concerns and advantages to the national grid balancing mechanism, led the way to it being increasingly desirable to allow small embedded generation sources to be able to feed and contribute power into the grid infrastructure, an infrastructure almost exclusively controlled upstream by the national grid. If an unpredictable and uncontrolled quantity of wind turbines and embedded generation were to be allowed to feed into the grid, some regulated basic protocols would be needed.

ER G59 attempts to specify basic functionality requirements to protect both the grid and the embedded power generation.

One of the recommendations within the requirement is for mains failure detection whilst the generator system is in parallel with the mains.

A traditional phase failure relay, sensing voltage only, may not detect a mains failure due to the generator operating in parallel and supplying power at the detection point.

Many manufacturers have specific G59 detection relays that will supervise the system when in parallel, constantly monitoring the mains/generator common voltage and generator output current to detect rapid changes in characteristics which would identify that the mains is no longer present and a mains failure has occurred.

A common misconception is that the G59 relay protects workers upstream if they isolate at MV/HV and commence to work on the network, assuming several downstream generators will keep the equipment live and in a dangerous condition. Firstly any planned outage would where possible, be re-fed via an alternative path on the grid to minimise outage and as a minimum you will be informed if this is not possible. Also a robust safe working practice will test and ensure the bus is dead before commencement of work, thirdly they will earth the power rail at the point on the network on which they are working.

Predominantly the G59 relay protection guards against unplanned system failure for both parties (grid and generator owner). The mains disconnection has to occur quickly for two reasons:

1 - If the dead utility network is not disconnected quickly, the site embedded generation will attempt to supply the local surrounding network and fail on over current, making the point of having the generators useless.

2 - Depending on where geographically the site is on the distribution network, an attempt to bypass the network fault will be made or auto re-closers on the network will attempt to reconnect power a number of times to see if the fault was temporary (a falling tree for example). Either way, power would reappear on the utility mains causing a crash synchronisation if embedded generation was still attached.

Depending on the size of the generator seeking a connection permission, its location and what else is already connected within that proximity, there are a number of other parameters in addition to ‘loss of mains’ that can be monitored and managed using G59.

- under and over voltage
- under and over frequency
- Phase vector shift
- NVD (Neutral Voltage Displacement)
- RoCoF (Rapid Change of Frequency)
- Reverse Power
- Over Current
- Earth Fault

## 9. Contractual Requirements

The contractual requirements for the DSR service are relatively unprecedented within the relationship between a DNO and consumers connected to their network. Under normal circumstances, any legal agreement would only relate to the connection conditions of a site as DNOs own and operate the distribution network of towers and cables that bring electricity from our national transmission network to homes and businesses. They don’t sell electricity to consumers and don’t bill directly for any services, other than capital works associated with provision of connections.

Therefore an entirely new contract form was needed to be developed and approved so that an appropriate relationship could be created with existing connected sites. This needed to enable a performance related payment to be made which reflected performance achieved against expected outcome. As a result, the contract needed to reflect a clear description of the expected action to be taken by the site, along with any payments, penalties or any associated remedial action that would be taken in the event of non-performance. In addition the contract required to include all the standard legal sections normally found within a ‘service agreement’.

The contracts that pre-exist within the industry for provision of DSR services by other parties such as National Grid have in the past received criticism for the length and complexity, and have even been accused of acting as a barrier to programme entry. It was therefore a key objective to simplify the contract for Project FALCON and seek attitudinal feedback from the potential counterparties as to its clarity and ease of understanding.

In simplifying the contract and attempting to make it as easy as possible to understand there were clear limitations on the number of terms to be included. As a performance contract it was necessary to include detail of performance assessment and payment details;

1. **Parties** – The names and addresses of all the contracting parties should be clearly stated.
2. **Definitions and Interpretations** – A number of specific terms needed to be clarified due to being particular to the proposed services. For example - “*Demand Response*" means the regulation of the amount of electricity consumed and/or generated by a Site to achieve the Agreed Capacity. and *"Policies"* means any instructions, rules or policies issued by WPD from time to time, including without limitation Policy Document: LE7 Relating to Bribery;
3. **Payment Provisions** – The value to be paid allows provision for an availability and utilisation payment enabling the terms to be flexible to support programmes with different payment models. The FALCON trial is testing an Utilisation only payment mechanism.
4. **Description of Services** – Simplification of the description is particularly difficult as there are many variables relating to the performance of the service delivery that in turn affects the payment provisions also. It is therefore necessary to include the performance and payment algorithms, developed specifically for the FALCON trials.
5. **Term of contract** – The contract duration for the trial has been defined two years, during winter. This reflects a period during which the service is most likely to be required due to high energy demand. In addition any sites that normally provide STOR services may be out of contract and avoid contractual conflicts with National Grid’s terms of availability.
6. **Limitation of liability**
7. **Termination provisions**
8. **Dispute Resolution** – The procedure to be followed if the parties have a dispute should be included. Inclusive of an option for arbitration or mediation where the issue cannot be resolved through internal escalation.

9. **Confidentiality** – restriction of disclosure of any technical information relating to the trials
10. **Force Majeure** – This clause should cover situations where performance of the contract is impossible through no fault of either party. For example, if there is a natural disaster or civil unrest.

As sections 3 and 4 are, in their own rights, complicated and potentially difficult to understand, a set of assistance notes were provided in order to offer a graphical explanation to the performance monitoring, targets and financial settlements. Extracts of this can be viewed in sections 10 , 14 and 15.1

## 10. Commercial Model

The establishment of a suitable commercial model for DNOs to access DSR as an alternative to capital investment in the network is at the heart of the FALCON Commercial Trials. It is critical for a DNO to establish a true value for DSR and test the associated sensitivities relating to its use case. Although previous trials have been carried out by DNOs to test the effectiveness of DSR as a new network tool, it has been isolated to the technical aspects of the service operation. In order to continue the service development principals, it is necessary to establish its financial effectiveness in relation to the other alternatives available of which the number of potential options are increasing with the introduction of alternative 'smart' technologies.

We did not assume that DSR will automatically be rolled out as a BaU method utilised simply because it is a new alternative. Any benefits over other alternatives were identified and the magnitude and nature of any advantages established against conventional reinforcement as well as any other new substitute solutions.

DSR has some added complications to consider. Typically, all the other techniques that could be employed are capital investments that have relatively fixed assessment parameters as outlined below:

- **Cost** – normally a fixed capital expenditure with relatively low operational or maintenance costs
- **Duration** - capital upgrades can have a balance sheet depreciation of 15+ years and an actual lifecycle even greater
- **Reliability** - once upgraded, capital investments typically have a predictable reliability and degradation curve
- **Ease / Speed of Deployment** - highly variable depending on technique. Significant upgrades can often include a variety of associated work including design, wayleaves, civil works, etc. More complex civil projects can incur delays that are not conducive to maintaining constraints within acceptable parameters.
- **Requirement Certainty** – a constraint may be transient or predicted but not result in a permanent need.

## 10.1. Establishing a Trials Budget

In order to have a reasonable likelihood of BaU application, it was necessary for the use of DSR to offer tangible advantages over conventional reinforcement. Using the assessment parameters stated above for establishing a trials budget, it was necessary that the annual cost for DSR was lower than the annualised cost of conventional reinforcement.

On this basis, a sample reinforcement cost to increase capacity of an 11kV substation can be calculated as follows:

$$\frac{(capital\ cost\ of\ reinforcement \div operational\ life\ in\ years)+annual\ maintenance}{Megawatts\ of\ Additional\ Capacity} = annual\ DSR\ budget\ per\ Megawatt$$

Once the budget was established, per MW it was possible to calculate how it would be extrapolated to customer payment. It was necessary to determine the volume of DSR required in terms of the expected number of hours that a constraint is likely to require to be managed by means of DSR.

Therefore, the calculation of the payment to be paid to the participant is:

$$\frac{annual\ DSR\ budget\ per\ MW}{total\ annual\ duration\ of\ expected\ DSR\ operation} = Hourly\ utilisation\ rate\ (£\ per\ MWh)$$

Within the FALCON trials, the network areas selected are not subject to any critical constraints that require immediate reinforcement. This enabled our operational scope to widely accept a variety of site types, locations within the trials area and to base the operations on a hypothetical financial model. A DSR volume of up to 40 hours over the period of each winter was assumed.

The benefit to a participating site is not limited solely to payment offered explicitly for FALCON operation. There are also implicit costs, revenue and savings to be considered in order to establish the full commercial impact of trials participation. Below is an approximation of the potential financial impact to a site with a 1MW diesel generator used to displace demand for 40 hours in conjunction with FALCON and Triad.

| Description | Unit Price (MW) | Total |
|---|---|---|
| FALCON payment | £300 | £12,000 |
| Electricity import avoided | £75 | £3,000 |
| DuoS avoided | £82.60 | £3,300 |
| Triad avoided | £25,450 | £25,450 |
| | | |
| Fuel Cost | £205 | £8,100 |
| **TOTAL** | | **£36,150** |

*Note – It is assumed that all the electricity generated is being consumed on site and therefore no GDUoS or electricity export payments are included in the above table.*

## 10.2. Cost versus Benefits

The cost vs benefit is only workable if it meets the requirements of all participating parties. As part of Project FALCON we assessed the viability of the available budgets for reinforcement to be attributed to a new DSR programme. This raises the potential of a disconnect between the available budget from a DNO as part of a well justified business plan and the expectations of any participant who will have a minimum threshold that will require to be met in order to secure their involvement. It is also worth noting that this is not necessarily a binary function, and that both the programme sign-up results and the quality of service delivery may be sensitive to the level of payment.

A participant may join the programme if their minimum expectations are met, but if the payment was higher, we may identify increased levels of capacity. In addition, the minimum payment level may result in a site agreeing but attaching a limited value to meeting their obligations under the performance contract as there are no punitive measures beyond that of 'loss of opportunity'. If a participant attaches adequate importance to the conditions against competing operational priorities then performance may not meet the expectations of the programme operator.

Only a portion of the trials data will be able to capture the true effect of price, as a sensitivity within the site performance as results data may also be accountable to conditions outside of a site's influence e.g. a mechanical or communications failure on the day of a DSR event. We therefore sought to carry out attitudinal analysis at various stages throughout the trial to determine the primary factors and their prevalence on the final performance results.

# 11. Customer Engagement

Proactive customer engagement is a relatively new proposition for DNO's as the main focus of the business is traditionally that of an engineering organisation, focussed on maintenance of the network. As a distribution business WPD own the system assets over 4 franchise areas, including 220,000km of network and 269,000 transformers plus associated switchgear.

Traditionally the main focus of the core business is responsibility for:

- Maintaining the electricity network on a daily basis;
- Repairing the electricity network when faults occur;
- Reinforcing the electricity network to cope with changes in the pattern of demand; and
- Extending the network to connect new customers.

With the focus largely being on the assets themselves, the majority of all customer interactions are either dealing with new connection requests, resolving issues raised by existing customers' and general notifications in advance of planned works.

DSR is not a solution that can be applied unilaterally by WPD without the support of external participants willing and able to change their demand patterns on request. By its very nature of being something that is being trialled also means that it is not necessarily an opportunity with which the majority of users will be familiar. Consequently it is necessary to educate, as well as recruit.

There are already service providers called aggregators who act as intermediaries within the UK market who seek to inform potential participants and develop the market opportunities on the participants' behalf. It is unclear whether aggregators or direct management of participants is preferable for a DNO or a combination of both, and therefore both approaches were trialled and assessed against each other. The assessments considered a variety of different aspects of the overall DNO DSR requirement and determined the priorities for creating and maintaining such services, particularly within a changing environment that is likely to see further evolution and additional market actors.

## 11.1. Direct Engagement

In creating the capability to operate the service directly with participants, there are several considerations that a DNO requires to address in order to establish its proficiency. This report has already identified some of the core requirements, such as contracts and back office systems that are requisite regardless of engagement model. There are several others however, that would not only be new functions within the existing business structure, but could considerable alter the scope and scale of the existing business structure by the engagement model chosen

Traditionally DNO's have very limited ongoing direct relationships with network users, outside of new connections and faults. Some large property developers may have named contacts or an account manager due to the volume of connections that they are responsible for, but beyond this the customer engagement resources within a DNO are limited. Establishing a new capability within the business to recruit, manage and operate the participants is considerable and requires scrutiny to determine the most appropriate channels.

The barriers required to be overcome are a combination of market conditions and physical capabilities, as outlined below.

**Market Barriers**
In order to be able to recruit participants a DNO should be able to offer a reflective value and capability in line with existing parties. This can be somewhat confusing as it can potentially be interpreted that aggregators, as well as SO, services are in conflict with DNO service requirements. This is largely due to the SO balancing services being operated under a contract that is very restrictive to being able to offer any other services, without any assessment of their conflict or synergy.

Aggregators do not operate their own DSR service programmes; they are restricted by the DSR programme operators' conditions. One of the primary functions of the aggregator is, therefore, to access the benefits of multiple revenue generating schemes and, by optimising a sites' participation within them. By doing so, they can increase the total financial benefit. Within such an environment it would be likely that to secure exclusive access to site for DSR use, a DNO would need to compete with the typical incentives accessible from other parties.

In the case of TSO Balancing services this is likely to necessitate a payment model that offers an availability payment as well as utilisation. In the majority of instances, sites will be of a capacity lower than the 3MW direct contract threshold and will be working with an aggregator. The precedent set by the rates within the existing market are unlikely to be determined by the SIM to be more economic than either conventional reinforcement or techniques 1 – 4. It is therefore important that, within the trial, the barriers and any solutions were identified that will enable DSR to be rolled out at a cost that is justified and appropriate given the range of alternatives.

In order to address the TSO barriers, a working group was established in association with all of the DNOs and TSO. It was chaired by the Energy Networks Association and Invitations were extended for suppliers and other possible programme operators to present their requirements. The group's focus was to consider and develop the potential of a shared service framework, which addresses conflicts and synergies between the parties. A proposal of a new set of arrangements has been developed that will enable sharing of a sites capability between programmes to ensure optimised value to all parties. More detail on this is available in section 18.

Should a TSO and DSO sharing framework be accomplished and the conflict between the programmes eliminated, it is expected that it would also be accessible to aggregators. It is ostensible that an aggregator will still be able to offer increased value over that of a DNO directly, at least for sites below 3MW. Over recent years, there has been increasing suggestion of a role transition by DNOs to a new and more active constituent of the network. It is typically referred to as DSO (Distribution System Operator).

Section 19 offers one view on what may be the broader roles and responsibilities for a DSO in the future. It's commonly recognised among the varying predictions of what this may include, that there will be a requirement to interact more closely with users of networks to understand and influence their behaviour. The applications for this are widespread, but may include the ability of a DNO to develop aggregation capability for their own use, but also to offer services to the same service operators that aggregators do currently, or intend to in the future.

This long term view carries many parallels with immediate challenges that a DNO will require to address in order to create internal resources necessary to operate a commercial DSR service.

**Direct Proposition**
In order to establish a direct proposition there are various skills and capabilities that currently don't exist with a DNO business, or of a scale that would support an operational DSR capability. Much of this relates to relationship development and management which is necessary to establish and manage participants engaged within performance contracts.

The process for techniques 5 and 6 are potentially quite different as there can be some assumed behaviours associated with distributed generation sites that are unlikely to be as simple with interrupting, reducing or deferring industrial processes. It is also the case that DNOs should have records of the majority of generation located within their own networks, which is a significant advantage in assessing the case to use DSR.

In order to identify potential sites with generation not already known to the DNO and for T5 it will need to have the capability to contact and communicate with sites. Due to the use case for DNOs being geographically sensitive, it may be that this resembles a professional and trained sales channel function that includes cold calling, either physically or through alternative means such as phone and email. After contact is established, it is necessary to communicate the value proposition to determine any appetite to participate and then assess the site's potential capacity.

Assuming that the engagement process is successful, further resources will be necessary to negotiate, agree, contract and manage the relationship. In addition there will be technical requirements, as even in the event that simple service dispatch options are employed, additional metering and associated services such as data collection will require to be provided.

**Sales**
After any 'general awareness' activity has commenced, it is not expected that a DSR proposition will be engaged into by participants on a solely elective basis and a DNO will need to have skilled staff able to meet with site representative to discuss the proposition in detail. This is likely to require in excess of a single meeting and require the ability to carry out negotiations in relation to arrangements, as well as lead any contractual dialogue in order to conclude and agree final terms.

**Capacity Assessment**
A capacity assessment is advisable to ensure that a site can realistically offer the capacity under negotiation. This is likely to require additional skills to review either the generation installation and its current condition as well as any associated connection permissions for T6. Capacity associated with T5 is more likely to require assessment by someone who has a knowledge of industrial processes to understand and verify the likelihood of their reliability as well as sizing the capacity.

**Training**
In order to improve the performance of the sites and act as a reminder to the conditions associated with an appropriate DSR action, initial training for site operators will need to be carried out, as well as potentially offering an annual refresher. This could be of particular value to ensure that site operations have not altered over the preceding 12 months, affecting the anticipated capacity.

**Commissioning**
On most sites existing metering will need to be supplemented so it can provide increased granularity from a calibrated device that can be remotely contacted and the data collected. Generators are likely to be able to offer the 1 min interval readings, but may present issues with accuracy of the reading to a recognisable standard, including calibrated clock and with the ability to access data. Despite DNOs having experience of metering, this would normally be settlement metering as opposed to direct connection to the output terminals of a generator which requires additional skills as well as specific method statements, permits to work and internal policies. Metering to measure a demand reduction site is similar to that of a standard settlement meter and will most likely be installed alongside the existing meter.

It is assumed at this stage that the DSR services would be dispatched manually by agreed communications method, most likely a phone call. If any automation or M2M integration is proposed, additional capability in this discipline will need to be developed or third party relationships established to meet the requisite.

**Test**
Once commissioned, it is necessary to ensure that all the components work correctly and that the participant will be able to meet the contracted reduction or generation capacity. As highlighted in the training requirement, it is probably necessary to repeat this part of the process annually to ensure that the capability of the site hasn't negatively altered.

**Operate**
The operation of commercial techniques will require similar enhancements for both direct and third party operation via an aggregator. To use the service for its intended purpose it is necessary to supplement the DNO control room with additional systems and policies to recognise where DSR capability has been introduced and mechanisms with which to dispatch it.

Post event, it will be incumbent on a DNO to have new systems in place that offer the facility to securely receive the performance data to assess and settle the payments. A beta version of back office software has been established by for the trial that demonstrates this functionality that can be further developed to meet full enterprise software requirements. More detail on this is available in section 15

**Account Management**
A very important aspect of the overall operation of commercial techniques will be the ongoing maintenance of the arrangements if it is expected that it is to be enduring. The role and responsibilities of an Account Management function are likely to be widespread and, as a front line representation of the DNO, it must be of a high professional standard.
Account management will be, for most participants, the first point of contact for any DSR issues , but, due to the limited public engagement within the existing DNO business model it can be expected that it will become the focus of non-DSR related contact as well.
Within the specific requirements of the programme operation it is likely that the account management function will include:

- Primary contact for DSR related enquiries;
- Initial training and annual refresher training;
- Declarations of availability or issue reporting;
- Performance reviews;
- Billing and payment enquiries; and
- Contract or performance issues.

The following section details the experiences/learnings encountered in designing, implementing and operating the trials with engagement via aggregators.

## 11.2. Engagement via Aggregators

*What is an aggregator?*

An aggregator, within the context of the UK Energy Industry, will generally be regarded as a service company who brings together the capability of many small sites, each with the ability to reduce their consumption or increase generation. Variations of this can also be referred to as a VPP (Virtual Power Plant), particularly in other international territories such as the United States.

This capability developed by the aggregator company is then used to participate in commercial programmes detailed in section 22.4, to derive an income that it then shares with its EPs (Energy Partners). In such applications, it is often advantageous to use aggregated demand side providers as an alternative to traditional power stations for a variety of reasons:

- Take advantage of existing infrastructure;
- Many small assets can respond more quickly than a traditional large power station;
- Large power stations require to burn large volumes of fuel to remain in a ‘stand by’ state;
- Distributed generation is less likely to be subject to single point of failure;
- Provides additional value opportunity to broad range of organisations, mostly out with energy industry.

At the time of authoring the report, there are a total of sixteen Demand Side Aggregators listed as UK service provider within National Grid’s list of commercial service providers. This is generally recognised to be the register for those seeking to offer services to others, although a small number of organisations have developed aggregation capability in order to operate multiple small locations of their own.

*GDF SUEZ Energy UK*
*Flexitricity*
*Npower Ltd*
*EnerNOC UK Ltd*
*KiWi Power Ltd*
*ESP Response Ltd*
*Matrix – Sustainable Energy Efficiency*
*Open Energi*
*UK Power Reserve Ltd*
*Tezla Energy Ltd*
*EDF Energy*
*Cynergin Projects Ltd*
*Energy Pool / Schneider Electric*
*REstore*
*Limejump Ltd*
*Stor Generation Ltd*

The list has altered slightly since the trial commenced with a small number of providers having ceased and a similar number having joined during that time. All of the listed parties at the time of the FALCON customer acquisition plan being authored were invited to participate within the commercial trials. From this group there were positive responses from six who wished to participate in the trials by either offering the inclusion of exiting EPs (Energy Partners) or attempting to acquire new ones within the trials zone.

The six aggregators listed alphabetically were:

Energy Pool;
Energy Services Partnership;
Flexitricity;
Kiwi Power;
Negawatt; and
Npower.

'STOR Generation Ltd' were a late entrant to the trials; they were not listed or operational at the time of initial invitations.

For the remainder of the document their identities will be anonymised and will be referred to by a reference name (Ag1) to (Ag7) to avoid any inappropriate disclosure of performance or other commercially sensitive information. Reference names have been allocated in no specific order but remain consistent throughout the report.

Each of the participating aggregators was provided with an aggregator briefing session and support document along with a copy of the newly developed DSR contract. Opportunities to discuss the scope receive training or request any further support was made equally available to all aggregator companies. Additionally they were also requested to review and make any minor revisions to the contract in order that a single consolidated contract could be used across all companies. The details and outcomes of this process are dealt with separately in section 15. It should be noted however that due to issues over the completion of the contract and other issues relating to its core activities (Ag7) did not progress to be a participant within the trials.

## 11.3. Customer Acquisition Plan

Using both direct means and in association with aggregators, an acquisition plan was developed to recruit the range of sites necessary to complete the learning objectives, as detailed in the previous section.

The first stage of this was to define a trial area with a defined geographical area in which the participants were required to be located. As part of the four technical intervention techniques, T1-4, WPD are working with a range of partners including Cisco, Alstom and Surf Telecoms to create an advanced communications network to support the project. The new WiMAX network provides low latency, high bandwidth communications to control the operation of T1-4 and gather back critical performance data on their impact.

The network area defined by T1-4 doesn't typically experience any substation overloading that would require intervention by the commercial techniques, 5 and 6. In order to maximise the potential of the recruitment of the desired sites to test the commercial methods, the same substations selected for T1-4 define the T5 and 6 trials area also. The red border on the map below provides a general indication of the trial area.

This total area provides an extensive section of network containing a broad cross section of users from rural through to industrial and dense urban environments.

| STATISTIC | VALUE |
|---|---|
| Approximate area | 150 KM² |
| Primary Substations | 7 |
| Secondary Substations | 188 |
| Overhead cables | Approximately 75km |
| Underground cables | Approximately 750km |
| Customer connections | Approximately 20,000 |

*Table 2: Total FALCON Trials Area*

The absence of real constraint problems requiring management also enables the trials to be operated but allowed to fail in the event of any complications, without causing disruption to customers. Additionally the network data being collected to establish the impact of DSR is less likely to be distorted by non-standard configurations of the network to manage issues.

No specific restrictions were placed on any of the aggregators who were invited to adopt their own approach to EP acquisition and MWs would be allocated contracts on a first come, first serve basis. The outline requirements for the identification of participants were as detailed below.

| **Trial Service Parameters** | |
|---|---|
| **Total MWs in Trial** | 10 MW |
| **Number of Sites** | 10 – 15 |
| **Minimum Generation capacity** | 100 KW - (total target 9MW) |
| **Minimum Load Reduction** | 20KW – (total target 1MW) |
| **Season** | Winter (Nov – Feb) |
| **Contract Duration** | 2 years |
| **Availability Time** | 16:00 – 20:00 |
| **Dispatch Notice** | 30 mins |
| **Min Event Duration** | 1 hr |
| **Max Event Duration** | 2 hrs |
| **Maximum Total Hours (per annum)** | 40 |
| **Payment (utilisation only)** | £300 per MWh |

In order to satisfy some of the learning objectives, it was preferable that the trial would allow the comparison of different asset types and contractual / operational arrangements within the 10MW target. A diversity of generation types were sought to include both CHP and stand by assets, and both gas and diesel fuelled units. Load reduction sites were sought that would only include genuine response type sites that reduce based on an instruction, rather than daily pre-emptive reduction for cost management purposes. The trial however did not preclude 'triad avoidance' as an additional learning objective was to detail the synergies between triad management and DNO DSR requirements. The diversity of participants and generation types required are shown below:

| DR Method | Large | Medium | Small |
|---|---|---|---|
| **Generation** | > 1 MW | 0.4 – 1 MW | < 400 KW |
| **Load Reduction** | >100 KW | 25 – 100 KW | < 25 KW |

The trial also sought to identify a direct participant who has existing experience DSR within another programme, as well as another with site who had no prior knowledge. The purpose of this was to gain a real comparison which can be performed with third party alternatives.

Due to this report representing interim findings after just the first winter trial period, and that further activity will be taking place over the winter 2014/15 period, only limited information can be included at this stage to avoid prejudicing ongoing work. A further commercial trials completion document will be published in June 2015 with the full output, including detailed results of customer engagement and acquisition activity.

In order to stimulate interest for direct participants, an external organisation NEF (National Energy Foundation) was recruited. NEF are an independent charity based in Milton Keynes, and have been at the forefront of improving the use of energy in buildings since 1988. Their stated aim is to give people, organisations and government the knowledge, support and inspiration they need to understand and improve the use of energy in buildings. NEF would provide an initial engagement through their local contact via direct knowledge sharing activities and attendances at a variety of local energy events and meetings.


Where any interest was generated through the general community engagement activities it was followed up by SGC (Smart Grid Consultancy Ltd) who are leading the Commercial Trials for FALCON. With nearly 10 years of detailed knowledge of the existing market mechanisms and a wide range of key contacts SGC recruited participants, completed the engagement process and carried out the commercial negotiations and final contracting arrangements on behalf of WPD.

SGC also carried out post trials gap analysis to determine the differences between current DNO skills and capabilities and those that would require to be attained in order to operate a DSR service as part of BaU activity.

The following leaflet was created during the Design Phase of FALCON and was shared with potential participants:

WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales

Project FALCON
(Flexible Approaches for Low Carbon Optimised Networks)

**Project FALCON**

FALCON is a project led by Western Power Distribution (WPD) and involves a number of partners. The project is being funded by energy regulator Ofgem under their Low Carbon Networks Fund, which tasks Distribution Network Operators (DNOs) like WPD to look at ways to provide security of supply at value for money as Great Britain moves to a low carbon future.

FALCON will test six alternatives to conventional network reinforcement methods, to see how they work in practice. It will also analyse their effectiveness in different situations, modelling their impact over many years. Ultimately, FALCON will provide guidance for network planners to select the best technique from a range of options. Four of these options are based around engineering approaches that will involve modifications to the network itself.

The remaining two options are Commercial Techniques, which focus on the energy consumption behaviour of businesses. Trials will be conducted with local businesses in the Milton Keynes area and will provide opportunities for participants to receive an incentive for changing their behaviour for a short period of time. This is commonly known as a Demand Side Response (DSR).

Cranfield ALSTOM BATH

WESTERN POWER DISTRIBUTION
Serving the Midlands, South West and Wales

LOWCARBONUK.COM

www.westernpowerinnovation.co.uk

THE CHALLENGE

When electricity is produced at a power station it needs to travel through the National Grid *TRANSMISSION* system then on through the lower voltage *DISTRIBUTION* network to which the consumers are connected. As the Distribution Network Operator (DNO) for the Midlands, South West and Wales, it is Western Power Distribution's responsibility to ensure that the installed infrastructure meets the needs of homes and businesses.

This means that the network is designed and maintained to cope with times of peak consumption, usually in the coldest days of Winter. This can lead to a huge expense and disruption, as more cables and transformers are laid. FALCON is testing smarter alternatives to reduce the need to do this.

THE SOLUTION

By communicating directly with users and paying them to either reduce their consumption or rely on an alternative such as emergency generators, FALCON will test the effectiveness of **'Demand Side Response'**. The network area that has been selected for the trials does not currently suffer from overloading constraints. It will however be benefiting from enhanced monitoring that is necessary to test the technical methods of intervention. This will allow Western Power Distribution to gain incredibly valuable information on the reliability of the service and detailed data on the network impact.

If successful it could not only improve the efficiency of the local network but also reduce CO2 and enable increased growth of renewable generation technologies.

*If you are an industrial or commercial user located within the red boundary on the map below, you may be able to take part in this unique trial.*

For further information about project FALCON and the opportunity to discuss getting involved please contact

Sanna Atherton
satherton@westernpower.co.uk
or
Gary Swandells
ggswandells9@westernpower.co.uk

*Diagram 9: Commercial Trials Leaflet*

It was expected that the majority of participants would be sourced via aggregators and with multiple parties (Ag1-6) working across the same area, rather than being allocated their own territories. This enabled the project to assess how the aggregators went about customer engagement.

Initial engagement processes were relatively diverse which was, to some extent influenced by their current core activities and maturity within the DSR environment. The more established companies were relatively quick to respond with existing sites located within the trials area. In addition, they also sought to influence some of their larger multi-sited Energy Partners who they already worked with, that had uncommissioned sites within the zone, to expedite the process to be available for the winter trial period.

Three of the six developed targeted campaigns to try and identify new capacity within the trials area. (Ag5) focussed its activity on their wide existing customer base, to which DSR is a new capability, and sought to use this as an opportunity to introduce the new service capability on the back of FALCON. (Ag6) engaged with an external call centre organisation that procured a profiled customer list and attempted a campaign of cold calling to generate prospects. This was not solely for FALCON, and the value proposition being promoted was still primarily focussed on STOR & triad, with DNO revenues as a small enhancement. However, the FALCON revenues were generally presented as 'guaranteed' which would not be the case in BaU, where it would only be accessed as necessary when constraints are likely.

Aggregators were provided with limited marketing materials from WPD to define the FALCON trials and were encouraged to present the importance and value of the trials in their own style and as part of their standard business development processes. A very simple process was then defined to offer a rapid approval route to confirm the status of any prospects and their participation within the trials as shown below. This was intended to serve as an opportunity to review the suitability of the site within the trial and to avoid the trials becoming oversubscribed.

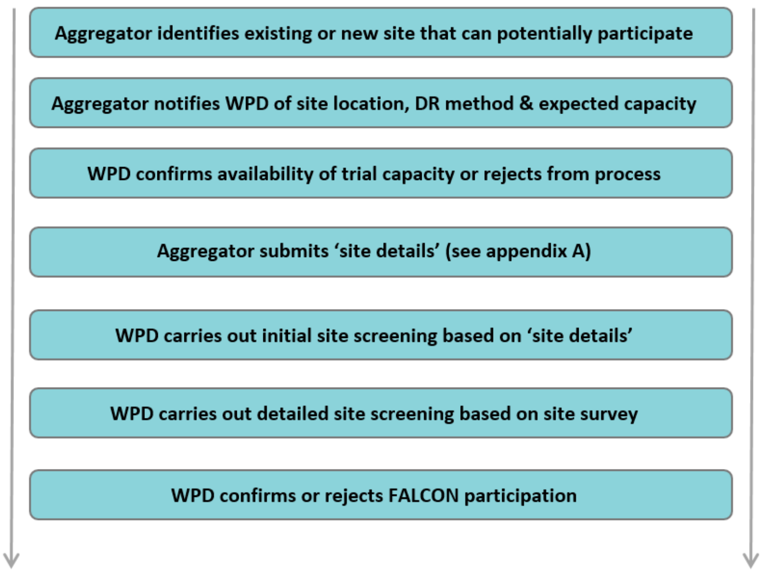



*Diagram 10: Aggregator Site Approvals Process*

Initial responses were very positive from (Ag1), (Ag2) & (Ag3) all of whom had existing capacity located within the trials zone and early indications suggested that there would be at least six stand by diesel sites that would meet the three size requirement categories that we wished to include within the tests.

Direct activity by SGC with organisations with which they had existing relationships also had very positive initial results with encouraging responses from;

**Anglian Water**

AW supply water and water recycling services to more than six million domestic and business customers in the east of England and Hartlepool.

The population they serve has grown by 20% in the last 20 years, but they still provide the same amount of water today as they did in 1990 – almost 1.2 billion litres every single day by minimizing leaks and encouraging more water-wise customers.

The huge region stretches from the Humber north of Grimsby, to the Thames estuary and then from Buckinghamshire to Lowestoft on the east coast with 112,833 km of water and sewer pipes. They supply and transport water across an area of 27,500 square km.

AW are the largest water and water recycling company in England and Wales by geographic area as well as one of the driest regions in the country, with just 600 millimetres of rain each year, on average a third less than the rest of England.

Compared with others, large parts of AW's region are typically flat and low-lying. The Fens of Cambridgeshire and the Norfolk Broads are just some of the stunning landscapes we enjoy in a part of the world where approximately a quarter of the land is actually below sea level. This requires AW to be aware of the risk of flooding and with few hills to help out with gravity feeding they have to rely on pumping water from place to place which uses very high volumes of energy.

In order to provide security of water supply, AW require to own and operate a sizable fleet of emergency generation so that they can continue to provide water in the event of disruption to mains supplies. Many of these are already contracted directly to National Grid for STOR as well as for triad avoidance activity.

**Thameswey Central Milton Keynes Limited**

In 2007, TCMK was set up as a subsidiary of Thameswey Energy Limited and owns and operates an Energy Station in Central Milton Keynes. TCMK was established to build and operate a Combined Heat and Power station to deliver district heating and a private wire network in the central business district in Milton Keynes.

The Energy Station is located in Central Milton Keynes and the heart of the station is two CHP units that are fuelled by natural gas with a combined an electrical output of 6.4 MW. The station supplies electricity and heat, via a district-heating and private wire network to The Hub, (a development comprising hotels, apartments and offices), Vizion, (a development comprising apartments, commercial outlets and a large Sainburys store) and The Pinnacle (the largest office development in Milton Keynes). It also has the capacity to supply electricity and heat to a proposed new residential area in the west end of Central Milton Keynes. The area served currently has a radius of some 1.5 km.

In 2010, TCMK generated more than 14 Gigawatt hours (GWh) of low carbon electricity and 12 GWh of heat from its Energy Stations. That's enough to provide electricity and heat to over 2,900 households. TCMK now has over 1,100 business and domestic customers who purchase their electricity and heat from our energy station.

With a high level of efficiency, TCMK can meet most of its customer's requirement with just one of the two generating units. This then provides TCMK with headroom capacity and an opportunity to use the remaining generation within DSR programmes.

Direct activity also identified a small number of opportunities to engage with companies who had little or no experience of DSR and would need a more thorough process to assist them on their technical suitability and business case assessment.

***Stadium*:MK**

The Stadium is a state of the art, purpose built venue that contains a 32,000 seated football ground, hotel, conference facility and new 3,420m² arena. The stadium was officially opened on 29 November 2007 by the Queen.

MK Dons' football ground, '*Stadium:*mk' became the focus of the activity, who had an emergency generator that had no permissions to operate in synchronous with the distribution network. Discussions were already underway with the stadium management team with regards to the siting of additional network assets to support engineering trials.

A series of meetings and an analysis of the site engineering requirements were carried out in order to provide an outline proposal including capital conversion costs and estimated annual running costs vs income.

The capital costs necessary for the 400kw generator needed to include conversions of the switchgear, controls and connection permissions. As the site only had consistent daytime loads of less than 200kw it was necessary to seek a permit to remain fully synchronised and export excess power back to the distribution network. This would result in an expenditure of more than £20K to set up and annual fuel cost in the region of £6,000 – 6,600 in order to receive an income of around £20,000.

In order to achieve this level of return on the initial investment the approximate benefit of multiple opportunities were included:

- STOR;
- Triad avoidance;
- DUoS avoidance;
- Electricity commodity; and
- FALCON.

A critical factor in being able to achieve the income is the ability to access the revenue from STOR is the ability to be aggregated within a group that meets the minimum 3MW contract threshold. This is not currently within the capabilities of a DNO and therefore to pursue any further the stadium would require to engage with one of the aggregators working within the FALCON trial.

At this stage *Stadium*:mk reviewed the available information and declined to proceed further on the basis that they already had a very high workload and were at advanced stages of a large engineering project to extend the Stadium facilities as part of its core development strategy. Attitudinal analysis interviews were carried out in conjunction with the decision maker at the stadium and the relevant output from this will be published along with the other participants in the final report June 2015.

The following section details the processes differences between recruitment for the two commercial techniques.

#### 11.3.1. T5 – Load Reduction

There are necessary differences between the profiling, targeting and acquisition of participants for T5 and T6. Similar findings have been determined in general across the DSR industry which continues to be dominated by generation rather than load reduction. Despite this, there continues to be a general dialogue within stakeholder groups that load reduction service should be easier than as well as greener than generation and the focus of any strategies to grow capacity for DSR programmes. This is also particularly interesting for consideration of areas outside the FALCON commercial trials scope. Specifically, the future extrapolation of any FALCON results to assess the value of domestic DSR which will undoubtedly be heavily biased to energy reductions rather than generation.

If generation and load reduction are valued at the same price by the DSR programme it is likely that the bias will still be to generation. The underpinning factor in this is the financial return versus the cost of acquisition and operation. Identifying sites that may be able to participate is potentially more difficult, although it can be accepted that they may be more plentiful. In order to identify it is unlikely that they will have clear identifiable factors that act as an indicator, other than total load. It should not be assumed that if a site has high loads at the periods where DSR is desired. A cold contact mechanism will be necessary to engage with prospective sites, which will require skilled sales type resources who can establish a dialogue to commence any subsequent process.

The process outlined is multi-stage and will typically require a well-trained and professional individual to manage. As well as someone to lead the process, the range of skills necessary to complete the activity will require multiple visits by appropriate skilled representatives. This is broadly the process that was used within FALCON, with none of the prospect sites progressing beyond contract completion to the site commissioning stage.

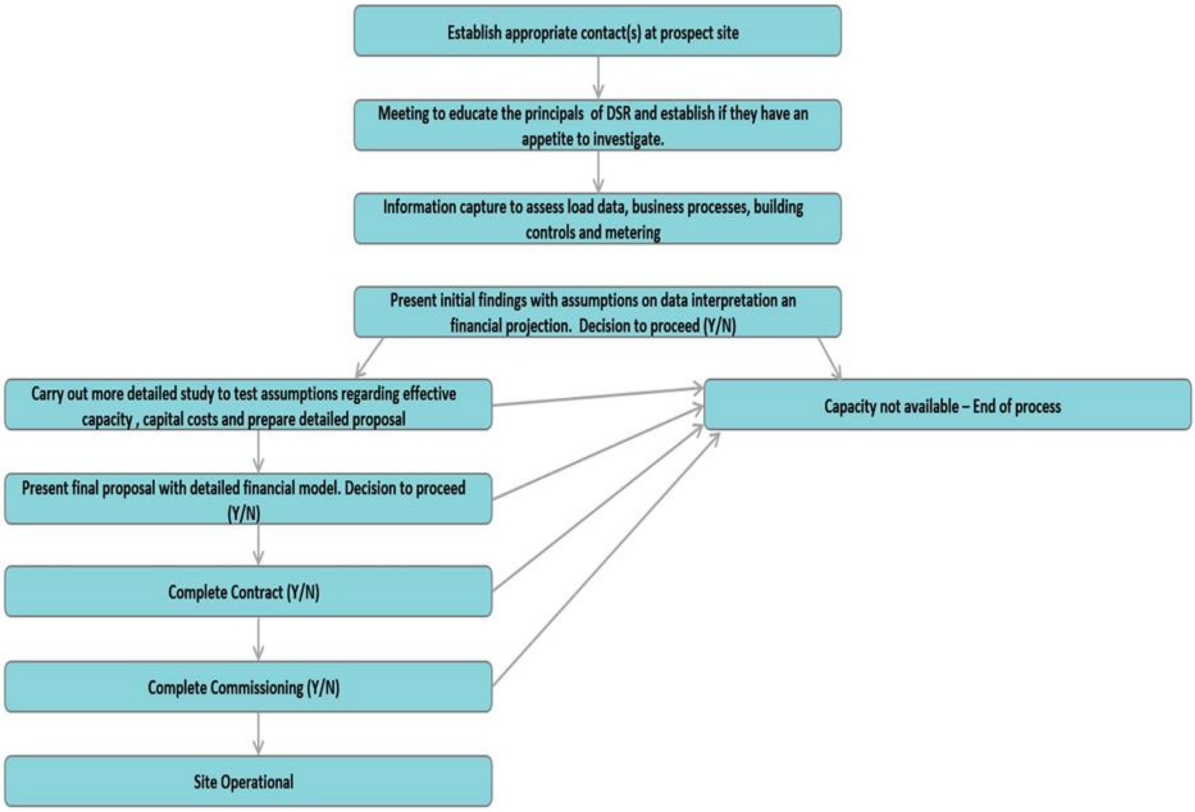



*Diagram 11: Process for Recruiting T5 – Load Reduction Participants*

No ownership of the process has been determined in the diagram above. This could be carried out internally by new resources within a DNO or in conjunction with, or entirely by a third party aggregator. The cost of operating this process is likely to be borne by the process owner and needs to be considered as part of the overall cost to operate DSR, over and above the customer payments when operational. As stated in the previous section, in order to access all revenues it may be necessary to be aggregated with other sites to achieve minimum contractual capacities.

The first season of winter trials did not successfully acquire any true load reduction sites. A number of the sites that had generation were metered at the site settlement point, which is identified within the back office systems as Load Reduction. This enabled the trial to test the back office systems against the T5 requirements but does not qualify toward the majority of load reduction learning objectives.

In general, load reduction sites are representative of having much smaller reliable capacity. It is difficult to determine an accurate statistic as to the difference between the average capacities of DSR participants using the alternative methods. It could potentially be by as much as a factor of 10. With such commercial conditions it is understandable why any organisation seeking to benefit financially is less likely to be use load reduction.

There are additional compelling factors that act in conjunction with the lower average capacity to further explain the difficulty with acquiring T5 participants:

- Difficulty identifying prospects;
- Complex / slow sales process;
- Less certain reliability long term;
- Can be in conflict with energy efficiency measures;
- Typically higher acquisition cost for lower return;
- Inadequate incentive to attract participants;
- Service operation can be complex depending on processes associated with reduction;
- Electricity supplier interest in existing load profile and future DSR potential may conflict DNO use case; and
- Final decision accountability.

Only a small number of serious prospects were developed during the course of the trial, and these required to extend beyond the period initially defined as the 'EP Acquisition' phase. In total the deadline was pushed back a on a total of three occasions with a final shortened duration 'T5 only' trial being attempted in April. Despite every effort and with no remaining opportunity to reschedule again the season 1 load reduction trial was abandoned.

Three separate aggregators had attempted to secure three different EPs, two of which are broader stakeholders with prior interest in Project FALCON. They all can generally be summed up as to have been unsuccessful due to a combination of the factors listed above.

### 11.3.2. T6 – Distributed Generation

The typically larger capacities that can be identified with generation sites can make it the preferred option for aggregators and direct service provider as the means by which to identify DSR.

Although the rewards are generally greater when compared with the small capacities associated with T5, generation sites can have several aspects that can complicate their recruitment. The trials have however clearly determined the overwhelming contrast with the difficulties securing the involvement of load reduction sites.

Aggregators were responsible for recruiting the majority of the site that participated in the first season and several of these were existing customers which expedited the process of acquiring capacity. This may not be the case if a BaU requirement occurs and will be largely dependent on where the constraint exists in the network and whether the located within a primary (7) or secondary (188) sub-station. However for a zone as large as the trial area this created a situation where almost the entire capacity being sought could be quickly provided by sites that already had the correct technical capability as well as operational experience.

It was the case however that one major site had no prior DSR experience and due to a recent change of generation assets did not have the appropriate permissions. This coupled with the experience at Stadium:mk enabled the trial to establish a similarities with the complexities of T5.

It should however be noted that in theory is should be easier for a DNO to attempt to identify potential participating sites by external indicators. In many cases a DNO may have a record of the generation located within the network. This may be because of existing synchronising permissions, prior application for synchronisation or physical evidence that can be observed such as exhaust stack or container enclosure. A DNO will therefore be best placed to develop a working record of generation sites located within their respective franchises. Currently out of scope from Project FALCON is also the opportunity to revise the connections application process to determine any positive practical DNO DSR applications when any future site seek permission to synchronise. This could reduce dramatically simplify the process of acquiring T6 participation by establishing a contractual arrangement at the time of an external party initiating a dialogue as well as present the opportunity for alternative incentives such as reduced capital charges.

A potential parallel activity outside of the scope of Project FALCON has been proposed to develop a new searchable database of all legacy generation within the network, including any past and all future connection applications, regardless of its final status of acceptance. This can be combined with other objectives, including consolidation of all generation to the latest G59-3 standards.

The process outlined is multi-stage and will typically require a well-trained and professional individual to manage. As well as someone to lead the process, the range of skills necessary to complete the activity will require multiple visits by appropriate skilled representatives.

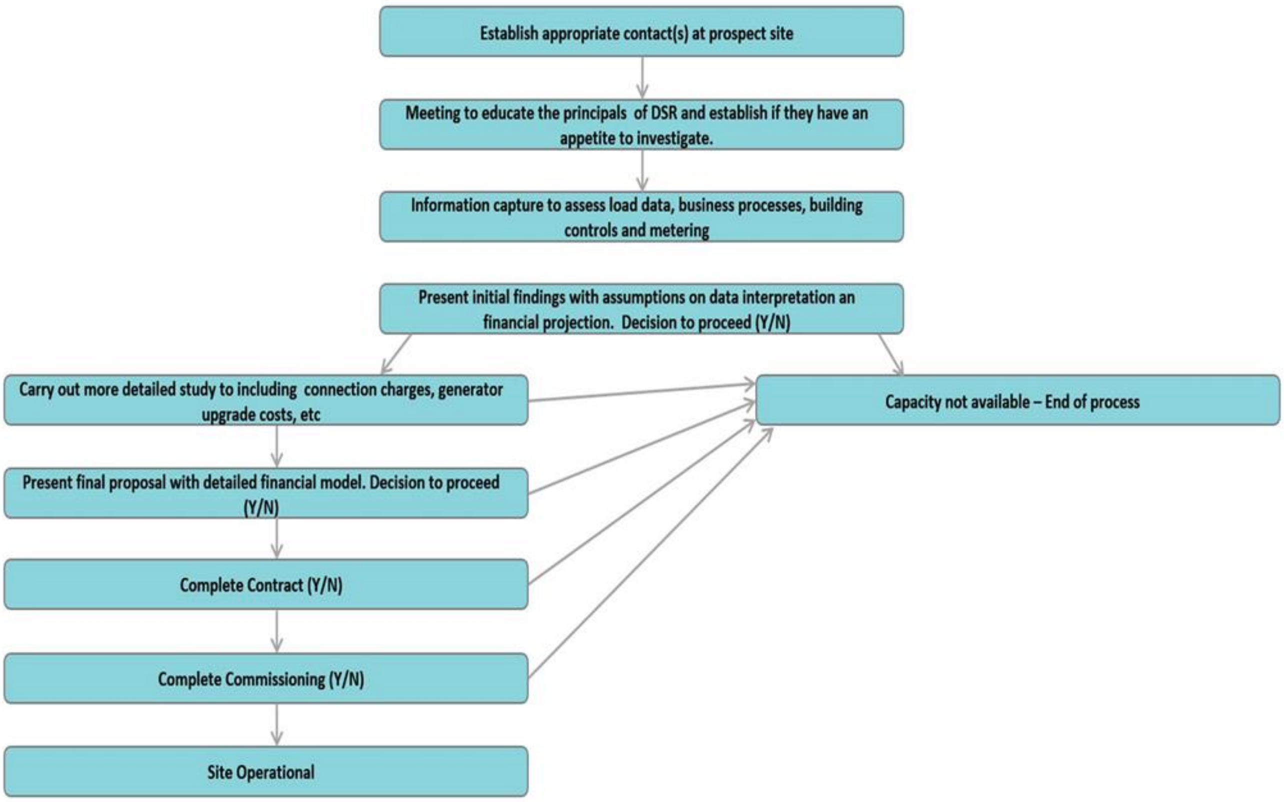



*Diagram 12: Process for Recruiting T6 – Distributed Generation Participants*

As with T5 Load Reduction, no ownership of the process has been determined in the diagram above. This could be carried out internally by new resources within a DNO or in conjunction with, or entirely by a third party aggregator. The cost of operating this process is likely to be borne by the process owner and needs to be considered as part of the overall cost to operate DSR, over and above the customer payments when operational. Again, similar to T5, in order to access all revenues it may be necessary to be aggregated with other sites to achieve minimum contractual capacities. However, it is more likely with generation to find a small number of sites which can meet the minimum capacity thresholds for direct participation in DSR programmes including STOR.

Within the first season trials we have managed to contract representation for all of the variations of DSR sites that were initially set out in the commercial trials scope, as outlined in the table below.

| | Diesel | | Gas | |
|---|---|---|---|---|
| | Direct | Aggregated | Direct | Aggregated |
| Small (<400kw) | - | 5 | - | - |
| Medium (400 – 999kw) | 1 | 4 | - | - |
| Large (>1000kw) | - | 1 | - | 1 |

*Table 3: Breakdown of DSR sites acquired*

## 12. Control Room

The control room is the heart of operational management of the network where skilled WPD network management engineers monitor the network status and take actions to enable planned outages for maintenance as well as any other active operation to optimise its operation. For the trial, the control room were fully consulted at all stages of its development design and build through to the event operations.

It is most likely that if a DNO opts to develop future DSR capabilities that although new resources will be required to establish the service capability, the owner and user will be the network engineers within the Control Room. As previously highlighted within the report, the Milton Keynes area of WPD's network is not subject to any serious constraints or seasonal overloading. Therefore the role of the control room within the trials does not require to include real operational decisions where commercial techniques would be necessary in assisting with the network operation. This has enabled the trials to be carried out in an impartial manner, where no favour has been given to any participants' location(s) and actual reliability could be tested by allowing sites to fail without risk to supplies.

In addition it was not necessary to test the methods and create suitable policies that will require to be developed in relation to when it is most appropriate to use DSR. This also enables the most suitable / effective dispatch mechanism(s) to also be left out of scope. Various other DSR programmes in the UK, and further afield, have already demonstrated there are many options ranging from very simple and low cost manual dispatch through direct contact (phone, text, email) to complex M2M systems that require no intervention in both the decision to dispatch event management. An advanced system such as this was developed in conjunction with the UK aggregator Flexitricity, as part of the 'Seasonal Generation' LCNF project in 2012. It was therefore deemed unnecessary to incur the expense of repeating such learning outcomes within FALCON.

The control room's role in the trials was largely limited to keeping them involved with any likely 'use case' or 'policy' development with regards to design and outcomes as well as liaising with during the trials to ensure that the trials did not create any negative impacts. A full briefing session on the Commercial Trials and the broader purpose of FALCON was carried out at a meeting of the Control Room shift managers and a Project Champion was nominated as primary liaison. As part of this role a general briefing was provided as key milestones were achieved.

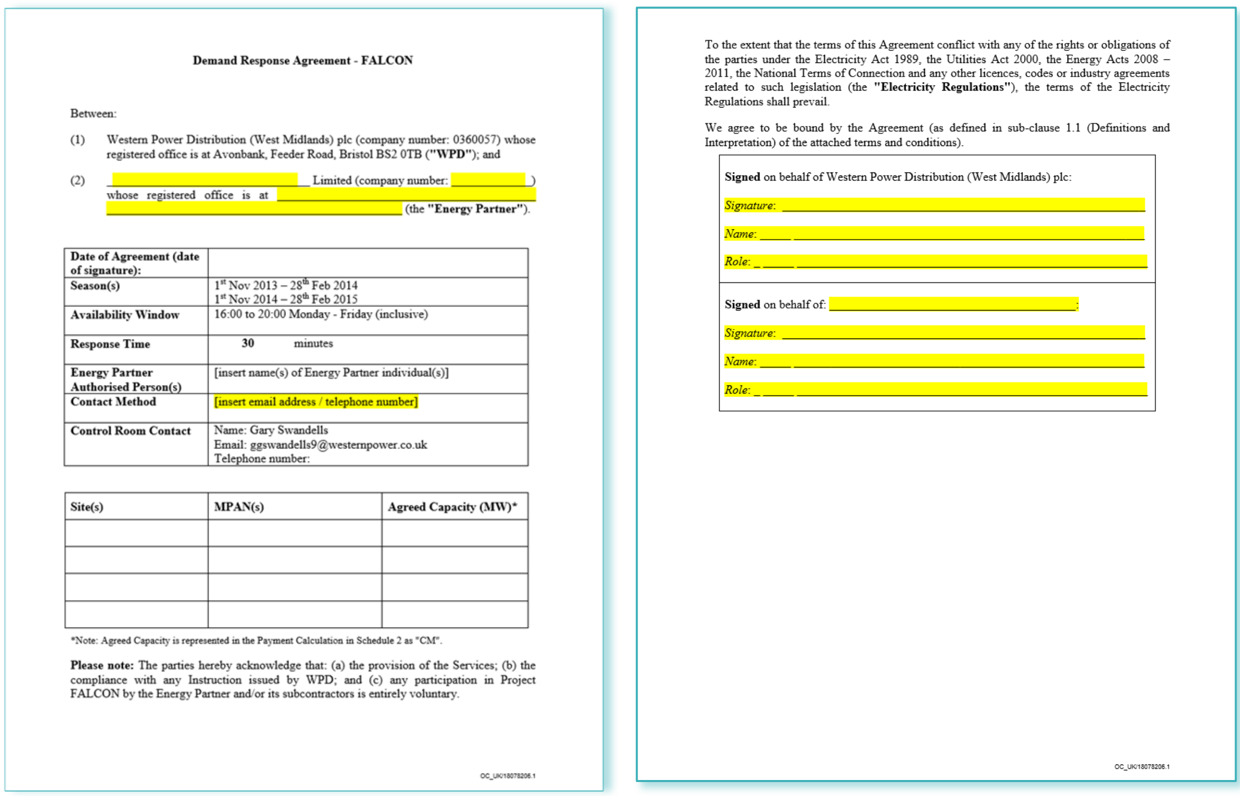
It was determined that for the trials the control room would not be required to dispatch the events directly and the Commercial Trials Lead would carry out this function. It would, however, be necessary for the Control Room to be briefed ahead of every event so that the network state and configuration could assessed and ensure that the trials would not contribute to any negative impact on the network. An agreement was therefore put in place to commence the daily event trials process with a call to the duty team leader to obtain permissions to operate.

## 13. Contract Development

The initial contract requirements defined by SGC (Smart Grid Consultancy) were authored into a draft contract which included all of the elements outlined in Section 8 of the report.

The contract was presented to WPD's lawyers for review and the content to be revised into a format that would conform to the style of WPD's existing external contract documents. In addition to the standard legal terms, it was necessary to determine a description of the intended service along with the parameters that would be agreed by each site as their delivery capacity and means of delivery.

A simple pair of tables at the front of the contract detail the DSR parameters along with the contracted party and site or sites, in the case of the participating Aggregators. The second page contains the signing element of the contract. A screen shot of the contract is shown below:



**Demand Response Agreement - FALCON**

Between:

(1) Western Power Distribution (West Midlands) plc (company number: 0360057) whose registered office is at Avonbank, Feeder Road, Bristol BS2 0TB (**"WPD"**); and

(2) ____________ Limited (company number: ________) whose registered office is at ____________ (the **"Energy Partner"**).

| | |
|---|---|
| **Date of Agreement (date of signature):** | |
| **Season(s)** | 1st Nov 2013 – 28th Feb 2014<br>1st Nov 2014 – 28th Feb 2015 |
| **Availability Window** | 16:00 to 20:00 Monday - Friday (inclusive) |
| **Response Time** | **30** minutes |
| **Energy Partner Authorised Person(s)** | [insert name(s) of Energy Partner individual(s)] |
| **Contact Method** | [insert email address / telephone number] |
| **Control Room Contact** | Name: Gary Swandells<br>Email: ggswandells9@westernpower.co.uk<br>Telephone number: |

| **Site(s)** | **MPAN(s)** | **Agreed Capacity (MW)*** |
|---|---|---|
| | | |
| | | |
| | | |
| | | |

*Note: Agreed Capacity is represented in the Payment Calculation in Schedule 2 as "CM".

**Please note:** The parties hereby acknowledge that: (a) the provision of the Services; (b) the compliance with any Instruction issued by WPD; and (c) any participation in Project FALCON by the Energy Partner and/or its subcontractors is entirely voluntary.

OC_UK18078206.1

To the extent that the terms of this Agreement conflict with any of the rights or obligations of the parties under the Electricity Act 1989, the Utilities Act 2000, the Energy Acts 2008 – 2011, the National Terms of Connection and any other licences, codes or industry agreements related to such legislation (the **"Electricity Regulations"**), the terms of the Electricity Regulations shall prevail.

We agree to be bound by the Agreement (as defined in sub-clause 1.1 (Definitions and Interpretation) of the attached terms and conditions).

**Signed** on behalf of Western Power Distribution (West Midlands) plc:

*Signature*: ____________

*Name*: ____________

*Role*: ____________

**Signed** on behalf of: ____________:

*Signature*: ____________

*Name*: ____________

*Role*: ____________

OC_UK18078206.1

*Diagram 13: DSR Contract*

As a performance type contract, the third and fourth pages are for schedule 1 and 2;

1. Demand Response Procedure
2. The algorithms for how sites will be measured and payments calculated (section13.1)

The contract was condensed into a total seven pages, with the final three presenting the general terms and conditions.

A full copy of the contract is available as an appendix.

After the approved contract was available from the solicitors, it was circulated to the Aggregators. They were offered the opportunity to provide their views on the contract and, if satisfied, confirm that they wished to participate in the trials.. In order to provide help with the understanding of the algorithms, the contract was accompanied by some assistance notes containing supporting notes and graphical representations of the algorithms.. The diagrams can be viewed in section 13.1

Five of the six Aggregators contributed to two further revisions with minor changes that was then able to be approved by their own legal representatives. These were all completed and returned with the exception of (Ag7) who were not proceeding well with EP recruitment and therefore declined to complete the contract.

The general feedback received about the contract was largely very positive and in particular the benefit of the supporting assistance notes.

# 14. Back Office Systems

In order to operate the demand response programme it was necessary to determine the operational requirement and the payment calculations in a form that can be enclosed within the contract, as well as support the processing of back office assessment and payments.

Contained in section 131 are the calculations algorithms as authored by Iain Whiteside, a PHD student at Edinburgh University with significant experience of working within Demand Response programmes following a placement with the UK's first Aggregator. This work has been subsequently peer reviewed by Dr Alastair Martin. Alastair is a professional energy engineer with experience ranging from gigawatt-scale coal and nuclear power stations, through industrial energy efficiency, to very small embedded wind, solar and hydro generators. He founded the UK's first aggregated smart grid services provider and has extensive experience with payment calculations for DR services.

The calculations are detailed in the following sections.

## 14.1. Calculations

**Assumptions**

- A 24hr day is split into (24*60 = 1440) one minute segments. Time segment zero represents 00:00:00 to 00:00:59, segment 1 represents 00:01:00 to 00:01:59 etc.
- We write the site consumption (metered power reading) at the time segment *i=0…1443 as* $C_i$. We assume that the site consumption is measure in MW.
- Given a start time (ST) and finish time (FT) — written as time segments — we assume that the length of the DR event is inclusive of ST and FT. This means that the total number of segments in a call is **FT-ST+1**. For example ST=3,FT=10 is a DR event running through segments 3, 4, 5, 6, 7, 8, 9, 10 (a total of 8).
- We note that there are two separate cases for DR sites:
  - Sites that *generate* and thus **increase** generation in response to a DSR event.
  - Sites that *consume* and thus **reduce** consumption in response to a DSR event.

  The meter value is treated differently in each case to calculate the ***delivery***, which we write as $D_i$ (at time segment i).
- The starting value against which performance will be monitored is AvC. Although this period is a variable, the default duration over which average is calculated is 5 minutes.

**Payment Calculation**

*Generation delivery calculation*
For a DR site that increases generation during a DR event, we calculate the delivery as:

$$D_i = \max[C_i - AvC, 0]$$

That is, at time *i*, the delivery is the current generation minus the average generation before the event. This value is compared with 0 and a maximum is taken to exclude the possibility that generation *decreases* during a DR event: we do not want to record negative delivery.

*Consumption delivery calculation*
For a DR site that reduces consumption, the opposite formula is required:

$$D_i = \max[AvC - C_i, 0]$$

Again, this means that, at time *i*, the delivery is the difference between the average and the current consumption. If consumption has been reduced during a DR event then this will be positive. If consumption increased, the maximum calculation caps it at 0.

*Average delivery during a DR event*

Given a DSR event with average demand figure AvC, start time ST, finish time FT, we calculate the *average delivery* as follows:

$$D_{avg} = \frac{\sum_{i=ST}^{FT} \min(D_i, CM)}{FT - ST + 1}$$

where CM is the contracted capacity in MW.

This formula sums the ***capped delivery*** (calculated as the minimum of the delivery and the contracted capacity) for each time segment in the DSR event then divides it by the number of segments in a DSR event. This gives an average delivery in MW.

*Total delivery and payment value*

Using the average delivery and the length of the DR event in hours, we can calculate the cumulative delivery in MWh as follows:

$$D = D_{avg} \times (\frac{FT - ST + 1}{60})$$

Then, the payment is calculated from the price per MWh, which is set at £300:

$$Payment = D \times 300$$

**Diagram (A) – DR Measurement Schematic**

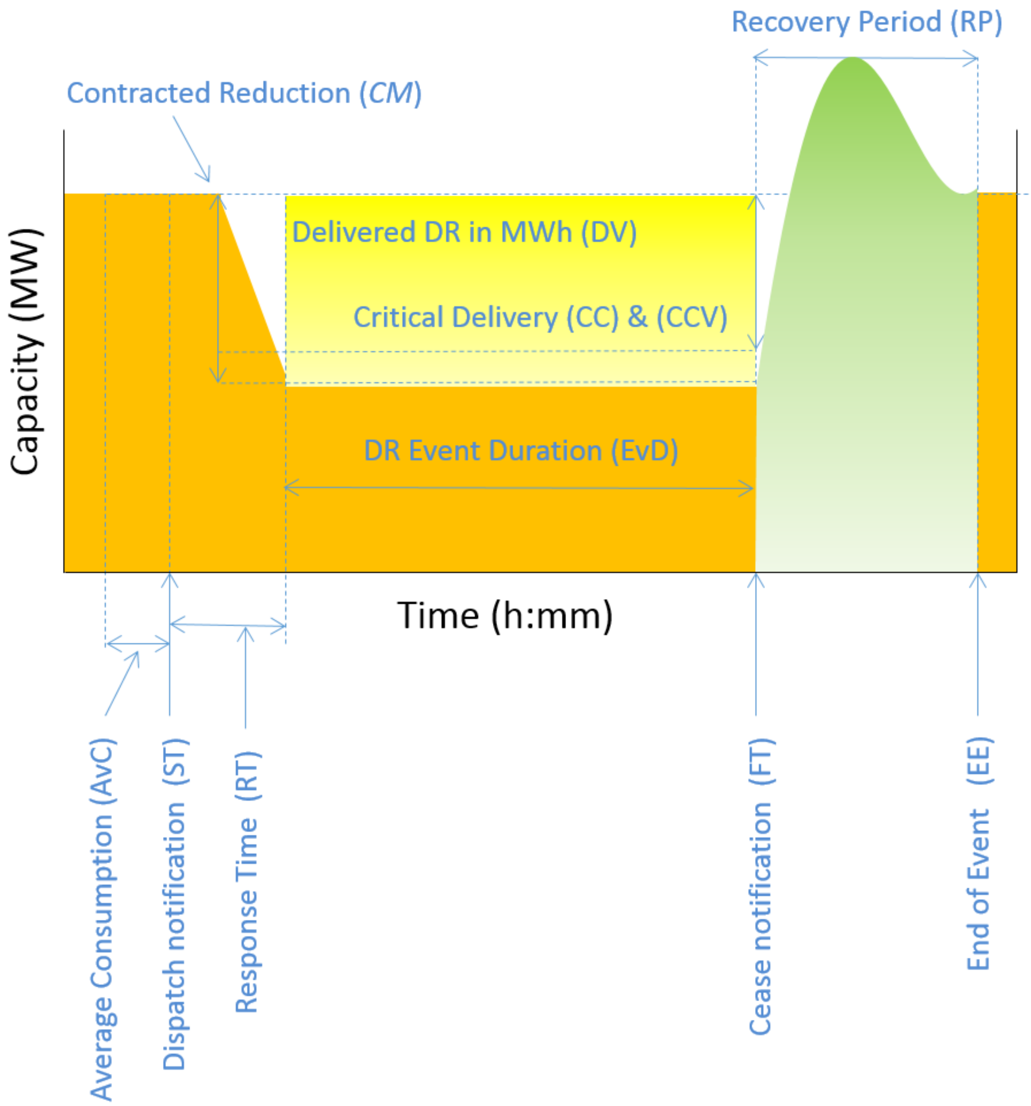



*Diagram 14: DR Measurement Schematic*

**Diagram (B) – DR Payment Schematic**

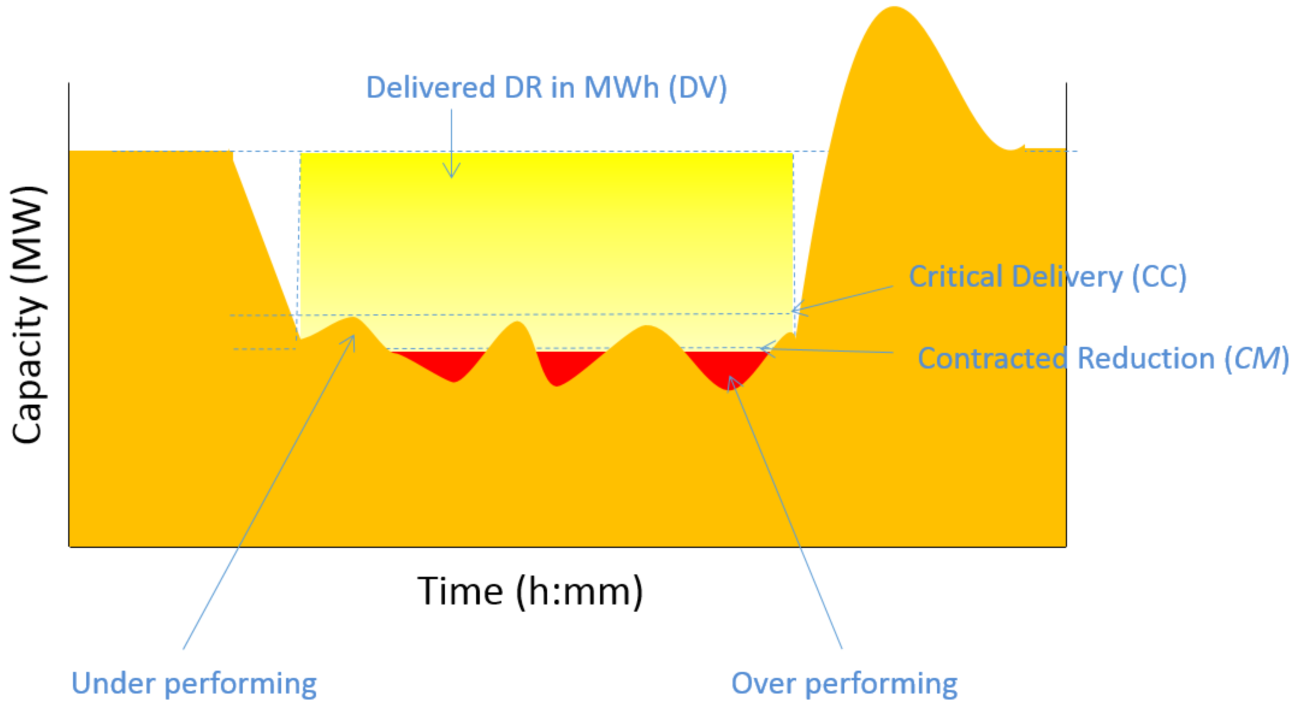



*Diagram 15: DR Payment Schematic*

## 14.2. Performance Contract Relationship

Within a BaU environment it is expected that the DNO will need to maintain ongoing relationships with the DSR provider, or an aggregator as an ongoing business activity. As a commercial service it cannot be assumed that, once a new DSR participant has completed the acquisition process (as outlined in section 10.3.1 and section 10.3.2) and are declared operational, a 100% performance will be achieved. There are many factors that could affect the potential reliability of a site, but through appropriate communications this may be influenced positively.

If DSR is not used regularly then it is likely to reduce in reliability, as outlined by some of the factors below:

- Change of energy usage at site, reducing flexibility or altering process time criticality;
- Change of management or operational staff and/or lack of training;
- Rarely tested generation is inherently unreliable;
- Limited familiarity with DSR process and expectations and
- Under investment in servicing and repairs.

In addition to the benefits of maintaining an ongoing relationship to ensure that the site conditions remain favourable to reliable performance, it is necessary to establish the function of account management. This will ensure that sites actively employed to provide DSR meet their targets and that payment processes follow as expected. If there are any deviations from the expected outcome for the DNO in the site performance, or for the site in relation to payment, this will require to be resolved by communications.

This would probably initially be provided by phone based first line support, but likely to require a face to face meeting in the event of any issues being escalated. Currently, there is not a similar roles contained within the DNO business structure. In order for DSR to be a BaU activity, this would be one of the prime areas where a gap analysis will need to be conducted in order to consider the extent of cultural change and new skills development. In the event that a DNO develops a service model that seeks to operate directly with participants it is likely that the challenge of developing such new capabilities will be significantly greater than if third party aggregators are employed. The requirement is not fully negated by outsourcing the DSR acquisition and operational functions as it would still be necessary to have a relationship management function for the aggregators.

## 14.3. Performance Assessment

Performance assessment is formulated to understand and analyse two important aspects of the Commercial Trials operation:

1) Functional assessment to establish impact, reliability, cost and potential benefit of using DSR as an alternative technique to manage constraints.
2) Operational function for the performance contract and financial settlement.

The functional assessment element is not a function of the back office system and has therefore been addressed in section 15.2 as a part of the 'Trial Operation.'

The data collected for the settlement process in the back office will also be used to assess the functional aspects of the commercial techniques. The output requirements of this are for to develop the necessary input data to the SIM, in order that the overall effectiveness can be measured against the other alternative techniques.

## 14.4. Financial Settlement

Financial settlement of the participants' role within the DSR service is a necessary aspect of the trials and any subsequent BaU operations. It was also deemed important and of great value to the industry to create a prototype back office system that would be designed around the DNO DSR 'use case' and contractual requirements. In order to provide a fair indicative cost for commercial techniques against the engineering alternatives which are predominantly large capital investments, it is vital to determine a 'whole life' cost.

By developing a back office system to manage the post event analysis and administration, the manual resource requirements should be reduced resulting in lower operational costs to the DNO. This should also present the additional benefits of creating a quicker and more accurate process than any manual process.

The calculations outlined earlier in this section are used to assess the performance within the software itself as well as within the contract to express the detail of what a participant is agreeing to in terms of their physical action. The action itself is measured in one minute increments and these are recorded on the daily file that should be submitted to the DNO the following day. Each file contains 1440 readings and if an event has occurred then between 65 and 105 of these should provide the necessary readings to provide an accurate indication of the event performance.

The software, therefore, needs to bring together a number of variable pieces of information for each customer to automate the financial settlement and provide customer statements, as outline below:

| Requirement | Source | Data type |
|---|---|---|
| Contracted Party | Contract | Static |
| Address | Contract | Static |
| Customer Reference | Contract | Static |
| Site(s) Name | Contract | Static |
| Site Address | Contract | Static |
| Unique ID | MPAN | Static |
| Generation or Reduction | Contract | Static |
| Contracted delivery value | Contract | Static |
| Critical Delivery % (de-rated capacity) | Programme parameters | Static |
| Response time | Programme parameters | Static |
| Maximum event duration | Programme parameters | Static |
| Minimum event duration | Programme parameters | Static |
| Event Notification time | Event records | Dynamic |
| Event cease time | Event Records | Dynamic |
| Daily data file | Data repository | Dynamic |

*Table 4: Billing System Requirements*

For the FALCON trials, the back office software was developed by CGI, SGC and hosted within the WPD restricted IT environment. This presented various challenges in creating a suitable test environment and establishing the permissions where FTP data files can be stored and accessed securely.

The operational release of the software was hosted as a packaged application creating a virtual environment that could be accessed by any WPD networked desktop PC. This could in turn access the participant data files that were stored within a secure DMZ (Demilitarized Zone) A DMZ (sometimes referred to as a perimeter network) is a physical or logical sub network that contains and exposes an organization's external-facing services to a larger and untrusted network, often the Internet. The purpose of a DMZ is to add an additional layer of security to an organization's local area network (LAN); an external attacker only has direct access to equipment in the DMZ, rather than any other part of the network.

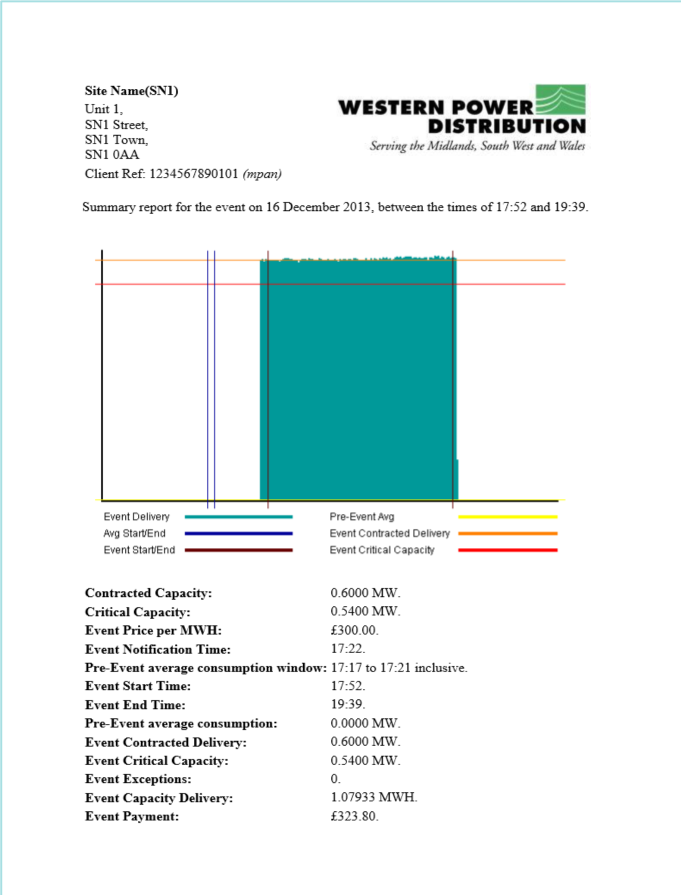
With the available data outlined in the table above, the software would retain all the necessary customer and site information that would typically remain static throughout the contract period of the service agreement. The dynamic information would then be uploaded against each participant for the dates on which events occurred. This should be a monthly process although due to a number of technical issues and ongoing software development this was not possible during the trials.

The general methodology of the software was to establish the baseline from which the measurement would take place by creating an average of the five consumptions values recorded prior to the event notification time. Thereafter, the event performance would be broken down into a calculation for each minute of the event that would assess the reduction against the agreed value to determine a binary success result as an overall record of failures that fall below the minimum de-rated delivery. This also generates a payment for each minute that is prorated with the incentive £300 MWh. This is repeated for each one minute increment until the event cease time is reached. From this a customer performance record is generated along with an event statement.

## 14.5. Procurement (Invoice / Billing / Payment)

The subsequent processes to complete the payments were completed manually within the trial but could be automated if sufficient volumes were able to justify the additional investment in systems development.

Each contracted party would receive a statement with a copy of all the individual site events as shown below and a summary with the total aggregated payment.


**Site Name(SN1)**
Unit 1,
SN1 Street,
SN1 Town,
SN1 0AA
Client Ref: 1234567890101 *(mpan)*

WESTERN POWER DISTRIBUTION
*Serving the Midlands, South West and Wales*

Summary report for the event on 16 December 2013, between the times of 17:52 and 19:39.



| | |
|---|---|
| **Contracted Capacity:** | 0.6000 MW. |
| **Critical Capacity:** | 0.5400 MW. |
| **Event Price per MWH:** | £300.00. |
| **Event Notification Time:** | 17:22. |
| **Pre-Event average consumption window:** | 17:17 to 17:21 inclusive. |
| **Event Start Time:** | 17:52. |
| **Event End Time:** | 19:39. |
| **Pre-Event average consumption:** | 0.0000 MW. |
| **Event Contracted Delivery:** | 0.6000 MW. |
| **Event Critical Capacity:** | 0.5400 MW. |
| **Event Exceptions:** | 0. |
| **Event Capacity Delivery:** | 1.07933 MWH. |
| **Event Payment:** | £323.80. |

*Diagram 16: Billing Software Statement*

If no concerns or disputes occurred with the contracted party they would then submit an invoice for payment that should then be processed for payment within 30 days.

# 15. Metering Standards

A requirement for the trial was to establish any specific metering standards during the initial stages, as many sites operated by aggregators would already have metering established. It was therefore accepted that, for the purposes of establishing a baseline from which we could test and identify whether this would be adequate for DNO purposes, the exiting metering would be acceptable if it could provide one minute granularity. As the primary service in which aggregator's sites are currently engaged is STOR, it was found that the majority of the generation sites were measured as a positive increase at the generator as opposed to a reduction at the point of import. This also determined that two separate processes needed to be created within the back office systems in order to fulfil settlement processes for both commercial techniques.

The metering at aggregator sites use a variety of physical devices ranging from the generators own controls to bespoke meters designed to communicate with their control centres. These were, on the whole, found to be of sufficient accuracy on which to settle the payment process. Issues did arise with the quality of the data file with a significant number of files received. The issues were:

- Interpretation of data file format;
- Intermittent submission of files and
- Missing fields corrupting the software file parser.

Some of these issues were addressed during the trial through additional training and process changes. The software was also revised at several stages through the trial and future functions identified to improve a full enterprise version.

With the directly contracted generation site at Anglian Water, (AW) it was agreed that we would be granted permission to trial an alternative metering solution. WPD SM (Smart Metering) would arrange the installation of a standard Elster A1700 meter that would be configured to one minute increments and installed directly to the output terminals of the generator. There was no current precedent for installing on a live generation asset so new policies were developed in relation to carrying out new commissioning work.

SGC provided an experienced engineer who developed a scope of works, method statement and resolved issues with WPD SM and AW's preferred contractor to support commissioning the site. Initial site surveys had to be arranged, metering components specified, ordered and assembled before a date for access could be arranged. Several dates were scheduled to install the meters and were delayed on multiple occasions due for a series of different reasons. A series of learning outcomes were achieved in relation to the process of scheduling and completion of the commissioning work, as outlined below:

- Availability of components for metering;
- Configuration of meter prior to commissioning;
- Ensuring adequate site access permissions;
- All necessary authorised personnel are available and briefed and
- Ensuring method statements and Scope of Works has been reviewed in advance by all parties.

Unfortunately, the meter specification was not suitable for its original intended purpose. in addition to active import, several parameters were being recorded and, as a result, the one minute intervals created a larger than expected data file for the data collector to receive before the meter timed out its daily download connection. The accumulation of data rapidly overwhelmed the limited the available meter memory, resulting in overwriting of information before it had been received in the data repository.

## 15.1. I.T. Requirements / FTP / Data Collection

WPD has a very stable IT environment operated by WPD IR. One of the core principals with the IT infrastructure strategy is to maintain security and minimise any external threats by maintaining a very stable environment without any direct access to services such as the internet. It was therefore potentially very challenging to operate a trial that required new software to be hosted within the secure network with access to files for external metering sources.

The initial suggestion by the FALCON Commercial Trials Lead to WPD IR was to keep the software standalone and operate the trial on a test environment on an independent PC or Laptop. WPD IR were keen to offer the trial their full support and ensure that the results were as real as possible, particularly with a reasonable expectation of commercial techniques becoming a BaU activity. The software was therefore tested for compatibility and packaged so as to be accessible via a virtual desktop arrangement. This would ensure that the software only existed centrally in a single release and no rogue versions could result from being installed on several machines. This not only allowed the software version control and licences to be managed, it would make the software accessible from any WPD networked desktop by users who were granted user permissions.

All of the aggregators were then given instructions and a test arranged to ensure that they could securely transmit the data files collected from site meters to a safe zone in the DMZ set up by WPD IR. The files would then be fully scanned for any threats before they would be made available to the data repository that could be accessed by the FALCON trials lead.

After the initial setup up, training and testing the IT / IR arrangements worked flawlessly and enabled that the back office software could be tested in a more challenging set of conditions reflecting those that would be expected in BaU.

## 15.2. Meter Types

In relation to the failures of the meter used for directly contracted site, the poor performance to date and the change of scope 2014/15 trial necessitated a change request to extend its scope. The increased number and importance of meters within the second season requires additional resources to ensure their successful operation. Therefore, in the Season 2 trials, WPD SM will be supporting a trial of two new devices that will be lab tested in a laboratory environment before installation at participant sites.

**Performance of Elster A1700 during Season 1**

Data was obtained from the meter in two methods:

1. Manually dialling the meter using the manufacturer’s engineering support software, Power Master Unit (PMU). This is a tool primarily meter configuration and investigation of faults and not suitable for ongoing data collection. PMU data collection was successful but due to the relatively large amount of profile data it is a very time-consuming activity requiring manual intervention.
2. Set up on SSIL’s data collection systems for automatic data retrieval. This was the planned method to obtain data during the project.

SSIL were able to set the meter up on their systems and retrieve data from the meter. However, the data was not complete both in terms of time periods where no data was retrieved and where data was not complete across all the channels set up on the meter.

SSIL's analysis showed in took a 45-minute GSM call to collect a single day of 1 minute profile data for a single channel. The requirement for the GSM network to sustain such a long call to retrieve data resulted in lots of failed calls and unreliable data retrieval.

The reason for this slow speed is the two-fold:

1. The primary reason is the Elster A1700 protocol. This can be traced back through ABB A1700 or PPM meter to the GEC PPM (early nineties) and before that the protocol was first used in an Opus data logger from the 80s. More recent meter protocols have taken advantage of modern communications methods and a greater understanding of data transmission resulting in significant improvement in data collection speeds.
   There is a further quirk in the Elster protocol requiring a whole day's data to be collected which removes the option to download multiple times per day resulting to benefit from shorter download times. Whilst the early calls would be shorter the last call of the day would still require the whole day to be downloaded taking 45-minutes.
2. The other factor is the communications mode. The data from the Elster was collected by CSD calls over GSM. This is slow and unreliable for such long call durations. Alternative meters would afford the opportunity to use GPRS data collection.

Reliable communications was more critical because the A1700 stored less than 3 days' data in its memory so that if the meter was not successfully downloaded regularly the profile data was lost. Typically in HH Settlement a meter has three months' of data stored to allow for delays in data retrieval; by Hand Held Unit if necessary.

There was a further complication in respect of time setting. With 1 min. profiling it is critical to get the meter correctly synchronised with GMT. However, the systems in place to do manage time and correct it are based around 30 min. profiling and although the impact of this needs further investigation there were significant issues with time drift which impacted data quality.

**Alternative Metering Solutions**

Two alternative metering solutions are to be trialled. Both meters will be installed locally at the same WPD site to get some actual and identical load on the meters.

1. EDMI Mk10A. This meter is widely used in the Advance Meter market – for smaller businesses just below the threshold to HH metered. The meter has a faster protocol and more easily supports GPRS communication. SSIL's testing show a single channel of 1 min data can be collected in under 2 min. compared to the 45 min. taken by the A1700.

2. CEWE Prometer. The Prometer is a more technically capable meter with two sets of independent profiles and communications ports. The meter has been requested by some of WPD Smart Metering's large distributed generation customers because of this increased capability; in particular it allows the customer to have their own monitoring systems connected to one of the two independent communications ports.

The purpose of the testing will be to establish the performance of the meters in the following respects:

1. Reliable collection of 1 min. import and export kWh data at Day+1
2. Reliable reporting of this data via FTP to WPD
3. Assessment of the time-stability of the meters and of the mechanisms to correct time given the narrow 1 min. width of the profiling
4. A comparison of the data from the two meters
5. An assessment of the time taken and cost to retrieve the data
6. An assessment of the ability of the meter to support by 1 min DSR data and 30 min Settlement data
7. Confirmation of the number of days' data stored by the meter in case of communications problems.

The trial will inform choices of metering solutions for the Season 2 trials.

## 15.3. Substation – Network Monitoring

In the Season 1 trials, the network monitoring did not require to be carried out at every primary substation therefore, only two substations were selected. Initially, two monitoring devices (Outram, Ranger PM700) were acquired from another project as a temporary solution to monitor the load at the substation. The primary function of the devices was to carry out comparative analysis on the impact of the action taken at the customer site and determine whether the resulting action on the network is predictable in terms of the load reduction experienced upstream. In order to provide suitable data, the Ranger was configured to take data readings at single minute intervals, allowing site and network data to be compared.


*Outram – Ranger Power Master 7000*

The initial data recorded by the Ranger device contained an extensive range of parameters, many of which did not offer any relevance or benefit relating to the purpose of commercial trials. There was also some difficulty in reading the results in a comparative manner as the data output provided by the ranger was in a format intended for reading and display by 'Pronto' software, packaged with the device.

The PM7000 has an extensive capability in excess of the parameters necessary for the commercial trials as it has limited engineering requirements to be investigated. Therefore when a request was submitted from the original project from which they had been acquired, to redeploy them for their original purpose, an alternative device was identified which aligned more appropriately with the FALCON test prerequisites.


*Eltek – Ranger Power Master 7000*

The PM7000 devices were replaced by Eltek Squirrel 1000 units installed to record the substation data in February 2013. The results recorded were not adequate for comparative analysis, as only three DSR events occurred in the final month giving too small a data set in order to be able to offer analysis with sufficient rigour to offer clear outcomes. The initial testing of the device at the end of the Season 1 trials has provided some positive initial data in a flat file format that is more suited to the comparative analysis desired. Season 2 trials will, as a result, be supplemented by additional devices that will record results at up to five primary substations. These are expected to be installed in September 2014 to allow calibration and testing ahead of going live on 1st November 2014Nov. The final commercial trials report to be published in 2015 will include the full results of the network monitoring.

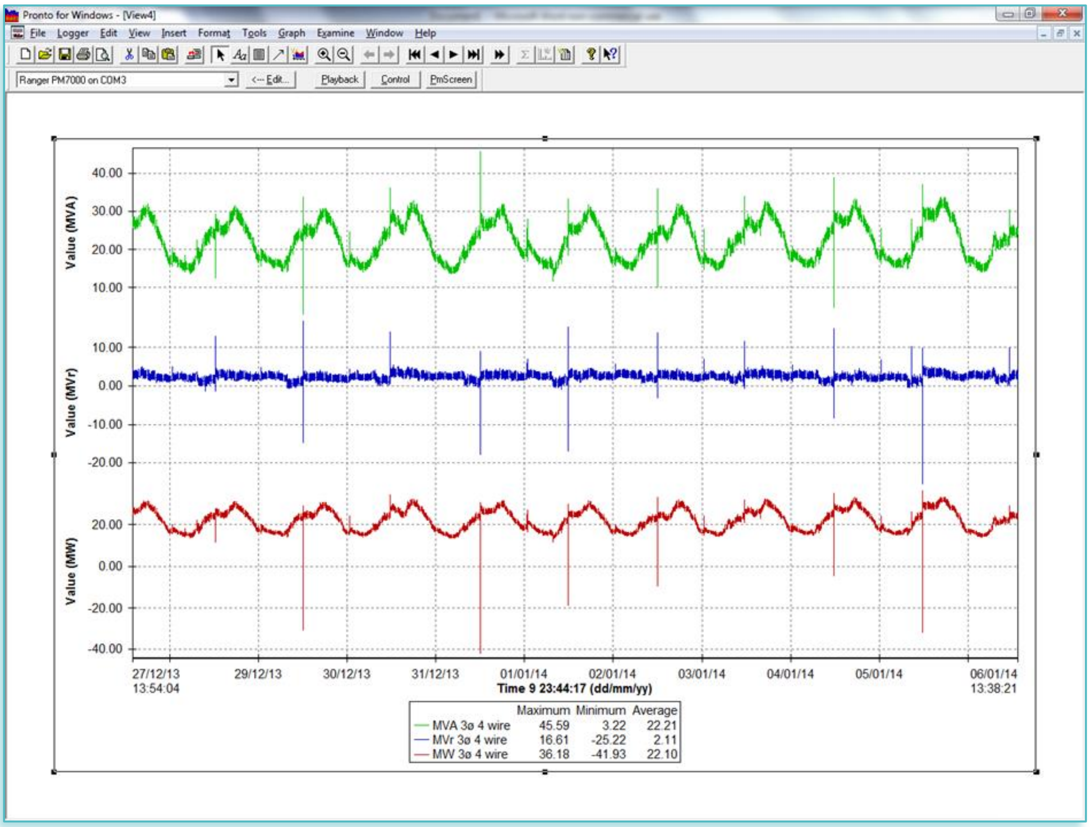



*Diagram 17: Desktop screen capture of Pronto software displaying Ranger Power Master*

# 16. Trials Operation

The distributed generation trials operation commenced on the 1st November 2013 as planned, with an expectation to run until the end of February 2014. Trials for T5 and T6 should have been operated in parallel over an identical time period but, due to the absence of any T5 recruits to test load reduction, a delayed initiation was offered to allow the three aggregators (Ag2, Ag3 and Ag4) with declared prospects the additional time required to ready their participants' sites. A further two additional attempts were agreed with the aggregators to offer every possible assistance to the T5 EP acquisition phase, but this was finally abandoned in April 2014. A further attempt will be made for season 2 trials, incorporating further changes in an attempt to improve the results.

The trials results for the remainder of section 17 of the report will therefore be referring specifically to T6 trials of distributed generation only.

## 16.1. Details

A total of 18 events were attempted with event number 3 on the 6th of December being prevented from taking place due to an unplanned outage event occurring on network. Permissions were sought from the Control Room duty manager but were not authorised due to the limited availability of network control engineers to check the Milton Keynes trial area due to the major incident elsewhere. The remaining 17 events were approved successfully by the Control room and the table below identifies when they took place and for how long. Due to the manual dispatch being made by one individual by phone contact, the start times were staggered and cease calls were also issued in the same order in an attempt to ensure that all sites completed approximately the same event durations.

| Event | Date | Time | Duration (h:mm) |
|---|---|---|---|
| 1 | 27th November '13 | 17:50 | 1:25 |
| 2 | 28th November '13 | 16:30 | 2:00 |
| *CANCELLED* | 6th December '13 | - | - |
| 3 | 9th December '13 | 16:10 | 1:40 |
| 4 | 12th December '13 | 16:00 | 1:54 |
| 5 | 16th December '13 | 17:20 | 1:46 |
| 6 | 20th December '13 | 17:00 | 1:47 |
| 7 | 9th January '14 | 17:05 | 2:00 |
| 8 | 10th January '14 | 17:45 | 1:46 |
| 9 | 14th January '14 | 16:45 | 1:53 |
| 10 | 15th January '14 | 16:20 | 1:32 |
| 11 | 17th January '14 | 17:25 | 1:42 |
| 12 | 22nd January '14 | 16:10 | 2:00 |
| 13 | 24th January '14 | 16:30 | 2:00 |
| 14 | 27th January '14 | 17:20 | 1:05 |
| 15 | 29th January '14 | 17:00 | 2:00 |
| 16 | 21st February '14 | 16:10 | 2:00 |

| | | | |
|---|---|---|---|
| 17 | 24th February '14 | 16:55 | 2:00 |
| 18 | 28th February '14 | 17:05 | 2:00 |

*Table 5: DSR Events attempted for T6 – Distributed Generation November 2013 – February 2014*

## 16.2. Performance Breakdown (Statistics Table)

One of the most critical statistics to be analysed within the trials operation was the reliability of DSR against conventional reinforcement or any of the other engineering alternatives being trialled. In order to be viable as a method with which to rely on for network support, DSR not only has to prove to be more economic, it must achieve similar levels of dependability. In order to do so, the benchmark should be in excess of 95% success for both availability and utilisation.

Availability was measured as declarations for whole weeks, and where the site would be unavailable for any portion of the week, it was recorded as a negative. In the event that an aggregator failed to provide a declaration by the Friday prior to the operational week, it would be automatically assumed to continue to be available or unavailable based upon its state the previous week.

Subsequently, once a site was declared available it would then be included in the utilisation reliability analysis. Utilisation already allows for a de-rated capacity only requiring 90% or above delivery of the contracted capacity. The site is then monitored and data provided at one minute increments. For each interval that the delivery is below the 90% minimum delivery threshold it is recorder as an EoD (Event of Default). With each of the 17 events that were successfully dispatched for the trial, if a participant failed to start or incurred greater than 5 EoDs it would be determined that the utilisation was insufficient and therefore the DSR event recorded as a failure to deliver.

No penalty was applied to the participant other than the loss of opportunity to earn the revenue from the FALCON trials.

## 16.3. Reliability

**Declared Availability**

The diagram below shows the declared availability of the T6 sites during the trials period and the performance against it.

| site | 04-Nov | 11-Nov | 18-Nov | 25-Nov | 02-Dec | 09-Dec | 16-Dec | 23-Dec | 30-Dec | 06-Jan | 13-Jan | 20-Jan | 27-Jan | 03-Feb | 10-Feb | 17-Feb | 24-Feb |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
| 1 | n | n | n | n | y | y | n | n | n | y | y | y | y | y | y | y | y |
| 2 | n | n | y | n | n | n | n | n | n | n | n | n | n | n | n | y | y |
| 3 | n | n | y | n | y | y | n | n | n | y | y | y | y | y | y | y | y |
| 4 | n | n | n | n | n | n | n | n | n | n | n | n | n | n | n | n | n |
| 5 | n | n | n | y | y | y | n | n | n | y | y | y | y | y | y | y | y |
| 6 | na | na | na | na | na | na | n | y | y | y | y | y | y | y | y | y | y |
| 7 | y | y | y | y | y | y | y | y | y | y | y | y | y | y | y | y | y |
| 8 | y | y | y | y | y | y | y | y | y | y | y | y | y | y | y | y | y |
| 9 | y | y | y | y | y | y | y | y | y | y | y | y | y | n | n | y | y |
| 10 | y | y | y | y | n | n | n | n | n | n | n | n | y | y | y | y | y |
| 11 | y | y | y | y | y | y | y | y | y | y | y | y | y | y | y | y | y |

*Table 6: Performance vs. availability of sites for T6 – Distributed Generation November 2013 – February 2014*

Across the period of the trial, the eleven aggregator sites were operated for a total of 17 weeks This created a maximum number of availability declarations that could be received of 187. This was reduced to 181 as site 6site6 was not fully commissioned due to connection permissions requiring to be provided by WPD and was only fully active in the trial week commencing 23rd December. Of the sites that were contracted and expected to participate throughout the trial period there was a total of 61 declarations stating they would be unavailable. The high level results were disappointing, only achieving 66.3% availability, well below the certainty that a DNO would require to rely on DSR as an alternative to engineering based options.

## 16.4. Sensitivities / Results

### 16.4.1. Communications

Despite the use of basic communications technology, employing email for weekly declarations and phone calls to manually inform of dispatch and cease times, the operational communications did not result in any failures to provide DSR.

### 16.4.2. Assets

The generation assets experienced a range of failures. These were not down to a common cause and a full detailed analysis of the events will be included following the conclusion of the Season 2 trials. Failures did include a catastrophic turbo failure on one site during a DSR event. This limited its role in the trial for almost three months until a repair was completed.

Failures were not limited to the stand by assets and a CHP site which is in regular use and produces several GWh of electricity also suffered a two week period of unavailability due to an unexpected issue relating to controls. This was rectified quickly and fortunately was available on all the dates during which events occurred and achieved a 100% performance in relation to utilisation

### 16.4.3. Metering

Metering also presented issues on a small number of occasions. When the aggregator operating the sites became aware of the metering issues during a DSR event they contacted the Commercial Trials Lead and were advised to cease their DSR event early to avoid operating but not capturing the data necessary to receive a settlement payment.

Other minor issues were also experienced in relation to the format and integrity of the provided data which are explained in section 15.4.5

### 16.4.4. Triad Interaction

One of the areas of additional interest was to map the interaction between triad avoidance activity between aggregators, electricity supplier and the potential DNO utilisation requirements. Unfortunately the winter of 2013 / 14 was a very unusual year with results that make it very difficult to extrapolate any conclusions from:

1) 25th November 2013, 1700-1730 *(period 35)*

2) 6th December 2013, 1700-1730 *(period 35)*

3) 30th January 2014, 1700-1730 *(period 35)*

An unseasonably mild winter with a great deal of damp conditions rather than any distinctly cold days made triad predictions very difficult to call for all parties participating. Consequently it would appear that all energy suppliers did not issue warnings to their customers on the 6th December. This is the first time in forty years that annual peak demand period has occurred on a Friday. This is due in part to the failure of all suppliers forecasting a high demand period coupled with very little variance between several of the winter high demand periods.

The analysis work in relation to triad interactions will be continued in to the second season to determine if there are any relationships between DNO requirements and other actors with an interest in managing national demand peaks.

### 16.4.5. Billing / Settlement

The software releases that CGI were able to provide during the trials process were early development forms of the software that did not include an easy to use graphical interface or many of the features that would be expected in a full release enterprise edition. The trial was able to demonstrate a scalable application that could store a large number of participants and events demonstrating its functionality to administer many variables for DSR programmes across a DNO's franchise area.

The processing of the events was coupled with software debugging and the early event processing experienced many difficulties due to inflexibility within the software to process files that did not adhere exactly to the format requested. This included process corruption even if a single data field contained within the metering files was incorrect or missing. This, in turn, highlighted data integrity issues with the data being received from more than one site on repeated occasions.

While the software was functional, the parallel development and debugging proved very time consuming. Consequently the trials were unable to meet the expected monthly timescales set out at the beginning of the trial for monthly statements and payments. On average the payments were 4 to 6 weeks behind and overall the aggregators demonstrated patience and understanding in relation to the delays. The screen shots below show the operation of the DRS software and the customer statement - an output of the software:

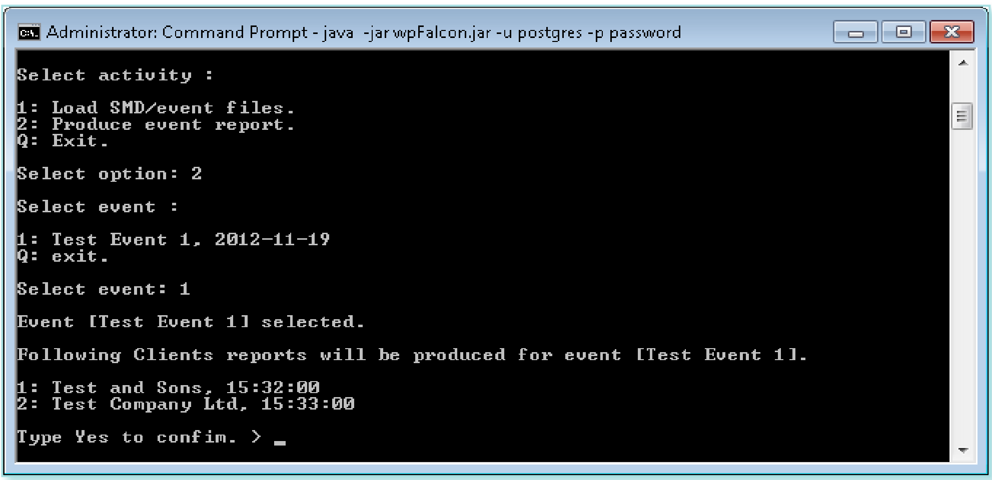



*Diagram 18: Output of DRS software*

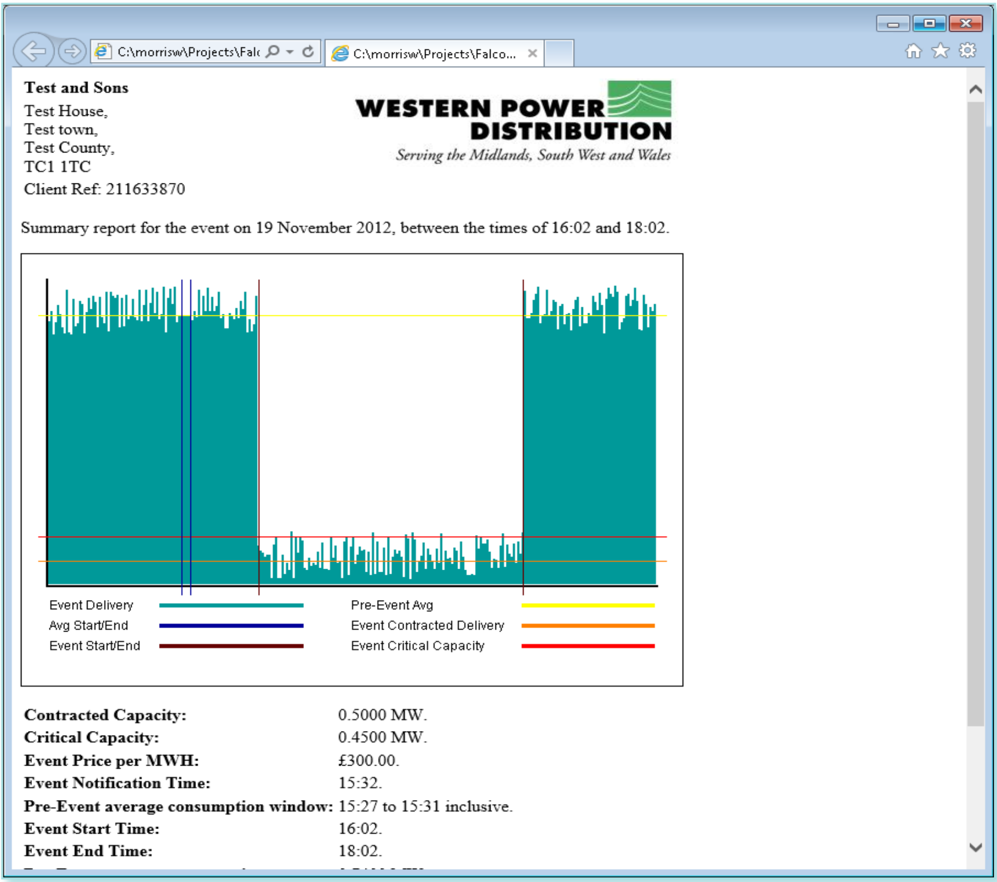



*Diagram 19: Output of DRS software*

Season 2 will require significant functionality developments in order to support the changes to the trials scope for 2014/15. Further information on the scope changes for the trials are published in section 20

### 16.4.6. Customer Report Samples

The software ultimately proved the efficacy of the calculation algorithms developed for the FALCON trial and supports measurement and settlement of the customer data in the manner set out in the initial design of the trials. Attitudinal analysis carried out in relation to the clarity and detail of the reporting was all positive with acknowledgement given to simplicity of understanding.

The statements shown below are actual results from the trial that have been anonymised.

Aggregator Name (Ag?)
1 Street Name St,
Town name,
TN1 0AA

WESTERN POWER DISTRIBUTION
*Serving the Midlands, South West and Wales*

**Payment Summary – December 2013**

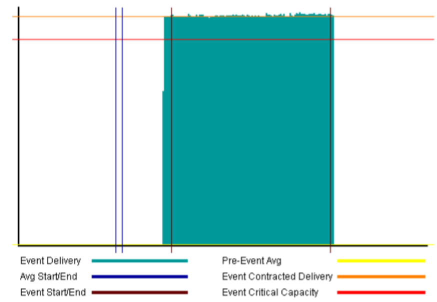
| Event Date | Site | Payment |
|---|---|---|
| 9th Dec | Site Name(SN1) | £302.81 |
| 12th Dec | Site Name(SN1) | £23.96 |
| 16th Dec | Site Name(SN1) | £323.80 |
| 20th Dec | Site Name(SN1) | £ 0.00 |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |
| | | |

| | |
|---|---|
| **Sub Total** | **£ 650.57** |
| **VAT** | **£ 130.11** |
| **Total** | **£ 780.68** |

**Site Name(SN1)**
Unit 1,
SN1 Street,
SN1 Town,
SN1 0AA
Client Ref: 1234567890101 *(mpan)*

WESTERN POWER DISTRIBUTION
*Serving the Midlands, South West and Wales*

Summary report for the event on 09 December 2013, between the times of 16:40 and 18:20.

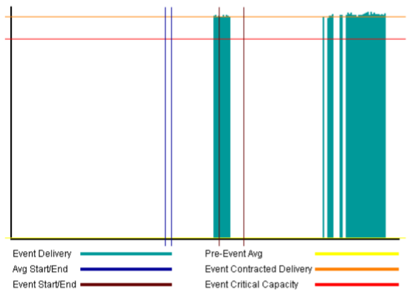



| | |
|---|---|
| **Contracted Capacity:** | 0.6000 MW. |
| **Critical Capacity:** | 0.5400 MW. |
| **Event Price per MWH:** | £300.00. |
| **Event Notification Time:** | 16:10. |
| **Pre-Event average consumption window:** | 16:05 to 16:09 inclusive. |
| **Event Start Time:** | 16:40. |
| **Event End Time:** | 18:20. |
| **Pre-Event average consumption:** | 0.0000 MW. |
| **Event Contracted Delivery:** | 0.6000 MW. |
| **Event Critical Capacity:** | 0.5400 MW. |
| **Event Exceptions:** | 0. |
| **Event Capacity Delivery:** | 1.00937 MWH. |
| **Event Payment:** | £302.81. |

**Site Name(SN1)**
Unit 1,
SN1 Street,
SN1 Town,
SN1 0AA
Client Ref: 1234567890101 *(mpan)*

WESTERN POWER DISTRIBUTION
*Serving the Midlands, South West and Wales*

Summary report for the event on 12 December 2013, between the times of 16:30 and 16:46.

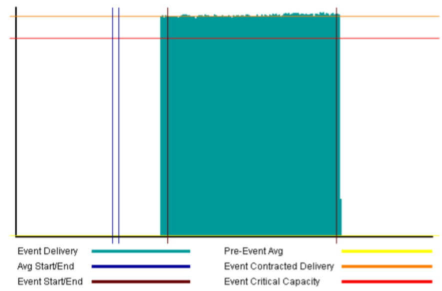



| | |
|---|---|
| **Contracted Capacity:** | 0.6000 MW. |
| **Critical Capacity:** | 0.5400 MW. |
| **Event Price per MWH:** | £300.00. |
| **Event Notification Time:** | 16:00. |
| **Pre-Event average consumption window:** | 15:55 to 15:59 inclusive. |
| **Event Start Time:** | 16:30. |
| **Event End Time:** | 16:46. |
| **Pre-Event average consumption:** | 0.0000 MW. |
| **Event Contracted Delivery:** | 0.6000 MW. |
| **Event Critical Capacity:** | 0.5400 MW. |
| **Event Exceptions:** | 9. |
| **Event Capacity Delivery:** | 0.07987 MWH. |
| **Event Payment:** | £ 23.96. |

**Site Name(SN1)**
Unit 1,
SN1 Street,
SN1 Town,
SN1 0AA
Client Ref: 1234567890101 *(mpan)*

WESTERN POWER DISTRIBUTION
*Serving the Midlands, South West and Wales*

Summary report for the event on 16 December 2013, between the times of 17:52 and 19:39.




| | |
|---|---|
| **Contracted Capacity:** | 0.6000 MW. |
| **Critical Capacity:** | 0.5400 MW. |
| **Event Price per MWH:** | £300.00. |
| **Event Notification Time:** | 17:22. |
| **Pre-Event average consumption window:** | 17:17 to 17:21 inclusive. |
| **Event Start Time:** | 17:52. |
| **Event End Time:** | 19:39. |
| **Pre-Event average consumption:** | 0.0000 MW. |
| **Event Contracted Delivery:** | 0.6000 MW. |
| **Event Critical Capacity:** | 0.5400 MW. |
| **Event Exceptions:** | 0. |
| **Event Capacity Delivery:** | 1.07933 MWH. |
| **Event Payment:** | £323.80. |

*Diagram 20: Statements derived from DRS software*

## 16.5. Key Learnings

### 16.5.1. Industry / Market

A primary focus of the commercial trials has been to understand in detail the broader market for commercial techniques and the potential role of a DNO amongst a growing number of actors and influences. This has helped with the development of a view that altered since the formation of the trials and one that will influence the Season 2 trials, scheduled to commence November 2014.

A comprehensive view of the Industry learning will be presented in the final trials report in 2015.

### 16.5.2. Environment / Carbon

WPD are working with CGI across all of the techniques being trialled to establish environmental and carbon impact of each. This work is ongoing and will be reported in the commercial trials report to be published in 2015, as well as provide an additional tier of learning that may support decision criteria used by the SIM.

### 16.5.3. Distribution Network Operators

In respect of the type of constraint expected that DSR will provide a potentially suitable resolution is likely to be defined by the following characteristics:

- Occasional or uncertain constraint (<20 events per annum);
- Short duration (<2 hours per event);
- Marginal in relation to total overall substation capacity and
- Feeding industrial and commercial sites that have sizable loads with flexibility or generation.

The diagram below shows that the ‘in-day’ requirement for DSR can be identified by the general shape of the red shaded area. The size of the area depicts the overall cost of operating the event.

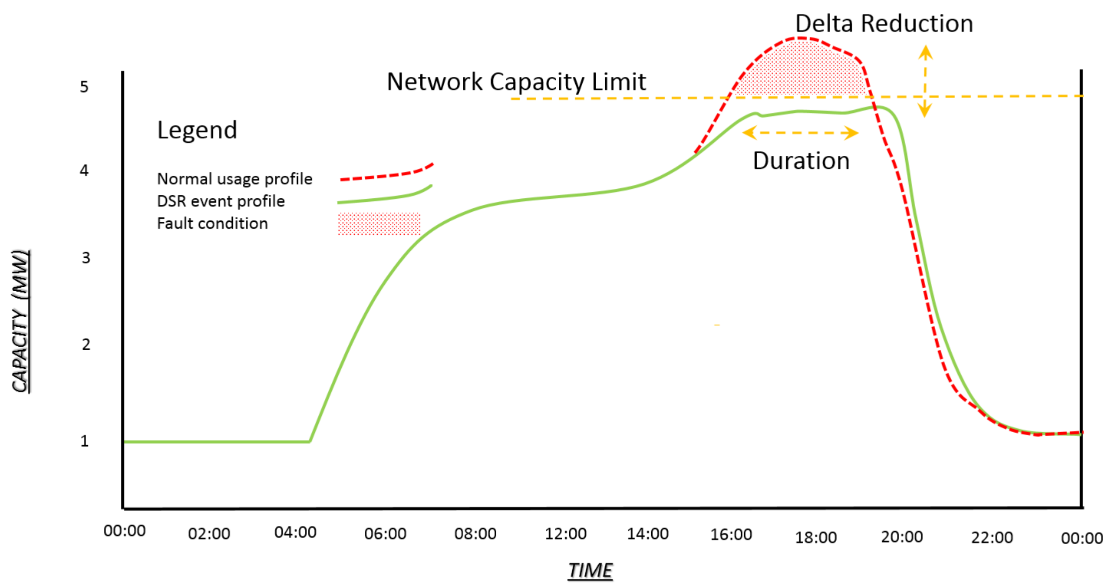



*Diagram 21: Load Profile of Constrained Substation*

## 16.6. Impact of Learnings

The interim learning captured and analysed within the commercial trials aspect of FALCON have already advanced the DNO view of DSR for constraint management. This has been to such an extent that the scope of the Season 2 trials has been extended to further build on the knowledge base and expedite the maturation of DSR to a BaU service.

Details of the changes to the ongoing trial scope and additional learning objectives can be found in section 20.

## 16.7. Attitudinal Analysis

Stakeholder engagement is a key part of Project FALCON ensuring that lessons learned from the FALCON trials are effectively captured and disseminated across the relevant stakeholder groups. It is also crucial to obtain the stakeholder's perspective on the approaches adopted in FALCON and to understand how the FALCON work meshes with the way these organisations operate. Engaging with key stakeholders to obtain their perspective formed the basis of this attitudinal analysis.

This section of the report provides interim findings about the stakeholder engagement work undertaken in Project FALCON in collaboration with the Open University (OU).

This section of the report is structured as follows:

- First we describe the approach to stakeholder engagement developed in this project. This was developed through three sets of inter-linked activities:

1. Stakeholder analysis;
2. Knowledge Capture & Dissemination and
3. Stakeholder Engagement Strategy.

- Secondly, we describe the method adopted to engage with key stakeholders to facilitate knowledge capture and learning.
- Third, we present the interim results from stakeholder engagement activities with relevance to the commercial trials.
- Fourth, we provide a summary and identify highlights from stakeholder engagement activities deployed so far in the project.

### 16.7.1. Approach to Stakeholder Engagement

**Stakeholder Analysis**

A stakeholder analysis took the meaning of 'stakeholder' from Freeman (1984) as "any group or individual who can affect or is affected by the achievements of the organisation's objectives". The stakeholder analysis involved:

a) Identifying key stakeholders;
b) Identifying stakeholder groups and
c) Identifying the nature and characteristics of each stakeholder group in relation to Project FALCON.

This stakeholder analysis will remain an ongoing activity throughout the Project. So far we have identified an extensive list of stakeholders relevant to Project FALCON, including those that may play a key role in the development of smart grids more generally. The stakeholders were identified from a series of interviews with participants in this Project and through a review of smart grid literature (e.g. policy and industry reports). While the stakeholders are multiple and diverse, we have identified key stakeholder groups, whose nature and characteristics are of particular relevance to Project FALCON. The interim findings from this stakeholder analysis are summarised in Table 7 below:

*Table 7: Stakeholder Analysis*

| Stakeholder Groups | Description and relevance to Project FALCON |
|---|---|
| Policy Developers & Regulators | Actors involved in developing national, regional and local policies and regulations to promote development of smart grids. |
| Electricity Generation & Supply | Actors involved in generating electricity and retail suppliers to customers. |
| Electricity Transmission & Distribution | Actors involved in electricity transmission and distribution. |
| Technology & Service Providers | Actors involved in facilitating development of smart grids through the technologies they develop and/or services they provide. |
| Customers & Communities | Actors engaged in practices that require electricity (e.g. industrial, commercial and domestic customers). |
| International Actors | Actors across the world relevant to the development of smart grids and demand side management techniques. |

The results from this stakeholder analysis are included in the Knowledge Capture & Dissemination framework developed in Project FALCON. This framework is described below.

**Knowledge Capture and Dissemination Framework**

The Knowledge Capture and Dissemination (KC&D) framework was developed by Project FALCON in collaboration with the OU. The purpose of this framework is to enable links to be made between the knowledge captured in Project FALCON and the interest of key stakeholders. The KC&D framework consist of three parts:

1. Knowledge capture: key lessons learned throughout the different work-streams of Project FALCON
2. Stakeholder groups: key actors with interest in the progress and outcomes from Project FALCON
3. Dissemination methods: this includes different methods of communicating knowledge generated from Project FALCON, so that key lessons learned throughout the Project are shared with key stakeholders.

This knowledge capture and dissemination framework includes learning generated within each work-stream of Project FALCON, including learning generated from engaging with external stakeholders. The strategy developed to engage with key stakeholders is described below.

**Stakeholder Engagement Strategy**

A stakeholder engagement strategy was developed to assist knowledge capture and learning generated from engaging with internal and external stakeholders throughout Project FALCON.  This strategy aims at constructing dialogue with key stakeholders (external and internal) to promote deliberation and learning for greater innovation of smart grids. The following idealised methods to engage with stakeholders are identified:

• Informing: one-way dialogue (e.g. social media, project reports, pod-casts) involving information about the project
• Consulting: two-way dialogue (e.g. interviews and workshops) with key stakeholders relevant to Project FALCON through which feed-back and comments from key actors can be gained.
• Collaborating: two-way dialogue involving in-depth collaboration with key actors to promote development of smart grids.

Having described the approach to stakeholder engagement developed in Project FALCON, we will now turn to the method deployed to engage with key stakeholder involved in the commercial trials.

**Method deployed to engage with participants in the commercial trials**
Following the first winter trials (2013-2014), a series of interviews were conducted with key stakeholders. The purpose of the interviews were to gain feed-back from stakeholders' experience from the trials and to enable multiple perspectives on the FALCON commercial trials to be gained. Key stakeholders included both those actors participating in the trials and actors relevant to the trials, but were unable to participate. An overview of key stakeholders identified through the commercial trials is provided in Table 8 below:

*Table 8: Stakeholder Categories*

| Stakeholder category | Description |
|---|---|
| Aggregators participating in the trials | Those actors who participate in the commercial trials through the aggregation service they provide. |
| Aggregators who were unable to participate in the trials | Aggregators who were invited to participate in the trials but were unable to. |
| Industrial and Commercial (I&C) Customers | I&C Customers who participate in the trials directly (i.e. not via an aggregator). |
| Internal stakeholders (WPD) | Actors and/or functions within WPD e.g. the control room. |

A semi-structured approach to interviews was selected for this stakeholder engagement activity. A semi-structured approach means that the interviews were structured in such a way that key informants were able to talk freely around predefined topics. The interview topics were developed by Project FALCON in collaboration with the OU. Moreover, interview topics were developed with reference to the role of each stakeholder category.  An overview of the interview topics and how the topics link to particular stakeholder category is provided in Table 9 below:

*Table 9: Interview topics and stakeholder categories*

| Interview Topics | Aggregators participating | Aggregators unable to participate | I&C customers |
|---|---|---|---|
| Information about the stakeholder (e.g. what they do) | X | X | X |
| What were you asked to do in the FALCON trials? | X | X | X |
| What needs to be done to enable commercial demand response to become business as usual? | | | |
| What did you consider to be the benefits/costs of participating? | X | X | X |
| Why did you participate? | X | | X |
| Why were you unable to participate? | | X | |
| Did you participation provide the benefits you expected? | | | X |
| What is your view on the contract in comparison with similar schemes? | X | | |
| What is the difference to working with other demand response schemes? | X | | |
| What if anything would you like to change for another trial? | X | X | X |
| Do you see any opportunities to work with your clients for demand reduction rather than generation? | X | X | |
| Consider a future when all electricity contracts included the option allowing I&C customers to be paid for generating and/or reducing electricity. Would this open up opportunities for your organisation? | | | X |
| What are the priority issues that need to be addressed in order to enable commercially driven demand response techniques? | X | X | |

The interviews were conducted by the OU after the first winter trials had been completed. A total of seven interviews were conducted with participants in the FALCON trials. The interim results are provided below.

**Interim Results – Lessons learned from engaging with participants in commercial trials**

The interim results from stakeholder interviews to date are presented in Tables 10 – 13 below.

*Table 10: Aggregators participating in the FALCON trials*

| Interview Topics | Aggregators participating |
|---|---|
| Information about the stakeholder (e.g. what they do) | Specialised in commercial demand response services involving both generation and load reduction. Services are provided for the National Grid and the Short Term Operation Reserve (STOR) programme, as well as other demand response programmes. |
| What were you asked to do in the FALCON trials | Aggregator firms provided generation. Existing relationship with client in the FALCON trial region (i.e. Milton Keynes) enabled participation. The established relationship with the client via the Short Term Operating Reserve (STOR) service was transferred to the FALCON trial.<br><br>Other clients were sought in the region, but it was noted by the aggregator firms that there was too little time to establish new relationships for this trial. Moreover, the investment needed to complete the necessary arrangement with clients to take part in the trial, may not be financially viable considering it is a trial and not an enduring programme. |
| What did you consider to be the benefits/costs of participating? | The trial presented an opportunity to take part in the development of a new demand response programme. More specifically, this includes the innovative activities of the trial and an opportunity to gain knowledge and understanding of what is going on in this part of the energy sector. Other benefits include the financial aspect and to reinforce customer relationship.<br><br>Benefits for clients include (1) financial aspects, and (2) opportunity to enhance company profile, including aspects of social responsibility in terms of making a contribution towards helping to resolve strategic energy challenges.<br><br>Cost of participating in the trial for the aggregator firm and its client include management commitments to set up the arrangement and operational costs related to the trial. |
| Why did you participate? | Project FALCON is seen as an opportunity to take part in the innovative activities of the trials and to learn more about the potential of commercial demand response programmes at a distribution level. |
| What is your view on the contract in comparison with similar schemes? | The contract was viewed as clear and easy to understand for both the aggregator firm and their clients.<br><br>It was noted that while the contract is useful for a trial, it is not seen as robust enough for a long term service e.g. STOR. |
| What is the difference to working with other demand response schemes | While the National Grids STOR is an established programme, the demand response scheme being trialled in project FALCON may open up opportunities for new forms of arrangements.<br><br>The contractual arrangement of STOR is more robust in terms of ensuring performance of aggregators and their clients. This include both utilisation-payment and availability-payment so that clients get paid to be on stand-by. Moreover, penalty arrangement are established if clients and/or |

| | |
|---|---|
| | aggregator fail to perform when required.<br><br>The FALCON trial only offers utilisation payment. Being paid only for utilisation is argued not to be cost-effective in the long term for clients.<br><br>The absence of penalty may also run the risk of attracting clients and aggregators that may not perform when required.<br><br>STOR services is automated and the FALCON trial is not. |
| What if anything would you like to change for another trial | To have some degree of automation would be useful for future trials.<br><br>The payment structure may need to change to facilitate the engagement of clients for future trials. Financial aspects to be considered is the investment needed for clients who are new to demand response programmes. Such payment structure could include both availability-payment and utilisation-payment. |
| Do you see any opportunities to work with your clients for demand reduction rather than generation | While there are opportunities for demand reduction, the challenge is to articulate the value of reducing electricity load as part of a demand response programme. For example, If a site can reduce its load they would do it permanently. |
| What are the priority issues that needs to be addressed in order to enable commercially driven demand response techniques | To explore the potential for various demand response programmes to co-exist and be compatible. For example, one approach may include development of demand response programme at a distribution network level that can work in parallel with demand response programme (e.g. STOR) at national level. Moreover, to ensure that demand response assets can be used in an optimal and intelligent way. |

*Table 11: Aggregators who were unable to participate in the FALCON trials*

| Interview Topics | Aggregators participating |
|---|---|
| Information about the stakeholder (e.g. what they do) | Specialised in commercial demand response services involving both generation and load reduction. Services are provided for the National Grid and the Short Term Operation Reserve (STOR) programme, as well as other demand response programmes. |
| What were you asked to do in the FALCON trials | Aggregator firms provided generation. Existing relationship with client in the FALCON trial region (i.e. Milton Keynes) enabled participation. The established relationship with the client via the Short Term Operating Reserve (STOR) service was transferred to the FALCON trial.<br><br>Other clients were sought in the region, but it was noted by the aggregator firms that there was too little time to establish new relationships for this trial. Moreover, the investment needed to complete the necessary arrangement with clients to take part in the trial, may not be financially viable considering it is a trial and not an enduring programme. |

| | |
|---|---|
| What did you consider to be the benefits/costs of participating? | The trial presented an opportunity to take part in the development of a new demand response programme. More specifically, this includes the innovative activities of the trial and an opportunity to gain knowledge and understanding of what is going on in this part of the energy sector. Other benefits include the financial aspect and to reinforce customer relationship.<br><br>Benefits for clients include (1) financial aspects, and (2) opportunity to enhance company profile, including aspects of social responsibility in terms of making a contribution towards helping to resolve strategic energy challenges.<br><br>Cost of participating in the trial for the aggregator firm and its client include management commitments to set up the arrangement and operational costs related to the trial. |
| Why did you participate? | Project FALCON is seen as an opportunity to take part in the innovative activities of the trials and to learn more about the potential of commercial demand response programmes at a distribution level. |
| What is your view on the contract in comparison with similar schemes? | The contract was viewed as clear and easy to understand for both the aggregator firm and their clients.<br><br>It was noted that while the contract is useful for a trial, it is not seen as robust enough for a long term service e.g. STOR. |
| What is the difference to working with other demand response schemes | While the National Grids STOR is an established programme, the demand response scheme being trialled in project FALCON may open up opportunities for new forms of arrangements.<br><br>The contractual arrangement of STOR is more robust in terms of ensuring performance of aggregators and their clients. This include both utilisation-payment and availability-payment so that clients get paid to be on stand-by. Moreover, penalty arrangement are established if clients and/or aggregator fail to perform when required.<br><br>The FALCON trial only offers utilisation payment. Being paid only for utilisation is argued not to be cost-effective in the long term for clients.<br><br>The absence of penalty may also run the risk of attracting clients and aggregators that may not perform when required.<br><br>STOR services is automated and the FALCON trial is not. |
| What if anything would you like to change for another trial | To have some degree of automation would be useful for future trials.<br><br>The payment structure may need to change to facilitate the engagement of clients for future trials. Financial aspect to be considered is the investment needed for clients who are new to demand response programmes. Such payment structure could include both availability-payment and utilisation-payment. |
| Do you see any opportunities to | While there are opportunities for demand reduction, the challenge is to articulate the value of reducing electricity load as part of a demand |

| | |
|---|---|
| work with your clients for demand reduction rather than generation | response programme. For example, If a site can reduce its load they would do it permanently. |
| What are the priority issues that needs to be addressed in order to enable commercially driven demand response techniques | To explore the potential for various demand response programmes to co-exist and be compatible. For example, one approach may include development of demand response programme at a distribution network level that can work in parallel with demand response programme (e.g. STOR) at national level. Moreover, to ensure that demand response assets can be used in an optimal and intelligent way. |

*Table 12: Customer participating directly in the FALCON trial*

| Interview Topics | Industrial & Commercial customer |
|---|---|
| Information about the stakeholder (e.g. what they do) | The I&C customer is a firm specialised in water supply and waste water treatment. Energy is one of the highest operating costs. A large proportion of energy is used for waste water pumping and aerating processes. The firm is a STOR service provider working directly for the National Grid. |
| What were you asked to do in the FALCON trials? | To provide generation from one of the firm's site when required. A stand-by generator was used for the purpose of this trial. |
| What did you consider to be the benefits/costs of participating? | The benefit of participating in the trial was to be involved at an early stage in the innovative activities. This was seen important considering that demand response at a distribution network level is novel with a potential to grow.<br><br>Moreover, development of demand response programmes provide firms who use large amount of electricity with an opportunity to make a contribution towards resolving some of the national energy challenges, e.g. security of electricity supply.<br><br>In terms of cost, it was noted that key individuals within the firm's organisation were required to commit time to facilitate and operate the trial. |
| Did your participation provide the benefits you expected? | The firm's participation in the trial provided the benefit they expected. However, it was noted that the time it took to become active in the trial was longer than anticipated. |
| What is your view on the contract in comparison with similar schemes? | The firm found the contract easy and straight forward. The contract was found to be similar to the contract they have with the STOR programme. |
| What if anything would you like to | The firm did not see any reason to change anything for another trial. |

| | |
|---|---|
| change for another trial? | |
| Consider a future when all electricity contracts included the option allowing I&C customers to be paid for generating and/or reducing electricity. Would this open up opportunities for your organisation? | The firm is participating in those demand response programmes provided by the National Grid that are suitable for their type of operations.<br><br>It was noted that stand-by generators that are owned by the firm and can be used for demand response programmes, may not be designed to run frequently throughout the year. Thus, if more options are made available to participate in demand response programmes, it may reduce the operational life of stand-by generators. |
| What are the priority issues that needs to be addressed in order to enable commercially driven demand response techniques? | Demand response programmes must be financially viable. The benefit of participating in the STOR programme is the availability-payment they offer.<br><br>To make sure that demand response programmes at distribution network level can work without being in conflict with other programmes. |

*Table 13: Internal stakeholder, the control room at Western Power Distribution*

| Interview Topics | Control Room |
|---|---|
| Information about the stakeholder (e.g. what they do) | The control room control the network and facilitates planned work. Practice of control include monitoring the network for issues that require a response to ensure that electricity is supplied to customers in a safe, efficient and effective manner. Planned work include the development and implementation of long term plans to maintain and/or reinforce the network. |
| What were you asked to do in the FALCON trials? | The control room were initially asked by project proponents to engage with customers during the trials. However, considering that this was a trial it was noted that any contact with customers should be managed within the trial and not by control room staff.<br><br>The role of the control room was therefore to control the state of the network during the trials. This required the shift manager to monitor the network in which the trials was taking place. It was noted that a procedure was needed that detailed what the shift managers were going to do when the trials were going live. |
| What is your view on the contract in comparison with similar schemes? | The control room has existing relationships with I & C customers who provide generation and/or load reduction when required. |

| | |
|---|---|
| What needs to be done to enable demand response to become business as usual? | It is recognised that the commercial trials cannot easily be deployed from it's current form into BaU. Implementing commercial techniques involving demand response require significant change in how the control room operate.<br><br>Commercial arrangements involving demand response measures may usefully be implemented so that it becomes an integrated part of the system that is already in place.<br><br>One approach to engage customers in a commercial arrangement involving demand response, could include a commercial constraint with automated control. |
| What did you consider to be the benefits/costs of participating? | Demand response can provide an additional capability to operate the network. While asset replacement and reinforcement measures are necessary, commercial arrangement could be added to the way the control room operates. |
| What are the priority issues that needs to be addressed in order to enable commercially driven demand response techniques? | A priority issue from a control room perspective is to ensure that demand response measures can be deployed in a reliable and safe manner. The reliability of customers' response (load reduction or generation) when requested by the control room to do so is of importance.<br><br>It is recognised that the commercial trials in it' current form involve a few participating customers. Deploying commercial demand response techniques on a larger scale may require a different arrangement to engage customers to deploy demand response measures. This could include automated arrangements. |

**Summary and Highlights**

Below we draw on the interim findings and raise key insights for further investigation

- The demand response programme deployed in the FALCON trials have similarities with the National Grid's STOR service, but there are also important differences.
    - **Similarities:**
        - The FALCON commercial trials were designed in such a way they enabled aggregator firms with experience of deploying demand response measures for STOR to participate.
        - Aggregators who were able to participate were those who had established relationships via the STOR programme involving customers situated in the region in which the trials were taking place. Aggregators could transfer their arrangement from STOR to the FALCON trials.
        - The customer participating directly in the FALCON trials was familiar with the demand response programme via their part in the STOR programme. Experience from the STOR programme was found transferable to demand response at distribution network level.
    - **Differences**
        - The National Grid's STOR programme is nationwide, while the demand response programme being trialled in project FALCON is restricted to a particular geographical region (i.e. Milton Keynes).
        - Aggregator firms have developed services that are suitable to the National Grid's STOR programme. While some services are transferable, others may not be easily transferred to the way Distribution Network Operators (DNOs) operate.
        - The contractual arrangement in the STOR programme involves both utilisation and availability payments, including penalties when pre agreed demand response parameters are not met. Project FALCON offered utilisation payment only.

- Priority issues that require further attention in order to enable commercial demand response programme at distribution network level include:
    - **Contractual arrangement**: while the contractual arrangement was seen by participants as useful and valid for a trial, a more robust contractual arrangement is needed for developing an enduring demand response programme at distribution network level. This may include similar aspects that are established in the STOR programme, e.g. availability payment and penalty arrangement.
    - **Automation**: it was noted by several key stakeholders that a more enduring demand response programme may require some degree of automation.

- **Compatibility:** It was noted by several aggregator firms that it may be useful to explore the potential for various demand response programmes to work in parallel to ensure optimal use of assets can be used for such measures.
- **Reliability**: any demand response programme has to work effectively and efficiently to be reliable for all stakeholders involved. This includes, but is not limited to: (1) commercial viability to enable the business case for demand response, (2) performance of service providers when required.
- **Engaging customers**: DNOs may have to learn how to engage with customers to enable a commercial demand response programme at distribution network level. There are several routes to engage customers such as (1) establishing direct relationship, (2) via aggregators or (3) other third party.

- Constructing further dialogue with key stakeholders is needed in designing and developing a robust demand response programme at distribution network level. Key stakeholders include, but may not be limited to:
  - **Demand side actors** (e.g. I&C customers) suitable for local demand response measures. Here we refer to demand side actors situated within the geographical area of the distribution network operator; and who have assets that can be used for generation and/or type of operations that allow for load reduction when required.
  - **Aggregator firms** have knowledge and experience about demand response measures; can link demand side actors with the distribution network operator to enable demand response programmes.
  - **The National Grid** is a key actor to engage in dialogue around demand response in order to avoid conflict with the STOR programme and the Triad scheme.
  - **Other Distribution Network Operators** in the UK and/or overseas with experience of deploying demand response measures may be useful to engage in dialogue with for the purpose of knowledge sharing.
  - **Regulator:** dialogue with the regulator of the electricity market (Ofgem) around deploying demand response measures may be of importance to develop an enduring programme at distribution level.

Development of demand response programmes at a distribution network level is at an early stage. It is therefore too early to draw some conclusions. Rather, we identify some discussion points to explore further. These discussion points include:

- How to engage customers to participate in demand response programme at distribution network level. This includes aspects of commercial viability to make the business case for demand response measures.
- The role of the Distribution Network Operator in commercial demand response programme. This may include practices of the control room through to development of commercial arrangements.
- Explore the potential for various demand response programmes to co-exist.

- How relevant institutions (e.g. regulations) have to change or adapt to emerging demand response programmes.

Drawing on these interim findings we suggest further investigation is needed to explore the roles and perspectives of key actors in development of demand response measures and programmes.

## 17. Summary / Conclusion

In many respects the trials have been a great success in the first year. The majority of the trials objectives were met during the first season trials including many significant developments for the industry and WPD alike. All key milestones were delivered on time and in accordance with the original plan for T5 and T6 as set out in the original LCNF bid and overall trials project plan. There were several major challenges during each phase of the project from the initial design and build through to the operational phase where the majority of the empirical data has been collected and allowed the range of learning objectives to be extended, resulting in a scope extension for the second year of operational trials.

To date the trials have successfully delivered key objectives:

- Overall plan for commercial trials;
- Assessment of a DNO requirement within a BaU environment;
- Identification of a market structure and barriers to BaU operation;
- An appropriate cost justification model for DSR;
- Established a trial environment;
- Created a performance contract for DNO DSR;
- Developed back office software for performance monitoring and settlement;
- Engaged the entire UK Aggregator sector for participation;
- Recruited T6 target capacity, meeting all diversity criteria to satisfy trial learning objectives;
- Recruited a directly contracted T6 participant for comparison with third party service providers;
- Engaged with wider industry of Network & System Operators to address market barriers;
- Execution of multi-site, multi-event DSR operational trial;
- Research to capture of post event attitudinal data;
- Collection of granular site data for performance assessment;
- Operation of new back office software for programme administration and
- Completion of phase 1 of T6 trials. On time and on budget.

There were several areas where the trials will require refinement to address the main failures of the first season as well as gain further data in order to complete all the original learning objectives that were proposed at the outset of Project FALCON:

- Acquisition of up to 1MW capacity for T5 load reduction trials;
- Operation of a functional Smart Meter solution for DSR;
- Improve DSR reliability rating for availability and utilisation and
- GAP analysis on DNO business to roll out DSR as a BaU service.

The interim findings presented in the report have already led to several observations that progressed the DNO view of DSR to date. Some of these new factors have to some extent devalued the original plan for Project FALCON to carry out two years of identical trials in order that the research could be further validated in the subsequent winter's operation. In particular the understanding of the current market and its barriers was broached within a working group that was chaired by the ENA and attended by the UK DNO's and National Grid.

The Energy Networks Association (ENA) Electricity Demand Side Response Shared Services group was established to provide an electricity network operator (distribution, transmission and system) perspective of how DSR could be utilised by different parties. It set out a potential sharing framework under which the electricity network operators would be able to jointly access DSR resources. The framework focuses on how network companies could maximise the DSR value chain within the price control periods for RIIO-T1 and RIIO- ED1, with particular emphasis on Distribution Network Operators (DNO) and National Electricity Transmission System Operator (NETSO). Further details regarding the findings and consultation published by the group are contained in section18.5.

The group developed a Shared Services Framework proposal that sought to address the conflicts between a DNO use case and the most commonly contracted balancing service STOR. This has a great deal of potential to enable participant to offer services to both a DNO and National Grid and we are therefore keen to incorporate a trial of some the main service requirements in the Season 2 FALCON trials. Some of the principals including week ahead notification of dispatch, presents the opportunity to address some of the outstanding objectives listed above.

Details of the change request and altered scope and objectives are listed in section 20.

The week ahead notifications may assist with a much needed improvement in the reliability of DSR for DNO use with constraint management which was a major learning outcome from the Season 1 trials. Based upon the current reliability statistics, it is very difficult to offer a recommendation to use commercial intervention techniques as a long term alternative to engineering based methods. There is however a growing case to use DSR as a shorter term solution to manage potential or transient constraint issues by operational methods rather than engineering upgrades to the network. This is particularly valuable while the investment case is not yet clear and the DNO is developing its well justified long term development plan.

With the changing use of electricity as highlighted in the early sections of the document, we expect to see increased volatility in the electricity demand profiles, as outlined in the table below. There are many factors that can, and will, interfere with making longer term predictions of what the future load characteristics will be on specific parts of the network

| Influence | Impact |
|---|---|
| Electrification of transportation | ↑ |
| Electrification of heating | ↑ |
| Energy Efficiency measures | ↓ |
| ToU Tariffs | ↔ |
| Businesses moves premises | ↓ |
| Businesses growth / expansion | ↑ |
| Embedded generation | ↓ |
| Government policy / incentives | ↕ |
| Domestic Smart Meters | ↓ |
| General growth in domestic consumer electrical goods | ↑ |

| KEY | |
|---|---|
| Increase demand | ↑ |
| Decrease demand | ↓ |
| Shift demand | ↔ |
| Conflicting impacts | ↕ |

*Table 14: Increased volatility in electricity demand profile due to changes in electricity usage*

DNOs require to continually upgrade and re-engineer the network, sometimes ahead of need but this can be made very difficult to predict with so many competing factors influencing the future demand. Therefore DSR can potentially play an effective role in the short term management of the investment decisions where the requirement is not certain or transient issues may occur. By contracting to use commercial intervention measures such as those being trialled within FALCON, it may be possible to avoid in making investment ahead of an established need or provide longer term solutions to ephemeral constraints. This would enable DNOs to improve financial performance without presenting unnecessary risks to the reliability of their networks.

If DSR is then required to be utilised for network support then this should trigger a review of the network planning to identify the best longer term course of action. The SIM can then be used to establish whether commercial techniques remain part of the optimal solution or whether a combination of any of the five other techniques modelled within FALCON are more favourable:

- Conventional Reinforcement;
- Dynamic Asset Rating;
- ; Automatic Load Transfer;
- Meshed Networks and
- Storage.

Additional research is also necessary to determine what additional barriers exist in relation to T5 Load Reduction, and the lack of participants presented that were willing or able to participate in the trials. This broadly reflects the disparity already found in other trials and DSR services where generation makes up the majority of capacity

## 18. Output to SIM

The full cost of operation will be determined during the remaining period of the trials to establish the true life cost of establishing a full BaU service along with all its associated components in addition to the payments to participants. This will require to include any costs for establishing a new department with sales and account management resources as well as those for systems development and is dependent on the completion of the gap analysis.

## 19. DSR Shared services

WPD's Tier 1 LCNF project Seasonal Generation Deployment was voluntarily ended prematurely due to vital learning outcomes relating to market barriers. These discoveries served as a basis to some of the objectives set out for the subsequent commercial trials incorporated within Project FALCON. The market barriers presented a substantial negative influence on widespread use of DSR by DNOs through the necessity to contract exclusively with a participant site. This conflict was primarily in association with National Grid's balancing service STOR.

In response to the identified issues the Energy Networks Association (ENA) Electricity Demand Side Response Shared Services group was established to provide an electricity network operator (distribution, transmission and system) perspective of how DSR could be utilised by different parties. It sets out a potential sharing framework under which the electricity network operators are able to jointly access DSR resources.

## 19.1. ENA Electricity Demand Side Response Shared Service Group Terms of Reference

The following is a copy of the Terms of Reference for the group as published in the Demand Side Response Shared Services Framework Concept Paper for industry consultation in April 2014.

**Introduction**
Demand Side Response (DSR) is being activity discussed in many areas within the electricity market as a tool which may potentially be utilised by multiple parties to assist in:

- balancing energy portfolios;
- balancing supply and demand in electricity networks;
- deferring and/or avoiding network investment and
- Addressing network constraint issues.

The Demand Side Response Shared Service Group will provide an electricity network operator (distribution, transmission and system operator) perspective of how DSR may be utilised by different parties and how DSR services could be developed in an inclusive manner that may potential allow multi-party use of a single DSR asset.

**Purpose and Aim**
The purpose of the group is to gain an understanding of the potential synergies and conflicts regarding multi-party use of DSR resources. In particular the group will focus on gaining:

- An understanding about how DSR is currently utilised by the network owners and operators;
- An understanding about how DSR could be utilised (and the benefits to the different parties involved); and
- An understanding of how DSR resources can be shared.

**Deliverables**
The group will have two key deliverables:

*Outputs*
The group will produce a report which will describe, from a networks perspective, how a DSR shared service model could potentially be developed. The report will provide:

- an overview of how DSR is currently being utilised by network operators and how the utilisation of DSR may potential develop in the future within the wide electricity market;
- a summary of a proposed shared service model (who uses it, when it is used and how is it used) along with the associated benefits, considerations and challenges; and
- a way forward identifying next steps in the initiative (including potential issues and challenges which would require resolution).

The report will be externally published and will provide the platform from which to further the discussions on this topic with other relevant parties through the appropriate industry channel.

*Reporting*
The group will report to the ENA Electricity Networks and Future Group (ENFG) and the Chair of the group will update the ENFG members at each meeting.

The group will provide regular updates to DECC's and Ofgem's Smart Grid Forum Workstream 6, given the close interaction in topic area.

**Membership & Logistics**
All ENA Electricity members, who have an interest in demand side response, will be invited to attend and actively participate in the group:

- Each ENA Electricity Member Company may appoint one or more representative(s) to sit on the group;
- The group will appoint an ENA Member Company representative to chair the group (nominally NGET representative);
- The secretariat for the Group will be provided by the ENA;
- Additionally the group may offer membership to external stakeholders (as and when appropriate).

The group will meet on a regular basis and normally meetings will be held at the ENA Offices in London. Following each meeting, the ENA secretariat will ensure that a record of action notes is completed and where necessary documents are circulated and actions followed up.

**Compliance**
The Group will at all times comply with the requirements of the 1998 Competition Act and will not deal with any matter which will or is likely to prevent, restrict or distort competition or constitute an abuse of a dominant position as construed within the Act.

## 19.2. Use Cases

The process applied within the group which met regularly for over a year sought to determine the exiting processes and how the key actors within the current market intend to use DSR for their differing needs. From this it was established that the use cases were different and that the contractual arrangement presented the greatest aspect of conflict.

The operational requirements have three key differentiators;

| Operational Requirement | DNO | TSO |
|---|---|---|
| Geographic sensitivity | Yes | No |
| Period of notice to dispatch | Long | Short |
| Availability of alternative capacity | Unlikely | Yes |

*Table 15: Operational requirements for DSR Shared Services Framework*

If the contractual challenges were not met and the status quo maintained it will establish a market price based on exclusive access to sites. The competitive conditions would create unjustifiable payments to participants in the majority of instances for a DNO to compete with National Grid. As both are ultimately funded by energy consumers it would be inappropriate to allow this condition to continue.

The variations between the operational requirements indicated that it may be possible to establish a single framework that allowed multiple access to a DSR asset. By doing so, it will be possible to;

- Address functional requirements of TSO and DNO in a cost effective manner;
- Demonstrate increased value to consumers;
- Improve conditions for DNO adoption of DSR;
- Increase the range of opportunities for DSR participants and
- Establish the principal of asset sharing.

## 19.3. Sharing Principles

The DSR shared service framework incorporated a number of key principles which provided a baseline against which the proposed framework concept was developed:

**Timeline**
The framework focuses on how network companies can maximise the DSR value chain within the price control periods for RIIO-T1 and RIIO-ED1, with particular emphasis on DNO and NETSO. (National Electricity Transmission System Operator)

It is acknowledged that the TOs (Transmission Operators) are considering how they could potentially utilise DSR for their network requirements and may in the future take an active engagement and interest in DSR services. However given the associated time scales, the main focus of the framework is the interaction between the DNO and NETSO requirements and the DSR service provider in the immediate future.

**Volumes**
It is anticipated that in the short to medium term, the volumes and frequency of DSR used by the DNOs will be small in comparison to that procured by the SO. If the volumes and frequency increased, the framework will be reviewed to ensure that it remain fits for purpose.

**Innovation**
The framework should facilitate innovation in how each party develops their DSR services given the individual specific requirements of the network companies (based on volumes and location).

**Multi Party Access and Interaction**
The framework considers the concept of more than one party (DNO and SO perspective) accessing a resource which provides a DSR service.

**Consumer Choice**
DSR service providers should have the commercial freedom and final choice to participate in the provision of DSR services to as many network companies as they choose

## 19.4. Proposal Summary

The group worked through the use cases and identified where there were areas of existing conflict and where changes to the current arrangements could enable increased synergy. A general concept for sharing was developed and two practical methods in which it could be implemented. The general concept was developed around the key differences in the operational requirements:

**Geographic sensitivity**
The primary function of the National Grid STOR service is to support system balancing on a National basis and for the majority of actions there is little differentiation on impact between participants regardless of location. For a DNO to benefit from DSR for constraint management it has to be located downstream of that point in the network, resulting in a critical requirement to be located within a restricted location.

**Period of notice to dispatch**
National Grid require to balance the system in real time and DSR events can be dispatched with as little notice as six minutes.

For pre-fault constraint management of the type that is being trialled in FALCON, a Control Room are likely to agree the need for DSR in advance as part of ongoing operational planning. While this is not currently a major activity within the operation of Distribution Networks, it is likely to increase as smart grids continue to develop. It was therefore assumed that a DNO could issue event notifications up to a week ahead.

**Availability of alternative capacity**
National Grid operates a tender process on an economic basis and will procure a variety of different sources of STOR including DSR and different types of power stations. The range of operational costs and diversity of asset type result in a large pool of capacity which will normally be dispatched when required in ascending price order. In the event that National Grid has agreed to relinquish the use of an asset under the sharing arrangements there should always be adequate remaining capacity, albeit a small marginal increase to the cost of a STOR event is expected.

The two models proposed are at this stage still restricted at this stage to general principals as depending on which is preferred there are still many details to resolve before a sharing model can be implemented. Some of these technicalities include the considerable likelihood that the asset may constitute a portion of a larger aggregated group and interaction with triads. Some of these specifics will be incorporated into the 2014/15 FALCON trials.

While the principal is very similar with the two proposed models, they establish different approaches as to the sharing of various components that make up the overall framework;

- Contract;
- System dispatch;
- Metering;
- Procurement and
- Monetary flows.

A consultation was published in April 2014, presenting the work of the group and the two approaches that address pre and post fault conditions for DNO constraint management:

- Alignment Path *(pre-fault only)*
- Asset Sharing *(pre & post-fault)*

### 19.4.1. Alignment Path

When the benefit from the DSR service is exclusive to one party, the 'Alignment Path' is most appropriate. The benefit of the 'Alignment Path' is in how procurement and utilisation of DSR services can be optimised to maximise the value of the DSR resources whilst acknowledging that parties (e.g. DNO and SO) cannot simultaneously dispatch the resource to meet the requirements of the respective parties.

*A circumstance when the alignment path may be utilised is outlined below:*

**The SO energy reserve products, DNO pre-event service**:

The DNO require the DSR resource to confirm their availability for pre fault conditions, DSR resource not available for selection by the SO.

For example, in circumstances where a NO may wish to peak shave in the winter to avoid/defer network investment, they may wish to use DSR as a cost effective alternative. Here the NO has pre knowledge of the peak and can plan the necessary actions and 'reserve' the DSR for the pre-event (i.e. the peak). In this situation, the DSR asset is locked out to the SO because of the known firm need of the NO. However during the summer, when the NO may not need the DSR service, it could be released for use by the SO and other parties.

The key benefit of this approach is the potential for increased procurement alignment which should enable the true economic costs of procuring DSR services to be reflected on the procuring party and facilitate the efficient procurement of the resources.
From an end consumer perspective it will ensure the network companies to consider and utilise the most cost effective solution to their network/system issue.

*The framework also proposes:*

- separate contractual arrangements between the DSR service provider and the relevant network companies;
- separate procurement strategies for the procurement of DSR services by the network companies;
- separate dispatch mechanisms for utilisation of the DSR services by the network companies;
- clearly defined data exchange arrangements between the network companies and the DSR service provider;
- clearly defined and complementary contractual arrangements (inclusion of any data sharing requirements) between the NO, SO and the DSR service provider; and
- the network companies are not adversely affected (monetary or service requirements) by the proposal.

### 19.4.2. Asset Sharing

In circumstances when the DSR services has no detrimental impact on either party (NO or SO), the framework proposes that an 'Asset Sharing Path' is most appropriate.

*A circumstance when the resource sharing path may be utilised is outlined below:*

**The SO energy reserve products, Network Operator post-event service:**

Both parties require access to the DSR resource with a single dispatch of the resource meeting both parties requirements; no detrimental impact.

In this situation the SO has a window of need (e.g. a balancing services window) but doesn't know when the need may occur. Likewise the NO knows there will be a need to use the DSR for a fault on the system but doesn't know when a fault may occur. Here there is no need for either party to hold the DSR from the other party as the DSR use could be mutually beneficial.

The key benefit of this approach is that the DSR resource is being used by multiple parties, negating the need for each service provider to procure additional DSR services and enabling more efficient use of the DSR resources providing increased value for money for end consumers.

*The framework also proposes:*

- separate contractual arrangements between the DSR service provider and the relevant network companies;
- separate procurement strategies for the procurement of DSR services by the network companies;
- separate dispatch mechanisms for utilisation of the DSR services by the network companies;
- clearly defined data exchange arrangements between the DNOs and the DSR service provider;
- clarity that the DSR resource is flexible and capable of fulfilling the contractual requirements of both the DNO and SO;
- clearly defined and complementary contractual arrangements (inclusion of any data sharing requirements) between the DNO, SO and the DSR service provider;
- clearly defined monetary flows for the payment of the DSR service by the appropriate network company and
- clarity as to when the electricity market accounts for the DNO use of the DSR resource.

## 19.5. Demand Side Response Shared Services Framework Concept Paper

The consultation published in April closed on the 16th May. The original published document can still be downloaded at the ENA Web Site:
http://www.energynetworks.org/modx/assets/files/news/consultation-responses/Consultation%20responses%202014/Demand%20Side%20Response%20Concept%20Paper_revised.pdf

At the time of authoring the interim FALCON report, the consultation responses had been received and were being collated by the group. It is the intention of the group to publish a 'next steps' document during the summer of 2014.

## 19.6. Next Steps

The development of a shared services framework could result in tangible benefits to the electricity market place and ultimately the end consumer by:

- revealing the value of DSR from a network perspective;
- clarifying interaction between network companies;
- raising awareness of market opportunities to (new and existing) DSR providers; and
- facilitating increased accessibility of DSR resources to the electricity market.

The proposed DSR shared service framework provides a pragmatic approach for developing the DSR market and ensuring that the value of DSR is accessible by the various market participants.

This consultation aims to seek the views of stakeholders (industry and non-industry) as to whether the ENA Electricity Demand Side Response Shared Services group has considered the issues and proposed pragmatic solutions to removing the current barriers to the multi-party use of a DSR resource.

The group is minded to take some or all of the following steps, contingent upon whether significant issues are identified within the consultation responses or not:

**Develop a common framework**

The group will consider whether to and/or how to combine the two shared service framework paths into a common framework. This could include, but not limited to, the following analysis:

- assess impact of DSR shared services framework pathways on existing processes;
- consider amendment options to existing contractual and commercial arrangements;
- clarify through desk top analysis the appropriate arrangements in the common framework.

The group believes that this first step is readily achievable.

**Understand the changes required to implement the proposed framework**

The group will develop a sensible delivery approach to implement the common framework taking into consideration how to engage with all stakeholders and embed the new arrangements. The group believes that this task is achievable.

**Develop an implementation plan, potentially testing the proposed framework in the electricity market through a trial**

The group proposes to consider the development of a pilot study, potentially under an innovation funded project, which will test the delivery approach before developing a full deployment implementation plan.

## 20. Distribution System Operator

There is a great deal of discussion across the energy market and beyond as to the expectation that a DNO will start to make the transition to becoming a DSO. The two terms sound very similar but they in fact are very different in terms of the roles and responsibilities that are associated with the two different organisational types.

There are several factors acting as catalysts within the developing energy and smart grids market that support the view that DNOs are well positioned to take a greater proportion of operational responsibility for the efficient use of energy. This will require a very extensive advancement in skills, resources and regulatory conditions to incorporate all the extra duties that would be expected of a DSO over and above the current DNO obligations to manage the delivery of electricity. Confusion can sometimes exist between the two terms as there is a lack of consistency across international markets, as some already use the term DSO for the role that is defined within the UK as a DNO.

The functions of a DSO include all those that are currently fulfilled by DNOs but with added obligation to actively optimise the network in much the same way that The SO does currently on a National basis and potentially incorporating aspects that would currently be the interest of suppliers. The table below outlines just some of the additional functions that implied that a DSO would be obliged to manage.

| Service | DNO | DSO |
|---|---|---|
| System Monitoring | X | X |
| System Automation | X | X |
| Fault Level Management | X | X |
| Voltage / Power Factor Control | X | X |
| Energy Storage | | X |
| Distributed Generation connections | X | X |
| Energy Management | | X |
| National Balancing Participant | | X |
| Distribution charging | X | X |
| Multi-Rate Time-of-Use Tariffs | | X |
| Dynamic Tariffs with increased locational granularity | | X |
| Local Balancing Services | | X |
| Distribution Network Constraint Management | X | X |
| Security | X | X |
| Local Energy Markets | | X |
| Demand Side Response | | X |
| Aggregation services | | X |
| Generation operator | | X |
| Energy trading | | X |
| Heat Networks | | X |

*Table 16: Additional requirements for a DSO*

Two of the most compelling factors that are often cited as giving the impetus for change are the growing interest in DSR and a nationwide rollout of smart meters, particularly within the domestic customer environment. This is because the role of users is also expected to change and customers will be expected to become active components of the network operation and management, with increased benefits available to those who can offer flexibility within the way they consume and / or generate. Naturally, this will require significant improvements in the understanding of users' requirements, enhanced network communications, alterations to regulation and advanced operational systems. This will take some time, but it is possible that provision of DSR will act as a transitional service and stimulate some of the more complex and structurally entangled to aspects of the current market to evolve.

## 21. Change Request

The learning achieved during the Season 1 trials offered an opportunity to for WPD to agree a variation to the final DSR operational trials in winter 2014/15.

As highlighted in section 20, the DSR Shared Services group have presented a principal for asset sharing that project FALCON is able to incorporate into the remaining tenure of the trials. This will help the industry develop an accelerated understanding of potential issues and viability the group proposals.

The inclusion of testing a new model will require a number of additional scope alterations. Three alternatives were therefore presented for approval to ensure adequate value would be achieved.

| No. | Title | Overview | Impact – learning |
|---|---|---|---|
| 1 | Re-run 2013/14 trials | • Run same T6 (DG) trials as before using same participants as generation fuel types and sizes and customer profiles achieved & no additional learning is likely to be gained.<br>• Re-open recruitment drive for T5 (turn down)<br>• Maintain £300pMW payment<br>• Replace Elster smart meter with one that works | • Direct comparison of the 2013/14 trials (with exception of T6 recruitment)<br>• Minimal additional learning<br>• Potentially no Demand turn down<br>• Will take into account new aggregators |
| 2 | Re-run 2013/14 trials and Increase payments to customers | • Run same T6 (DG) trials as before using same participants as generation fuel types and sizes and customer profiles achieved & no additional learning is likely to be gained.<br>• Re-open recruitment drive for T5 (turn down)<br>• Increase payments from £300pMW to £600pMW<br>• Replace Elster smart meter with one that works | • Minimal cost to project<br>• Direct comparison of the 2013/14 trials (with exception of T6 recruitment)<br>• Minimal additional learning<br>• Potentially no Demand turn down<br>• Will take into account new aggregators<br>• Assesses whether increasing costs motivates participants to T5, Turn down |
| 3 | Trial elements of DSR shared services report | • Week ahead notice rather than 30 min notice<br>• Measure customer performance by capping import or minimum export rather than a delta measurement.<br>• For T6, offer existing participants opportunity to take part<br>• Re-open recruitment drive for | • Implements elements of the Shared Services group report in a timely manner, which no other DNO is doing<br>• Reduces the ability for customers to ramp up load to glean as much payment from FALCON as possible<br>• Maximises learning and implements industry learning<br>• Potentially no Demand turn down<br>• Will take into account new aggregators |

| | | | |
|---|---|---|---|
| | | T5 (turn down)<br>• Trial two different types of smart meters<br>• Increase payments from £300pMW to £600pMW | |

*Table 17: Summary of Season 2 Options*

Option three was selected and approved, resulting in the addition of the following key objectives for delivery. The next steps are to:

- Present changes to scope to participants and aggregators;
- Confirm ongoing participants subject to programme changes;
    - Week ahead notification of DSR schedule;
    - Capped demand / Minimum export metering model;
    - Additional smart meter installation;
    - New contract;
    - New Payment model;
    - Double T5 payment to £600 MWh;
- Open participation to other aggregators;
- Recommence recruitment for T5 and any outstanding T6 capacity requirements;
- Develop new contract;
- Develop new back office software and
- Establish new learning objectives and additional methodology for analysis.

## 22. Glossary of Terms

| | |
|---|---|
| AW | Anglian Water |
| B2BB2B | Business to Business |
| Balancing Services | The NETSO supplements the Balancing Mechanism with forward contracts for a range of Balancing Services. The NETSO will enter into these agreements where it believes that it cannot source the service through the Balancing Mechanism, or it wished to reduce the costs of Balancing Mechanism actions by guaranteeing the available of certain units |
| BaU | Business as Usual |
| BM | Balancing Mechanism |
| CHP | Combined Heat and Power |
| CTL | Commercial Trials Lead |
| DAR | Dynamic Asset Rating |
| DCUSA | Distribution Connection and Use of System Agreement |
| DECC | Department of Energy and Climate Change |
| DMSDMS | Distribution Management System |
| DNO | Distribution Network Operator |
| DRDR | Demand Response |
| DSBRDSBR | Demand Side Balancing Reserve |
| DSM | Demand Side Management |
| DSO | Distribution System Operator |

| | |
|---|---|
| DSR | Demand Side Response |
| DUoS | Distribution Use of System Charge |
| ENA | Electricity Networks Association |
| ENFG | Electricity Networks and Future Group |
| EoD | Event of Default |
| EP | Energy Partner |
| EPRI | Electric Power Research Institute |
| EU-15 | Comprised of the following 15 countries: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, and United Kingdom. |
| FALCON | Flexible Approaches for Low Carbon Optimised Networks |
| FTP | File Transfer Protocol |
| GAP analysis | A technique that organisations use to determine what steps need to be taken in order to move from its current state to its desired, future state. |
| GDUoS | Generation Distribution Use of System Charge |
| GWh | Gigawatt Hour |
| I&C | Industrial and Commercial |
| IFI | Innovation Funding Incentive |
| kV | kilovolt |
| kw | Kilowatt |
| kwh | Kilowatt Hour |
| LCNF | Low Carbon Network Fund |
| LCT | Low Carbon Technology |
| LoU | Location of Use |
| M2M | Machine to Machine |
| MK | Milton Keynes |
| MPAN | Metering Point Administration Number |
| MW | Megawatt |
| MWh | Megawatt Hour |
| NETSO | National Electricity Transmission System Operator |
| NG | National Grid |
| NIA | Network Innovation Allowance |
| Ofgem | Regulator for the UK Energy Industry |
| OU | Open University |
| PC | Personal Computer |
| PPA | Power Purchase Agreement |
| RIIO-ED1 | The next electricity distribution price control which will set the outputs that the 14 electricity DNOs need to deliver for their consumers and the associated revenues they are allowed to collect for the eight-year period from 1 April 2015 to 31 March 2023. |
| RIIO-TD1 | The current electricity transmission price control which sets the outputs that the 3 electricity TOs need to deliver for their consumers and the associated revenues they are allowed to collect for the eight-year period from 1 April 2013 to 31 March 2021. |
| SBP | System Buy Price |
| SBR | Supplementary Balancing Reserve |
| SGC | Smart Grid Consultancy |
| SIM | Scenario Investment Model |

| | |
|---|---|
| SME | Small to Medium Enterprises |
| SO | System Operator |
| SSP | System Sell Price |
| STOR | Short Term Operating reserve |
| STP | Short Term Parallel |
| T5 | Technique 5 – Load Reduction |
| T6 | Technique 6 – Distributed Generation |
| TCMK | Thameswey Central Milton Keynes |
| TNO | Transmission Network Operator |
| TNUoS | Transmission Network Use of System Charge |
| ToU | Time of Use |
| TSOTSO | The System Operator |
| WPDWPD | Western Power Distribution |
| WPD IR | Western Power Distribution Information Resources |
| WPDWPD SM | Western Power Distribution Smart Metering |
| WS6 | Ofgem Work Stream 6 |

# 23. Appendices

## 24.1. Definition of DSM / DSR and the Marketplace

Demand Side Management (DSM) and Demand Side Response (DSR) seem to be regularly mistaken and confused with each other. For the purposes of clarity, and to ensure that the correct nomenclature is both understood and adopted in relation to the terms DSM and DSR, the correct definitions are provided below.

Energy demand management, also known as Demand Side Management, is the modification of consumer demand for energy through various methods, such as financial incentives and education. Usually, the goal of DSM is to encourage the consumer to use less energy during peak hours, or to move the time of energy use to off-peak times such as night-time and weekends. Peak demand management does not necessarily decrease total energy consumption, but could be expected to reduce the need for investments in networks and/or power plants for meeting peak demands. An example is the use of energy storage units to store energy during off-peak hours and discharge them during peak hours. The provision of DSM can also more broadly be regarded as any change of activity or behaviour from sites connected directly to the distribution network. This includes but is not limited to:

- Energy Efficiency / Reduction;
- Energy Storage;
- Distributed Generation;
- Dynamic Pricing;
    - Time of Use (ToU)
    - Location of Use (LoU)
- Smart Metering;
- Increased or Flexible demand devices (Electric Vehicles and Heat Pumps);
- Dynamic Demand; and
- *Demand Side Response (DSR).*

The term DSM was coined following the time of the 1973 energy crisis and 1979 energy crisis. Demand Side Management was introduced publicly by Electric Power Research Institute (EPRI) in the 1980s. Nowadays, DSM technologies become increasingly feasible due to the integration of information and communications technology and power system, resulting in a new term: Smart Grid.

You will note from the list provided, that DSR can be regarded as a sub-set of DSM.

Demand Side Response is defined as "actions voluntarily taken by a consumer to adjust the amount or timing of their energy consumption". Actions are specifically in response to a dynamic signal, and not to be confused with DSM behaviour incentives to follow predetermined price incentives. DSR is a reduction in demand designed to reduce peak demand or avoid system emergencies. Hence, DSR can be a more cost-effective alternative than adding generation capabilities to meet the peak and or occasional demand spikes. The underlying objective of DSR is to actively engage customers in modifying their consumption in response to programme providers' signals.

## 24.2. Purpose of DSR

In electricity grids, DSR is similar to dynamic demand mechanisms to manage customer consumption of electricity in response to supply conditions, for example, having electricity customers reduce their consumption at critical times or in response to market prices. The difference is that DSR mechanisms respond to explicit requests to reduce demand, whereas dynamic demand devices passively shut off when stress in the grid is sensed through automated sensors monitoring parameters such as frequency or voltage. DSR can involve actually curtailing power used or by starting on-site generation which may or may not be connected in parallel with the grid. This is quite a different concept from energy efficiency, which means using less power to perform the same tasks, on a continuous basis or whenever that task is performed. At the same time, demand response is a component of smart energy demand, which also includes energy efficiency, home and building energy management, distributed renewable resources, and electric vehicle charging.

Current UK DSR schemes are typically implemented with industrial and commercial participants, often through the use of dedicated control systems to shed loads in response to a request by the System Operator. Services (pumping, heating, air conditioning) are reduced according to a pre-planned load prioritisation scheme when instructed to respond. An alternative to load shedding is on-site generation of electricity to supplement the power grid.

DSR will typically reduce demand for various reasons which are specific to the programme provider, thereby reducing the peak demand for electricity for limited periods. Since electrical generation and transmission systems are generally sized to correspond to peak demand (plus margin for forecasting error and unforeseen events), lowering peak demand reduces overall plant and capital cost requirements. Depending on the configuration of generation capacity, however, demand response may also be used to increase demand (load) at times of high production and low demand. Some systems may thereby encourage energy storage to arbitrage between periods of low and high demand (or low and high prices). This type of DSR, sometimes known as 'Footroom' is out of scope for the FALCON trials.

There are three types of demand response - emergency demand side response, economic demand side response and ancillary services demand side response.

- Emergency DSR is employed to avoid involuntary service interruptions during times of supply scarcity. This may result from the failure primary plant such as a power station or wind farm and is not necessarily only applicable when annual system peaks occur. It may also be the case that this does not relate to a commodity shortage but instead a constraint that affects the ability to supply a specific geographic location. This is often overlooked as a form of DSR, as its primary purpose is to maintain continuity and the signal that is being responded to is generally either loss or threat of loss to the primary supplies.

- Economic DSR is employed to allow electricity customers to curtail their consumption when the product or convenience of consuming that electricity is worth less to them than paying for the electricity. Schemes of this nature are mostly focussed on benefits of trading and arbitrage and most likely to be operated by suppliers. It is expected these will increase in capacity in participant volumes significantly over the coming years as suppliers learn how to harness its value.
- Ancillary services DSR consists of a number of specialty services, as outlined in section 6.3. These services are needed to ensure the secure operation of system balancing and transmission. Some of these services have traditionally been provided by generators.

Different programme operators seek to achieve different impacts when they dispatch an instruction to participants to either increase generation or drop demand. This is likely to increase significantly in its use by all parties as we experience further development of Smart Grids. The previous diagram in section 5 represents an outdated view of the networks, where the expectation was that almost all generation occurred in large centralised plant and fed in a single direction without any great complexity. With many drivers including securing future energy supplies and encouraging more sustainable living, the networks require to adapt to the perpetually changing landscape.

In the past there were predictable loads served by large centralised generation. We now have increased variability in both load and, potentially, direction. As shown in the following diagram, current networks have solar and wind generation connected throughout the network at a range of voltages that are often convenient as a point of connection, but not necessarily beside a source of demand. The power flows therefore a greater level of monitoring and control to safely and efficiently operate the networks.

This supply challenges are further compounded by the undefined future demand profiles as we see further expansion within the electrification of transport and heating. It is therefore likely that interest will also swell as to how best the competing challenges of supply and demand can be used in a complimentary fashion through voluntary or mandatory schemes.

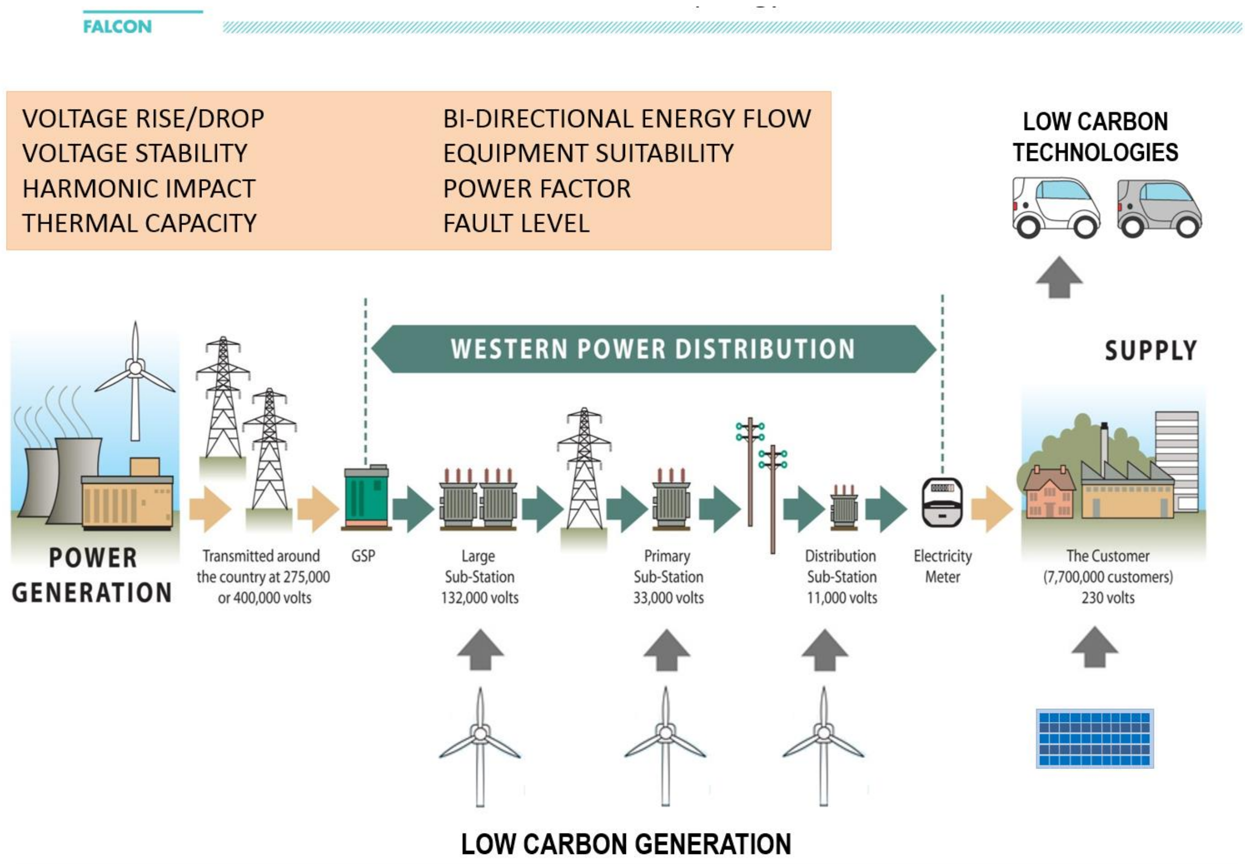



*Diagram 22: DNO Network Challenges*

## 24.3. Current Market

The current opportunities to offer DSR in the UK are generally focused on participation by the industrial and commercial sectors. The potential of the domestic properties is expected to be leveraged on the roll out of smart meters and is likely to still be several years away. The focus of this section is therefore restricted to considering either current or expected programmes aimed at primarily non-domestic involvement and its impact on the 11kv WPD network in the FALCON trials area.

DSR opportunities are typically operated as a performance contract with a small number of different models already being available within existing programmes. There are, however, a variety of potential 'use cases' for different actors within the energy industry. National Grid in the role of The System Operator, is currently the most mature programme provider and has utilised DSR in various forms for more than ten years. DNOs and suppliers can also potentially benefit from DSR programmes that may appear similar, however are being used for entirely different purposes. A third significant actor is expected to develop within the marketplace over the next few years as suppliers develop their own strategies to gain benefit from the potential efficiencies they can offer. With such different requirements it is possible that some services will be able to be operated alongside one another but it is more likely that conflicts will result in a shift from current conditions to one where increased participation is driven by escalating incentives.

Current programmes are not aimed solely at relatively small demand side contributors and still represent a minority within an increasingly competitive market. This market can include merchant power stations, dedicated farms of diesel generation and sizeable capacities from very large industrial consumers. Over recent years, over stimulation of the new demand side opportunities at a time when many merchant power stations were also shifting capacity into this area has driven down the rates for participation dramatically.

The broad spectrum of participant types has, however, created a diverse range of capabilities with variations around price, speed, volume, duration and locations. Some of these capabilities may be of varying value in different programmes and there might be conflicts in offering availability to multiple programme operators. Section 6.3 below provides context around the existing opportunities and some of the general conditions they require to be met to qualify.

## 24.4. Existing Programmes

Contained in this section is a high level summary of fully operational, existing programmes that can currently be participated in by sites connected to the distribution portion of the network. The information provided is indicative and may be subject to changes by the individual programme operators or other parties. If you require more detailed information on any of the programme requirements and incentives please contact the provider detailed.

### 24.4.1. Triad or TNUoS avoidance (Transmission Network Use of System)

**National Grid TNO (Transmission Network Operator)**

The “triad” system is the means by which industrial and commercial electricity consumers’ pay for the electricity transmission network in Great Britain. The triad system doubles up as a peak load management mechanism. Triad charges are part of Transmission Network Use of System (TNUoS) charges, which National Grid recovers every year from Licensed Generators (23%) and Licensed Electricity Suppliers (77%). The TNUoS charges which Electricity Suppliers pay for the consumption of their half-hourly (HH) customers are in the form of triad charges. The cost of owning and operating the transmission network is driven by the peak demand which the network must satisfy, (National Peak Load), and is higher where demand is high and generation is insufficient. The triad charging system has been designed to penalise consumption during peaks, especially in highly stressed parts of the network.

This encourages participants to optimise their demand or generation thereby mitigating their contribution towards the system's peak load. Peak loads are three HH periods on three days during a time period of five months each year (Nov-April). These three HH periods typically occur between 4.30 and 6.00pm. It takes 15-20 events during the five month period to contribute to peak shaving on triad days and for the participants to receive discount with 1kW granularity.

The “triad season” runs from the beginning of November to the end of February every year. Once the triad season is over and half-hourly meters have been read, the three half-hour periods of maximum demand are identified. It is expected most parties involved will require to act in 15-20 events during the five month period to achieve reductions on the three HH eventually declared. Prediction in advance is further complicated by the need for the three HH triad periods to be separated by at least ten clear days.

For each Electricity Supplier, its customers’ average consumption, in each network zone, over the three triad periods, is calculated. This is multiplied by the triad charge for that zone to create the total amount which the Supplier must pay to National Grid. The charges associated with TNUoS can appear to be disproportionate as during these three 30 minute periods with real terms increase from typical charges of as much as 10,000% depending on location and how a site procures its electricity. It is for this reason that over 1GW of capacity is minimised by participants’ seeking to reduce their usage and/or maximise export whenever there is a high expectation of National Peak Load being neared.

The 1GW reduction is made up of customers who are reduce their energy consumption during periods that are have a high potential of being declared as one of the three annual peaks. For some sites this is done by simply avoiding consumption during such periods, while others will use any on-site generation to supplement or avoid the mains supply from which the TNUoS charge is calculated. It is also possible to earn incremental revenue with the same level of disproportion in the event that the site has excess generation capacity and can export to sell the TNUoS benefit to an energy purchaser as part of their PPA (Power Purchase Agreement).

### 24.4.2. STOR (Short Term Operating Reserve)

**National Grid - SO (System Operator)**

Short Term Operating Reserve is one of National Grid's most important tools for securing the national electricity system in real time. It is also the most common and widely known UK DSR programme. In order to balance the supply and demand of electricity on short timescales, the UK National Grid has contracts in place with generators and large energy users to provide temporary extra power, or reduction in demand. These reserve services are needed if a power station fails for example, or if forecast demand differs from actual demand. National Grid has several classes of reserve services, which vary in several respects, bust most critically the speed and volume with which they can respond when required.

The fastest acting are frequency services, followed by Fast Reserve and then STOR. The response times for this service start at six minutes and extend out to as much as two hours, although such variability is reflected in both the prices and quantities that are accepted during the tendering exercises.

Under the STOR arrangements, National Grid pays a ‘rent’ (termed ‘availability’) for STOR capacity to be kept exclusively available during certain periods, and pays further a usage charge (utilisation) when the reserve is dispatched, such as during demand peaks, or when large power stations fail.

STOR is a year-round service, available to National Grid on a 24-hour basis, although most participants restrict their provision to The SO defined premium periods for which availability payment is offered. Availability is paid during key ‘windows’ where the system experiences rapid load change or peak demand. These windows vary seasonally, but generally fall within the period 07:00 to 22:30, and amount to roughly 11 hours per day. Most STOR utilisation occurs within these windows.

The STOR market has been growing in volume and overall value for several years, due to the reduction of flexible coal and oil electricity generation capacity, and the increase in forms of generation which can require increased levels balancing, such as renewables.

STOR is subject to a number of restrictions and conditions which include a minimum capacity threshold of 3MW. Above this capacity it is possible to tender directly to National Grid for the provision of STOR services or via the assistance of an agent. Prospective providers can choose to use an Agent to administer their tender process and, on their behalf, submit STOR Tenders to National Grid. National Grid perceives the role of an Agent as essentially a “go-between”, interfacing with both the prospective Reserve Provider and National Grid. National Grid is willing to deal with Agents provided that no part of the tender process or contracting process is hindered. It should be noted that using an Agent (or not) does not affect evaluation of STOR Tenders.

The alternative option for sites that either don’t have the 3MW minimum capacity at a single location or would rather defer the operational responsibilities to a specialised third party service provider. The role of an Aggregator is to develop and operate multiple sites (STOR Sub Sites) and offer these to National Grid as single STOR Site(s). This role is specifically different to that of an Agent.

Whilst an Aggregator can be an asset owner, typically an Aggregator will act on the behalf of one or more third party asset owners to submit “composite” STOR Tenders to National Grid. National Grid therefore perceives the role of an Aggregator as essentially a “Reserve Provider”, holding the STOR Contract itself whilst managing the necessary interfaces with the various individual asset owners. The role of aggregators vs direct service provision is explained in greater detail in Section 12 of the report.

Further information on STOR can be obtained from the National Grid’s web site, including detailed requirements, joining instructions and market information.
http://www2.nationalgrid.com/uk/services/balancing-services/reserve-services/short-term-operating-reserve

### 24.4.3. FCDM (Frequency Control by Demand Management)

**National Grid - The SO (System Operator)**

FCDM is required to manage large deviations in frequency which can be caused by, for example, the loss of significantly large generation. The service is a route to market for demand-side providers, and compliments other non-dynamic service provisions. The electricity demand is automatically interrupted when the system frequency transgresses the low frequency relay setting on site.

A FCDM participant must provide the service within two seconds of instruction and maintain delivery for minimum 30 minutes. Restrictions include minimum 3MW capacity which may be achieved by aggregating a number of small loads, typically at same site. This can be at the discretion of National Grid if contracting directly but can also be facilitated by aggregators. The role of aggregators vs direct service provision is explained in greater detail in Section 10 of the report.

Bid available capacity for load shedding based on bilateral contracts, triggered by drop in system frequency to a pre-agreed set point. The participant is rewarded only for availability not the utilisation. Events typically occur at up to ten occasions per year but failure to deliver diminishes all availability revenue. Suitable metering, an output signal and a type approved trigger relay are required in order to offer service.

Further information on Frequency Control by Demand Management can be obtained from the National Grid’s web site, including detailed requirements and joining instructions.[1]
http://www2.nationalgrid.com/uk/services/balancing-services/frequency-response/frequency-control-by-demand-management/

### 24.4.4. Energy Trading and Fuel Arbitrage

Energy trading and fuel arbitrage are opportunities only pursued by a small number of participants in the current UK market. There is a relatively high risk, as with other trading environments, they carry risks over and above those that are incurred in the provision of ancillary services programmes. The risk element in most service arrangements are limited to the loss of opportunity to earn or relatively small penalties in the event of delivery failure. When trading energy it is important that a site completes the action that was associated with their final 'position' in order to complete the transaction. This will generally involve agreements in relation to consumption of fuel, production or consumption of electricity. If the site fails to comply with the arrangement that were made in advance the exposure to negative costs can be of a magnitude many times more than the potential earning that were available. This is a specialist type service that is going to be attractive to some niche sites with advanced understanding of their energy needs and a great deal of operational flexibility.

On this basis we will not reviewing the opportunity in great detail as it is likely that it will be restricted to a small number of participants for the short term, and will only expand if energy pricing and market volatility increase significantly, improving the opportunity rewards for trading fuels and / or electricity.

## 24.5. Further Opportunities

### 24.5.1. DSBR (Demand Side Balancing Reserve)

**National Grid – The SO (System Operator)**

Demand-Side Balancing Reserve (DSBR) has been developed as a simple, low cost solution to stimulate rapid growth in the provision of demand-side services to the System Operator. DSBR has been designed to provide additional support to the SO in balancing the transmission system against a background of tightening capacity margins during 2014-18.
The following information has been extracted from the 'Open Letter to UK Electricity Market Participants, Industry Stakeholders and Large Energy Consumers: Volume and Procurement of new Balancing Sevices' dated 10th June 2014[2]:

'The volume requirements determined for this time period are set out below:

| Year | Maximum De-rated volume |
|---|---|
| 2014/15 | 330MW |
| 2015/16 | 1,800MW |
| 2016/17 | 1,300MW |
| 2017/18 | 800MW |

These represent the maximum de-rated volumes required. The actual volume required will be that which delivers best value for customers, balancing costs against value of lost load in accordance with the methodology, and will depend of the prices submitted in the process tendered for these services. Note that these volume requirements are de-rated values, and the actual volume procured will depend on how individual DSBR and System Balancing Reserve, (SBR), resources are de-rated. For example, if at 2014/15 requirement is met by DSBR, it is proposed to de-rate initially to 75%, and the actual volume procured will be up to 440MW in order to meet the 330MW de-rated requirement.'

The product is aimed at non-domestic consumers with the ability to reduce demand /load shift or run small embedded/on-site generation for at least an hour during the winter evening peak. At the highest level, this proposal would enable the System Operator to ask large energy users to reduce their demand in exceptional circumstances, and would remunerate them for doing so.

The service has been designed around demand reduction / load shifting, with low investment costs but high delivery payments that reflect the value that consumers place on the continuity of their electricity supplies. It is not intended to stimulate investment in new generation or storage facilities, but to tap into the huge potential for non-domestic consumers to reduce their demand in response to a strong commercial incentive.

This service is unlikely to be called frequently, if at all, during a winter period. However, in the unlikely event there is insufficient plant available to meet demand, consumers signed up to the scheme may be asked to reduce demand in return for a payment. There would be no obligation to respond or penalties for not responding; the scheme relies on payments for delivery as the incentive to deliver.

The DSBR product is designed to facilitate demand-side participation in balancing the system, which will become increasingly important as traditional thermal generation is replaced with increasing volumes of intermittent plant. DSBR should help develop the market for demand side resources to meet this growing need.

### 24.5.2. Footroom

**National Grid - SO (System Operator)**

A relatively new concept, where instead of reducing demand or increasing generation, an opposite action is required. Initial trials for this service by aggregators are currently being developed but at the time of authoring this report there are no commercially operational sites being paid to take action.

Need will grow with volume of installed intermittent renewables such as solar & wind. Capability to absorb excess generation is most likely to be required for critical balancing during the night when normal demand is low. It is also expected that relatively substantial minimum capacities are necessary in order to be of practical value to the System Operator in order to address the issues. Early indications also highlight that there is likely to be particular geographic sensitivities that will require to be considered when contracting and may present additional complexity where an aggregated group includes broadly distributed locations amongst the participants.

### 24.5.3. ToU (Time of Use) Tariffs

**Electricity Supplier**

Time of Use tariffs can be used as a pre-emptive method of managing the load on the system and will have impact in managing behaviour of users. As highlighted in section 22.1 there are key differences between DSM, where predetermined tariffs that alter and therefore predictable behaviour develops, and DSR, which is a dynamic response to an explicit signal. The current market for DSR in the UK doesn't generally offer mass market opportunities, where dynamic pricing signals result in meaningful volumes of demand or generation being shifted at short notice. There is, however, many supplier offerings based on time variable tariffs which can have an impact on DSR programmes with both positive and negative results. The supplier offerings can take a number of forms;

- ToU pricing where electricity prices are set for a specific time period on an advance or forward basis. This typically doesn't change more than twice a year. Prices paid for energy consumed during these periods are pre-established and known to consumers in advance, allowing them to vary their usage in response to such prices and manage their energy costs by shifting usage to a lower cost period or reducing their overall consumption;

- Critical peak pricing where ToU prices are in effect, except for certain peak days when prices may reflect the costs of generating and/or purchasing electricity at wholesale level;

- Real-time and dynamic pricing where electricity prices may change as often as half hourly. Price signal is provided to the user on an advanced or forward basis, reflecting the utility's cost of generating and/or purchasing electricity at a wholesale level; and

- Peak load reduction credits for consumers with large loads who enter into pre-established peak load reduction agreements that reduce a supplier planned capacity obligations.

In addition to the above, there are other time of day charging mechanisms operated by DNOs. These are explained in section 6.4.4 and 6.4.5 below.

### 24.5.4. DUoS (Distribution Use of System) Charge Avoidance

**Distribution Network Operator**

Every electricity customer's bill includes a Use of System charge. This is broken down into two elements. The first of these is the Transmission Network Use of System Charge (TNUoS). This is explained further in section 22..4.1.

The second element of the Use of System charge is the Distribution Use of System (DUoS) charge.

Distribution Use of System Charges cover the cost of receiving electricity from the national transmission system and feeding it directly into homes and businesses through regional distribution networks. The DUoS charge covers the costs of installing, operating and maintaining the regional distribution network, to ensure a safe and reliable electricity supply.

DUoS charges are made up of a variety of charges including:
- The availability/capacity supply charge
- Excess availability charge (applicable only if the agreed supply capacity is exceeded)
- Standing charge
- Reactive power
- Unit rates, which are split into three time periods; Red, Amber and Green. These charges vary per Distribution Company. Please see the chart below for the applicable time bands for each company.

| DNO | Band | Weekday | Weekend |
|---|---|---|---|
| **Western Power - Midlands, South West & Wales (EMEB & MIDE)** | **Red** | **16:00 - 19:00** | |
| | **Amber** | **07:30 - 16:00 & 19:00 - 21:00** | |
| | **Green** | **00:00 - 07:30 & 21:00 - 24:00** | **all day** |
| **Western** | **Red** | **17:00 - 19:30** | |

| | | | |
|---|---|---|---|
| Power - Midlands, South West & Wales (SWALEC) | Amber | 07:30 - 17:00 & 19:30 - 22:00 | 12:00 - 13:00 & 16:00 - 21:00 |
| | Green | 00:00 - 07:30 & 22:00 - 24:00 | 00:00 - 12:00 & 13:00 - 16:00 & 21:00 - 24:00 |
| Western Power - Midlands, South West & Wales (SWEB) | Red | 17:00 - 19:00 | |
| | Amber | 07:30 - 17:00 & 19:00 - 21:30 | 16:30 - 19:30 |
| | Green | 00:00 - 7:30 & 21:30 - 24:00 | 00:00 - 16:30 & 19:30 - 24:00 |
| NorthEast (YELG) | Red | 16:00 - 19:30 | |
| | Amber | 08:00 - 16:00 & 19:30 - 22:00 | |
| | Green | 00:00 - 08:00 & 22:00 - 24:00 | all day |
| NorthEast (NEEB) | Red | 16:00 - 19:30 | |
| | Amber | 08:00 - 16:00 & 19:30 - 22:00 | |
| | Green | 00:00 - 08:00 & 22:00 - 24:00 | all day |
| London Power (LOND) | Red | 11:00 - 14:00 & 16:00 - 19:00 | |
| | Amber | 07:00 - 11:00 & 14:00 - 16:00 & 19:00 - 23:00 | |
| | Green | 00:00 - 07:00 & 23:00 - 24:00 | all day |
| Eastern (EELC) | Red | 16:00 - 19:00 | |
| | Amber | 07:00 - 16:00 & 19:00 - 23:00 | |
| | Green | 00:00 - 07:00 & 23:00 - 24:00 | all day |
| South Eastern (SEEB) | Red | 16:00 - 19:00 | |
| | Amber | 07:00 - 16:00 & 19:00 - 23:00 | |
| | Green | 00:00 - 07:00 & 23:00 - 24:00 | all day |
| North West (NORW) | Red | 16:30 - 18:30 & 19:30 - 22:00 | |
| | Amber | 09:00 - 16:30 & 18:30 - 20:30 | 16:30 - 18:30 |
| | Green | 00:00 - 09:00 & 20:30 - 24:00 | 00:00 - 12:30 & 18:30 - 24:00 |
| Scottish Hydro (HYDE) | Red | 12:30 - 14:30 & 16:30 - 21:00 | |
| | Amber | 07:00 - 12:30 & 14:30 - 16:30 | 12:30 - 14:00 & 17:30 - 20:30 |
| | Green | 00:00 - 07:00 & 21:00 - 24:00 | 00:00 - 12:30 & 14:00 - 17:30 & 20:30 - 24:00 |
| Southern Electric (SOUT) | Red | 16:30 - 19:00 | |
| | Amber | 09:00 - 16:30 & 19:00 - 20:30 | |
| | Green | 00:00 - 09:00 & 20:30 - 24:00 | all day |
| Manweb | Red | 16:30 - 19:30 | |

| | | | |
|---|---|---|---|
| (MANW) | Amber | 08:00 - 16:30 & 19:30 - 22:30 | 16:00 - 20:00 |
| | Green | 00:00 - 08:00 & 22:30 - 24:00 | 00:00 - 16:00 & 20:00 - 24:00 |
| Scottish Power (SPOW) | Red | 16:30 - 19:30 | |
| | Amber | 08:00 - 16:30 & 19:30 - 22:30 | 16:00 - 20:00 |
| | Green | 00:00 - 08:00 & 22:30 - 24:00 | 00:00 - 16:00 & 20:00 - 24:00 |

*Table 18: DUoS charging time bands per DNO*

The DUoS tariffs are calculated using a combination of two charging methodologies. The first methodology is called the Common Distribution Charging Methodology (CDCM) and it is used to calculate charges to users who are connected to the LV and HV levels of the network. The second methodology is the EHV Distribution Charging Methodology (EDCM) and it is used to calculate site specific charges to users who are connected to the EHV levels of the network.

The methodologies are incorporated into the Distribution Connection and Use of System Agreement (DCUSA). This agreement governs the contractual relationship between DNOs and users of the networks. This agreement also sets out the methodologies and the procedure for interested parties to propose changes.

Both the CDCM and EDCM are common charging methodologies used across Great Britain by all DNOs. The methodologies were developed through joint collaboration between DNOs, Ofgem and interested stakeholders. The CDCM was implemented in April 2010 for both demand and generation users connected at LV and HV. The EDCM was implemented in April 2012 for demand users connected at EHV and in April 2013 for generation users connected at EHV.

While the methodologies are identical across all DNOs, the inputs to the methodologies reflect the characteristics of the network and the number and characteristics of consumers in each DNO area.

Charging commonality has brought a number of benefits to Suppliers and other users of the distribution networks. The biggest benefits have been:

- The move from more than seven different charging methodologies for LV / HV tariffs and site specific charges to one for HV / LV and site specific;
- The consolidation of more than seven sets of tariff structures, including many legacy tariffs, to one condensed set of common tariff structures; and
- The incorporation of the charging methodologies into DCUSA so that any interested parties can bring forward change proposals through the governance process.

Since the incorporation of the methodologies, interested parties have initiated change proposals. These proposals have been progressed to bring further enhancements to the methodologies including changes to reduce volatility in the movement of tariffs from one year to the next.

Further information on each of the DNO's charging methodology can be found by accessing the following links:

Electricity North West –
http://www.enwl.co.uk/our-services/use-of-system-charges

Northern Powergrid –
http://www.northernpowergrid.com/downloads/system.cfm

Scottish Power Distribution and Manweb –
http://www.scottishpower.com/pages/connections_use_of_system_and_metering_services.asp

SSE Power Distribution
http://www.ssepd.co.uk/Library/UoS_Charges/

UK Power Networks
http://www.ukpowernetworks.co.uk/internet/en/about-us/regulatory-information/

Western Power Distribution
http://www.westernpower.co.uk/About-us/Our-system/Use-of-System-Charges.aspx

### 24.5.5. GDUoS (Generation Distribution Use of System) Charge

**Distribution Network Operator**

Based on the same principal as DUoS the GDUoS has existed for many years and until the introduction of time zones it existed as a charge against the generator, to pay for the use of the network if they were using it to export and sell electricity. It is not based on the gross output of the generator but the net volume that is exported and data collected via the settlement meter.

With the introductions of the CDCM in 2010 the GDUoS Negative charges (credits) are applied when the additional exported power has a positive effect on the distribution of electricity via the local grid. The charging methodology also has the same time of day bandings as outlined in the DUoS avoidance in the previous section,

GDUOs prices are calculated each year by the local DNO and suppliers are notified of any charges and credits. These are then passed through to a generator as per their agreement. The most recent DUoS & GDUoS rates can be viewed via the DCUSA (Distribution Connection and Use of System Agreement) web site http://www.dcusa.co.uk/Public/Default.aspx.

The most recent rates were published in May 2014 and based upon variable including location and time the charges range from zero to a credit of £91.09 per MWh. At this level it is still unlikely that many generators will not find this a sufficient level of incentive to operate their assets commercially for the majority of time and locations. This could potentially alter in the future as the magnitude of incentives increases the combined impact of DUoS avoidance, GDUoS, ToU avoidance and Cash Out Tariffs.

### 24.5.6. PPA - Power Purchase Agreement

A PPA is generally sought by any site with energy export capability in order that any electricity that is not used on site while operating generation is accounted for and that a payment is received for its use by others. While it will be physically used in real time by the next closest source of demand to the point of export, the accounting reconciliation is carried out afterwards once meter data is collected.

Typically the PPA will be based on one of two payment models to establish the price of the electricity being sold.

1. Fixed Price Tariff - The self-descriptive title reflects the nature of the arrangement. It is probably more attractive to either a site that has little control over the time of export, exports at times of lower value or requires increased certainty over the value of the power. It is therefore more attractive to renewables, but it will tend to reflect the value of the power at the very low end of the value that electricity trades at in real time.

2. Cash-out Tariff - rather than securing a fixed price in advance, using a 'cash-out' agreement will fix a percentage of the electricity in relation to its closing value for the balancing market. The System Sell Price (SSP) and the System Buy Price (SBP) are the 'cash-out' prices or 'imbalance prices' that are used to settle the difference between contracted generation or consumption and the amount that was actually generated or consumed in each of the 48 half hour trading periods per day.

   A tariff of this type is preferential for a site that believes its export will on the whole be during periods where the average price will be greater than a fixed contract unit value. This is most likely when the site is engaged in programmes where the site will generate at times of capacity shortage or constraint that will be reflected in increased commodity pricing.

Combined with the DUoS and GDUoS charging methodologies that are applied on a ToU basis by the Distribution Network operators, there can be a very significant variance between fixed price and cash-out tariffs at different times of day.

## 24.6. DSR – Carbon and The Environment

A great deal of debate and inconsistency has circulated regarding the impact of DSR on the environment, specifically in relation to $CO^2$ emissions. Much of this has been based on a limited set of assumptions, which are often incorrect, largely in respect of DSR offered by distributed generation. This is understandable, as the subject matter is highly complex and it is critical to encompass as many impacts, both at a local and SO level. It is necessary to understand the impact of distributed generation versus large centralised generation plants.

To establish the true impact of DSR on the environment, in particular $CO^2$, there several aspects that are recommended to be incorporated into any calculation.

Not all DSR programmes will have the same impact and in order to understand this it is important to consider their individual purposes as explained in Section 22.3 'Existing Programmes'.

From the perspective of generators and suppliers, DSR facilitates the integration of intermittent renewables and diminishes the need to run thermal plants at inefficient levels in order to maintain acceptable levels of dispatchable capacity in the event that they are required. This improves capacity factors of existing plant and reduces the need for new capacity, which is in itself a very difficult impact to quantify. However in a report in 2013, National Grid did offer a response to critics in respect of the 'claimed benefits' with a report that attempts quantify and justify the positive assertions.
http://www.scottish.parliament.uk/S4_EconomyEnergyandTourismCommittee/NATIONAL_GRID.pdf

Further, DSR could be used to curtail the system's generation margin, which ensures that generation capacity is greater than demand at virtually all times, by using DSR to prevent steep peaks. Rather than having installed generation for all potential and highly infrequent shortages, some of these can be addressed by DSR, which makes the system more efficient. From a supplier's perspective, DSR could moderate the price volatility in wholesale electricity markets significantly, as demand reduction could cap prices once capacity shortage occurs and prices start to rise steeply.

In the US, it has been estimated that $3bn could be saved annually by realising the market potential of DSR to reduce demand peaks, taking technical, economic and acceptance constraints into account. In the EU, a 2008 study by Cap Gemini found that a high penetration of DSR in the EU-15 could lead to annual energy savings of up to 202TWh, annual $CO^2$ emission reductions of up to 100 million tons, avoided investment of up to €50bn and annual savings in electricity bills for customers of up to €25bn by 2020.
http://www.capgemini.com/resources/demand_response_a_decisive_breakthrough_for_europe

For DNOs, DSR can facilitate the integration of distributed generation into existing distribution network infrastructure, reduce congestion in substations and enable deferring investment. The potential deferral of distribution network investment is potentially the key benefit for DNOs. Postponing investment to a time when DNOs will have gained better understanding of the new distribution infrastructure requirements in the context of new loads and increased embedded generation will reduce the risk of stranded assets. Many previous reports have stated that DSR will become important in managing the distribution networks and maintaining their reliability.

In the aim to decarbonise the electricity system, DSR constitutes a source of carbonless or lower carbon balancing services for the System Operator. DSR can replace the need to operate large thermal plant which is inefficiently part-loaded, i.e. spinning reserve to retain capacity for the delivery of balancing services, which reduces the large thermal plant's efficiency by 10-20%, thereby increasing relative $CO^2$ emissions and costs. A widely circulated report by IPA Energy + Water Economics highlights that delivering balancing services with DSR, even with flexible embedded generation, grants $CO^2$ emission reductions compared to spinning reserve. Carbon benefits occur as embedded generation is only run when actually needed. No carbon is emitted in availability mode, however, for available spinning reserve more efficient plant has to be part-loaded regularly, thereby emitting more carbon. Hence, running diesel-fired embedded generation for the infrequent times the balancing service is actually utilised leads to lower total emissions. IPA Energy + Water Economics estimated the carbon benefits of DSR replacing spinning reserve to be in the order of 300-700 tonnes $CO^2$ per MW/year:
www.ipaenergy.co.uk/publications/69441kel0003460000.pdf

Other reports over recent years also further identify the following benefits of DSR for the SO:

(1) DSR facilitates the integration of wind generation, as it provides additional short-term flexibility and reduces the need to constrain wind generation. Where Footroom capability is developed, demand can be increased when high wind intersects with low demand.
(2) The use of DSR in specific locations can also yield benefits of relieving grid congestion and location-specific transmission constraints, which enhances system reliability and can reduce the need for transmission network upgrades.
(3) DSR improves operational flexibility and efficiency by providing the SO with an additional tool to manage the system.
(4) Finally, DSR participation in balancing markets increases competition, which potentially reduces cost, mitigates gaming or use of market power and generally improves market efficiency.

The above mentioned benefits to SO, DNOs, generators and suppliers have the potential to reduce the costs to the customer, aid the decarbonisation of the electricity system and facilitate system reliability. Although due to the extensive variables with provision of DSR and cost to run the system, specific values are difficult to detail.

Project FALCON aims to quantify the specific benefits that are likely to be realised in relation to local impact and consider factors such as:

- Reduced distribution losses;
- Improved operational efficiency of the network; and
- Deferment or avoidance of capital works.

The research analysis proposed within Project FALCON will not extend to the multiple benefits that may be incurred from multiple benefits that potentially occur to suppliers, The SO or Transmission Network Operator, (TNO)as a result of complimentary effects at time of dispatch.

## 24.7. Low Carbon Network Funded DSR trials

A recent development within the UK energy sector has been that the energy regulator, Ofgem, (Office of Gas and Electricity Markets) has made changes to the structure of the framework and incentive criteria by which DNOs are funded.

Over the next decade, DNOs face an unprecedented challenge of securing significant investment to maintain a reliable and secure network.

Ofgem, as the regulator, must ensure that DNOs deliver this at a fair price for consumers. To help achieve this, they developed a new performance based model for setting the network companies' price controls which will last eight years. The model is called RIIO: Revenue=Incentives+Innovation+Outputs.
RIIO is designed to encourage network companies to put stakeholders and customers at the heart of their decision making process, invest efficiently to ensure continued safe and reliable services and innovate to reduce network costs for current and future consumers. DNOs will need to play a full role in delivering a low carbon economy and wider environmental objectives.

As part of the transition to the new RIIO-ED1 price control Ofgem created the Low Carbon Network Fund. The LCN Fund allows up to £500m to support projects sponsored by the DNOs to trial new technology, operating and commercial arrangements. The aim of the fund is to help all DNOs understand how they can provide security of supply at value for money as Britain moves to a low carbon economy.

There are three tiers of funding under the LCN Fund. The first tier allows DNOs to recover a proportion of expenditure incurred on small scale projects. Under the second tier of the LCN Fund, an annual competition for an allocation of up to £64 million to help fund a small number of flagship projects is held. The third tier is the discretionary reward mechanism, by which DNO's can apply for a reward at the end of the project. The amount that can be applied for is capped at the amount the DNO contributed towards the project.

In LCNF projects, DNOs explore how networks can facilitate the take up of low carbon and energy saving initiatives such as electric vehicles, heat pumps, micro and local generation and demand side management. They also investigate the opportunities that smart meter roll out provide to network companies. As such, the LCN Fund should provide valuable learning for the wider energy industry and other parties. The LCN Fund is replaced at the end of the transitional period by the Network Innovation Allowance, NIA. The NIA is a set allowance each RIIO network licensee receives as part of their price control allowance to limited funding to RIIO network licensees. Its purpose is to fund smaller technical, commercial, or operational projects directly related to the licensees network that have the potential to deliver financial benefits to the licensee and its customers

There are other funding mechanisms available for Smart Grid initiatives through European programmes, research councils and organisations such as the Technology Strategy Board. These, however, are not typically used for the development of DSR services.

As the LCN Fund and IFI (Innovation Funding Incentive) have been the primary mechanism by which DSR programmes have been investigated by DNOs, a list of some the current trials is provided in the remainder of section 7.1. A full list is available via the Energy Network Association, Smart Networks Portal http://www.smarternetworks.org/Index.aspx?Site=ed

Many of these are unlikely to be adopted as business as usual propositions without significant commercial and technical development. As part of the LCN Funding governance, the DNOs are obliged to share the learning and experience of their trials with the industry that will result in 'best practice' developments and changes to the codes under which they are regulated. One such development, directly relating to DSR is a working group that reports to Energy Network Futures Group, ENFG, and includes the SO and all DNOs. It was recognised that the current markets and commercial frameworks would act as a barrier to create unnecessary competition in the marketplace that would ultimately be borne by consumers. As a result there was a clear objective to create a shared services model to allow multiple programme operators to have access to a DSR participant rather than the current restrictions resulting from their exclusive arrangements. Further information on the scope and expected outcomes from this group are provided in Section 18

Some aspects of research from preceding LCNF trials have assisted the scope creation for FALCON's commercial trials and duplication of already established factors have been avoided. Also, through publication of the FALCON learning outputs, it is hoped that a far greater value will be achieved across the industry by the research than just satisfying the core requirement of providing real results data to the SIM.

### 24.7.1. WPD – Tier1 LCNF Trial – Seasonal Generation Deployment

http://www.smarternetworks.org/Project.aspx?ProjectID=374

**Reference:**
WPDT1005
**Starts - Ends:**
01/2011 - 04/2013
**Estimated Expenditure:**
£300,000

**Introduction**:
Future energy scenarios clearly show that peak demand on the distribution network is set to increase. This project will explore a solution to reduce the impact on the existing network from such peaks. It will test the technical aspects associated with controllable demand and automated generation, and development of innovative commercial arrangements for generation availability and operation. The project will deliver new learning on the cost effectiveness of such arrangements. The project will consist of two phases:
Phase 1 will involve the installation of a single point of generation at an 11kV substation site. The key objective of this phase will be to initiate, develop and deploy the engineering interface, commercial arrangement and first stage generation control methodology.
Phase 2 will utilise existing network connected generation along with strategically placed generation connected to an adjacent section of 11kV network, which will be a test within a more complex network environment. This will provide a platform for commercial arrangements and control methodologies to be further developed.

**Project objectives were as follows:**

- Develop and deploy an automated network generation control system
- Provide network support through the integration of an automated demand triggered generation system
- Develop and deploy an availability and commercial operating arrangement - DNO to DSO
- Provide a commercial arrangement similar to the Short Term Operating Reserve (STOR) arrangements between aggregators and NG, but specifically tailored to reflect the needs of the local grid rather than GB system balancing
- Increase network flexibility and security through the use of robust generation
- Ensure that the engineering model and commercial framework are aligned in order to provide maximum benefit for existing assets and end user customers
- Assess the benefit from capital deferment, by complimenting existing network assets with strategic generation thus maximising asset life.

**Expected Benefits:**

- Ability to use temporary seasonal Distributed Generation (DG) to lop peaks - reliability, contribution to design standards, etc.
- Suitability of contracting existing DG to avoid peaks - reliability, contribution to design standards, etc.
- Develop a local market mechanism
- Identify customer appetite for participating in such a scheme
- Assess business case
- Identify regulatory/other barriers

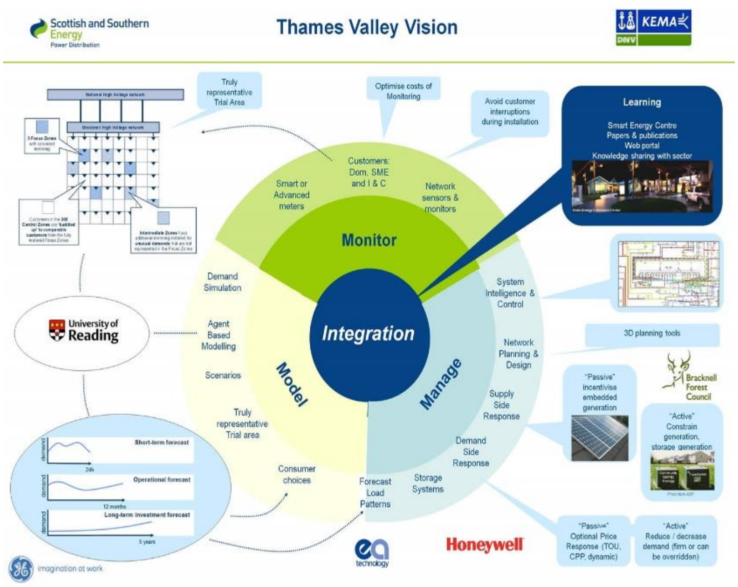
- Explore interaction with STOR and other market mechanisms.

### 24.7.2. Thames Valley Vision - Scottish & Southern Energy Power Distribution

http://www.thamesvalleyvision.co.uk/

**Reference:**
SSET203
**Starts - Ends:**
01/2012 - 03/2017
**Estimated Expenditure**
£27,230,000

**Introduction:**
Thames Valley Vision (TVV) will revolutionise the way in which DNOs utilise their existing networks. This project is a complete solution that will allow us to anticipate, understand and support behaviour change in individuals, small businesses and larger companies to help us manage our networks more effectively as GB moves towards a low carbon economy. Building on the techniques developed for supermarket loyalty schemes, TVV will use data intelligently to identify and predict network stress points in the short, medium and long term in order that DNOs can make more informed decisions.




TVV proposes that a better understanding of and more active role for electricity consumers can minimise the investment required to maintain secure distribution networks that meet customer needs.

**Objectives:**
The project will evaluate solutions including:
- A new network and planning environment
- Industrial and Commercial and Small and Medium sized Enterprises (SMEs) automated demand side response
- Low Voltage (LV) static voltage control
- Street level energy storage
- A range of communications solutions
- Additionally the project will incorporate learning from other projects from GB and worldwide.

TVV will deliver new commercial agreements, procedures, policies and will inform national standards. It will disseminate learning through targeted communication and our low carbon community advisory centre. Ultimately, TVV will enable DNOs to avoid £5bn of network reinforcement through the involvement of all customers groups and a comprehensive understanding of networks.

**Expected Benefits:**
Scottish and Southern Energy Power Distribution are confident that TVV will provide a range of benefits for DNOs as energy is decarbonised.
Further to this is anticipated that TVV will yield more immediate benefits including:

- Accelerated low carbon technology connection for customer
- Avoidance of supply failure resulting from unanticipated demand peaks
- Reduction of network losses as a result of power factor correction
- Informed business plans going into RIIO-ED1 with the ability to model scenarios
- Customer groups with an improved understanding of how to self-mitigate network issues through the way in which they select and implement low carbon solutions
- Evaluation of resource and skill requirements
- Training and learning dissemination
- Enhanced data to inform DPCR5 output measures
- A range of specific innovative alternatives to reinforcement
- A no Customer Minutes Lost (CML) impact implementation strategy
- Enduring productive relationships with stakeholder.

### 24.7.3. SoLa Bristol – Western Power Distribution

http://www.smarternetworks.org/Project.aspx?ProjectID=394

**Starts - Ends:**
12/2011 - 01/2015
**Estimated Expenditure:**
£2,484,000

**Introduction:**
GBs transition to a low carbon economy will require significant changes to the way we supply and use energy. Electrification of transportation and heating, combined with dense deployments of PV panels, will give rise to additional constraints on electricity networks, particularly at Low Voltage (LV). These constraints cannot be ignored, and will ultimately adversely affect the customer and their own low carbon aspirations. To address this, networks can be strengthened using conventional reinforcement or by developing novel approaches.
The SoLa Bristol project is an innovative combination of energy storage in customers premises, coupled with new variable tariffs and integrated network control to overcome generation or load related constraints at key times of the day. It will explore the use of Direct Current (DC) power in customer premises in conjunction with battery storage shared virtually between the DNO and customer, providing benefits to both parties. Through batteries, the LV network will be operated more actively with additional capacity to manage peak load, control voltage rise and reduce system harmonics.
The techniques trialled will, through reduction in constraints and need for network reinforcement, facilitate the connection of low carbon devices at reduced cost at over 40 locations in a range of premise types including homes, schools and a business.

**Objectives:**
The project will test the following Hypotheses:

- Should new Low Carbon Technologies (LCTs) increase distribution network peaks and cause thermal overloads, then battery storage, demand response and DC networks could be an efficient solution, conventional network reinforcement for short thermal overloads may not the most efficient use of customers money

- If DC networks in properties could be used to reduce network harmonics, phase distortion and improve voltage control then their use may be vital in the connection of LCTs. Because the safe, efficient operation of distribution networks is reliant on the power quality and voltage being within statutory limits
- If DNOs and customers could share battery storage on DC networks with a variable tariff, then the mutual benefits may make battery storage financially viable, as battery storage could be a shared asset or sold to customers as a service.

**Expected Benefits:**

Western Power Distribution have identified four areas where customers could benefit from the proposed solution:

- Keeping the lights on, through the installation of the BRISTOL system, the batteries will be used to provide enhanced resilience during power outages. Lighting, computing, telecommunications and potentially central heating pumps will be available from the battery storage even during network power outages
- Lower energy bills through a better control of energy; a variable tariff rewarding customers for reducing their peak energy demand, passing on the cost savings. Clearer, more transparent energy bills through the LV connection manager using energy efficiency, better use of PV
- Improved energy efficiency: Supplying DC equipment using a high quality AC/DC converter and PV panels powering the DC network instead of a large number of inefficient AC/DC converters will reduce electricity losses
- Quicker and cheaper connections: Conventional network reinforcement can not only be costly, but also require significant scheduling; the BRISTOL solution is one that could be implemented much faster and cost effectively.
- There are nine areas where DNOs could benefit from learning as a result of the BRISTOL project:
- The project will develop a tool that could rapidly be deployed by DNOs to reduce network hotspots created by the connection LCTs
- The project will test the benefits of storage located at customer premises, rather than at substations, providing the additional LV feeder load and voltage control support
- By oversizing the battery in the customer’s premises, the project will explore the business case for DNOs operating a virtual partition of distributed storage
- BRISTOL will test how batteries can be used with demand response by customers to take advantages of variable retail tariffs. From this DNOs will gain an insight into the residual impact of LCTs on the distribution networks
- The project will provide insight into how customers perceive innovative solutions such as the BRISTOL solution
- BRISTOL will create an intelligent self-managing network linking together the substation with multiple properties with battery storage and demand response to reduce voltage rise and reduced peak demand
- This project will use intermittent generation and battery storage when making network planning assumptions for the connection of other customers
- BRISTOL will explore lower harmonic distortions on the network voltage by solving the problem, reducing power quality issues
- The Project will provide better use of the existing distribution assets.

### 24.7.4. Capacity to Customers – Electricity North West Limited

http://www.enwl.co.uk/c2c

**Reference**:
ENWLT203
**Starts - Ends:**
01/2012 - 12/2014
**Estimated Expenditure:**
£9,597,000

**Introduction:**
Capacity to Customers (C2C) engages customers in an innovative form of demand/ generation side response that accommodates much higher demands on existing electricity networks without the need for reinforcement. Customers are at the heart of C2C and it seeks to prove that the innovative application of existing technology together with new commercial offerings can be combined to meet customers' future low carbon needs at much lower cost. C2C's technical elements leverage techniques developed for customer service improvements to offer significantly higher capacity to customers. C2C will be piloted on High Voltage (HV) networks supplying 12% of our customers allowing them secure access to the networks' previously unavailable latent capacity.

As GB fulfils its decarbonisation obligations under the Climate Change Act 2008, to cut greenhouse gas emissions by 80% by 2050, the demand on electricity networks will dramatically increase. Various reports forecast overall electricity demand to grow by 1.2% per annum to 600TWh/year by 2050, an approximate 100% increase from current levels. This increase in network demand will be driven primarily through the decarbonisation of heat, transportation and electricity production rather than by a growing population. The Problem has two direct consequences which will need to be resolved in order to move the UK towards a decarbonised economy:

- High costs to customers
- Significant environmental & societal impacts.
- The techniques that traditional reinforcement use are also very intrusive for local communities and can often involve extensive excavations and disruption. Average reinforcement timescales are in the region of 12-16 weeks for work involving cable upgrades or switchgear and much longer when involving new transformers or more complicated work.

**Objectives:**
- The key objectives of the C2C project are as follows:
- Adaptive network control functionality: The trial will develop advanced network control functionality that will through productisation be available to all GB DNOs
- Demand response commercial templates: The trial will produce a series of model commercial contracts that can be used by all DNOs to extend the C2C Method and its benefits to all DNO customers
- Customer segmentation template: The trial will produce a customer segmentation template, describing how a DNO's customer base can be segmented and hence better approached for the introduction of demand response contracts
- New connections process: The trial will produce a new connections process detailing those technical and commercial steps required to extend the benefits to future C2C customers
- Overall customer feedback: This includes feedback from customers participating in the C2C Project including; comments on connections process, the form of response and feedback from customer engagement on planned interruptions and unplanned interruptions

- Network data: Detailed analysis of the benefits of the C2C Method on network losses and power quality in the form of a full set of network performance data
- Modelling/Simulation outcomes: The simulations will provide a detailed technical and economic assessment of the benefits of the C2C Solution
- New design and planning standard: The Method represents a fundamental change in the evolution of grids from passive to active operation and Electricity North West Ltd in conjunction with Parsons Brinckerhoff Power will produce proposals regarding new operating and design standards to inform the amendment or replacement of Engineering Recommendation P2/6.

**Expected Benefits:**
The principal benefit to customers of the C2C Solution is that it enables significant additional network load and generation to be connected, without incurring the high levels of expenditure associated with traditional HV and EHV network reinforcement. Electricity North West Ltd.'s analysis shows that if the technical and commercial elements of the C2C Solution were adopted across the Electricity North West Ltd network, then it would release 2.4 GW of existing capacity on the HV networks, without reinforcement. This is around 35% of the existing firm HV network capacity or around 50% of simultaneous HV demand. Analysis of electrical energy scenarios to 2050 suggests the C2C Method could thus replace much of the traditional HV reinforcement activity in the period to 2035; however this is viewed as a conservative estimate and could indeed defer reinforcement in certain networks to 2050.

Electricity North West Ltd has undertaken initial modelling work on the potential benefits of its C2C Project. This modelling has been based on assessing a sample of real customer connection applications and general reinforcement projects, and the associated network reinforcement expenditure. Electricity North West Ltd and Parsons Brinckerhoff Power have examined these case studies to determine both the viability of the proposed C2C Solution and to assess their value to customers. Under the C2C Project Electricity North West Ltd will more accurately quantify the benefits arising from the Method, enabling Ofgem and network operators to examine future incentive arrangements and allowance mechanisms within the new RIIO (Revenue, Incentive, Innovation and Output) price control.

The C2C Solution negates the need for much of the engineering works associated with reinforcement, by better utilising the installed network capacity.

## 24.7.5. Low Carbon London – UK Power Networks

http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Low-Carbon-London-(LCL)/

**Reference**:
EDFT2001
**Starts - Ends:**
01/2011 - 06/2014
**Estimated Expenditure:**
£36,060,000

**Introduction:**
Low Carbon London is a pioneering learning programme. Its aim is to use London as a test bed to develop a smarter electricity network that can manage the demands of a low carbon economy and deliver reliable, affordable zero carbon electricity to businesses, residents and communities.
London has a unique opportunity to be at the heart of this drive towards a low carbon economy. Currently it has the highest levels of carbon emissions in the UK, one of the most utilised electricity networks in the country and a very tough carbon reduction target of 60% on 1990 levels by 2025.
To cut its carbon emissions, London is calling for a big increase in distributed and micro-generation, electric vehicles, combined cooling heating and power systems, and heat pumps. Low Carbon London is about learning how to accommodate these new demands on the electricity network, while helping customers to make the best use of national low carbon electricity production.
London's approach to carbon reduction is likely to be mirrored across UK, so the knowledge gained in London will help electricity networks across the country to prepare for a low carbon future.

**Objectives:**
The outlook for the project over the next reporting period, despite the various challenges, is very positive. The addition of a second energy supplier to the project provides an increased available pool of residential and potentially Small and Medium Enterprises (SMEs), commercial trial participants, whilst developing links with various industry organisations.
Low Carbon London will develop a new approach to distribution network management to meet growing demand from emerging low carbon technologies, such as electric vehicles, heat pumps and distributed generation. It will focus on carbon reduction targets and the need to reduce dependency on conventional reinforcement.


**Expected Benefits:**
Low Carbon London will demonstrate how to develop electricity networks that enable a low carbon world and, at the same time, offer customers informed choice about their electricity consumption.
The results of the trials will clearly indicate the potential for new approaches to network management to deliver real savings to customers as UK Power Networks move towards a low carbon economy. These approaches will be valid and meaningful for customers across Great Britain

### 24.7.6. Customer-Led Network Revolution– Northern Powergrid

http://innovation.ukpowernetworks.co.uk/innovation/en/Projects/tier-2-projects/Low-Carbon-London-(LCL)/

**Reference**:
CET2001
**Starts - Ends:**
01/2011 - 12/2014
**Estimated Expenditure:**
£52,620,000

**Introduction**:
The move to a low-carbon economy, in particular the growth in Low Carbon Technologies (LCTs), will place additional strain on electricity distribution networks. If innovative solutions are not found this will require significant extra network investment and could delay the take-up of LCTs. This will start to be a problem on pockets of network by 2015 and a wider more significant issue from 2020. Therefore knowledge gained over the next three years will be relevant to the price control RIIO ED1 period.
The network costs associated with mass uptake of LCTs could be significantly reduced, and delivery accelerated, by using a combination of:

- New network technologies
- Flexible customer response from both demand and generation.

This will only happen if new commercial arrangements between suppliers, DNOs and customers are developed.

**Objectives**:
The project aims to ascertain:

- What are current, emerging and possible future customer (load and generation) characteristics?
- To what extent are customers flexible in their load and generation, and what is the cost of this flexibility?
- To what extent is the network flexible and what is the cost of this flexibility?
- What is the optimum solution to resolve network constraints driven by the transition to a low carbon economy?
- What are the most effective means to deliver optimal solutions between customer, supplier and distributor?
-

**Expected Benefits:**
The solution is expected to deliver significant net benefits to customers. Northern Powergrid expect it to accelerate the take up of LCT's. In addition Northern Powergrid expect the project to optimise the use of installed network capacity and promote the use of Demand Side Response (DSR).

## 24.8. FALCON Season 1 DSR Contract

### Demand Response Agreement - FALCON

**Between**:
(1) **Western Power Distribution** (West Midlands) plc (company number: 0360057) whose registered office is at Avonbank, Feeder Road, Bristol BS2 0TB ("WPD"); and
(2) ___________________________________ Limited (company number: _____________) whose registered office is at ________________________________________________ ________________________________________________________ (the "Energy Partner").

| | |
|---|---|
| **Date of Agreement (date of signature):** | |
| **Season(s)** | 1st Nov 2013 – 28th Feb 2014<br>1st Nov 2014 – 28th Feb 2015 |
| **Availability Window** | 16:00 to 20:00 Monday - Friday (inclusive) |
| **Response Time** | **30** minutes |
| **Energy Partner Authorised Person(s)** | [insert name(s) of Energy Partner individual(s)] |
| **Contact Method** | [insert email address / telephone number] |
| **Control Room Contact** | Name: Gary Swandells<br>Email: ggswandells9@westernpower.co.uk<br>Telephone number: |

| **Site(s)** | **MPAN(s)** | **Agreed Capacity (MW)*** |
|---|---|---|
| | | |
| | | |
| | | |
| | | |

*Note: Agreed Capacity is represented in the Payment Calculation in Schedule 2 as "CM".

**Please note:** The parties hereby acknowledge that: (a) the provision of the Services; (b) the compliance with any Instruction issued by WPD; and (c) any participation in Project FALCON by the Energy Partner and/or its subcontractors is entirely voluntary.

To the extent that the terms of this Agreement conflict with any of the rights or obligations of the parties under the Electricity Act 1989, the Utilities Act 2000, the Energy Acts 2008 – 2011, the National Terms of Connection and any other licences, codes or industry agreements related to such legislation (the **"Electricity Regulations"**), the terms of the Electricity Regulations shall prevail.

We agree to be bound by the Agreement (as defined in sub-clause 1.1 (Definitions and Interpretation) of the attached terms and conditions).

| |
|---|
| **Signed** on behalf of Western Power Distribution (West Midlands) plc:<br><br>*Signature*: ______________________________<br><br>*Name*: ______________________________<br><br>*Role*: ______________________________ |
| **Signed** on behalf of: ______________________________:<br><br>*Signature*: ______________________________<br><br>*Name*: ______________________________<br><br>*Role*: ______________________________ |

**Schedule 1**
**(Demand Response Procedure)**

1. By 10:00am on each Friday of the Season, the Energy Partner shall notify the Control Room Contact by email of the Sites that are **unavailable** to provide Demand Response during the next Availability Window.

2. In the absence of any notification to the contrary under paragraph 1, WPD shall be entitled to assume that all Sites are **available** to provide Demand Response (**"Available Sites"**).

3. If the Energy Partner becomes aware of any changes to the availability of a Site as notified to WPD under paragraph 1, it shall update the Control Room Contact by email of such change as soon as reasonably practicable.

4. During each Availability Window:

(a) the Energy Partner shall ensure that the Contact Method is available and operational; and

(b) the Control Room Contact may issue via the Contact Method one Instruction per day per Available Site to the Energy Partner.

5. On receiving an Instruction, the Energy Partner shall within the Response Time:

(a) procure that the Demand Response is carried out at each Site in accordance with the relevant Instruction; and

(b) in the event that a Site is unable to maintain the Critical Capacity (CC) during the Response Time then the Energy Partner Authorised Person shall email the Control Room Contact to notify this.

6. The Energy Partner shall procure that the Demand Response ceases at each Site at the end of the relevant Response Period or, if earlier, as requested by the Control Room Contact .

**Schedule 2**
**(Payment Calculation)**

***Generation delivery calculation***

For a Site that increases generation during a Demand Response event, we calculate the delivery as:

$$D_i = \max[C_i - AvC, 0]$$

***Consumption delivery calculation***

For a Site that reduces consumption, the opposite formula is required:

$$D_i = \max[AvC - C_i, 0]$$

***Average delivery during a Demand Response event***

Given a Demand Response event with average demand figure AvC, start time ST, finish time FT, we calculate the *average delivery* as follows:

$$D_{avg} = \frac{\sum_{i=ST}^{FT} \min(D_i, CM)}{FT - ST + 1}$$

***Total delivery and payment value***

$$D = D_{avg} \times \left(\frac{FT - ST + 1}{60}\right)$$

$$Payment = D \times 300$$

*(a detailed payment calculation document with full parameter definition and graphical representation is available on request)*

**(Terms and Conditions)**

**It is agreed** as follows:

**1. Definitions and interpretation**

1.1 In this Agreement, unless the context otherwise requires, the following words have the following meanings:
**"Agreed Capacity"** means the target net MW consumed or generated by a Site during the Response Period as set out on the front page of this Agreement;
**"Agreement"** means this agreement (including the details set out on the front page, the Terms and Conditions, and any other schedule or annexure to it) made between the parties;
**"Applicable Legislation"** means all Policies and laws, statutes, acts, regulations, codes, judgments, orders, directives or determinations applicable to the performance of the Services;
**"Authorised Person"** means the individual of the Energy Partner specified as the authorised person on the front page of this Agreement;
**"Availability Window"** means 16:00 to 20:00 (inclusive) on Monday to Friday (inclusive);
**"Contact Method"** means the contact method specified on the front page of this Agreement;
**"Control Room Contact"** means the individual at the WPD facility from where network is monitored and managed, who is specified as the contact on the front page of this Agreement;
**"Date of Agreement"** means the date specified as the date of signature on the front page of this Agreement;
**"Demand Response"** means the regulation of the amount of electricity consumed and/or generated by a Site to achieve the Agreed Capacity;
**"Payment"** means the payment calculated in accordance with Schedule 2 of this Agreement;
**"Policies"** means any instructions, rules or policies issued by WPD from time to time, including without limitation Policy Document: LE7 Relating to Bribery;
**"Response Period"** means a period of time between one to two hours during which the Demand Response is to be maintained for a Site as set out in the Instruction;
**"Response Time"** means the maximum period of time (in minutes) which is permitted to elapse from receipt of the Instruction by the Energy Partner and achieving the Agreed Capacity at the relevant Site(s) at set out on the front page of this Agreement**;**
**"Services"** means the services to be provided by the Energy Partner as set out in clause 3 and Schedule 1;
**"Settlement Period"** has the meaning ascribed to it in the Balancing and Settlement Code published by the National Grid Company plc;
**"Site"** means each of the sites set out on the front page of this Agreement;
**"VAT"** means value added tax chargeable under English law for the time being and any similar, additional tax.

1.2 In this Agreement, unless the context otherwise requires: (a) words in the singular include the plural and vice versa and words in one gender include any other gender; (b) a reference to a statute or statutory provision includes: (i) any subordinate legislation (as defined in Section 21(1), Interpretation Act 1978) made under it; (ii) any repealed statute or statutory provision which it re-enacts (with or without modification); and (iii) any statute or statutory provision which modifies, consolidates, re-enacts or supersedes it; (c) references to: (i) any party include its successors in title and permitted assigns; (ii) a "person" include any individual, firm, body corporate, association or partnership, government or state (whether or not having a separate legal personality); (iii) clauses and schedules are to clauses and schedules of this Agreement and references to sub-clauses and paragraphs are references to sub-clauses and paragraphs of the clause or schedule in which they appear; and (iv) the headings are for convenience only and shall not affect the interpretation of this Agreement.

**2. Commencement and Duration**

This Agreement shall commence on the Date of Agreement and shall continue in force until terminated by either party on one month's written notice to the other party (the **"Term"**).

**3. Demand Response**

3.1 The Energy Partner shall: (a) during the Season, carry out its obligations as set out in Schedule 1 in accordance with Applicable Legislation and the terms of this Agreement; and (b) during the Term, permit WPD to collect and on request shall provide to WPD, any metering data in respect of each Site.

3.2 The Energy Partner may sub-contract its obligations under Schedule 1 to any third party provided that such appointment shall not relieve the Energy Partner of any obligation under this Agreement, and the acts or omissions of

any such sub-contractor shall, for the purposes of this Agreement, be deemed to be acts or omissions of the Energy Partner.
3.3 The Energy Partner may not assign, transfer, charge or otherwise encumber, declare a trust over or deal in any other manner with this Agreement or any right, benefit or interest under it.

**4. Payment**
4.1 In consideration of the provision of the Services in accordance with the terms of this Agreement, WPD shall pay to the Energy Partner the Charges as set out in this clause 4.
4.2 Subject to clause 10.6, WPD's liability to the Energy Partner shall not exceed the amount of the Charges and WPD shall not be liable for any other payments incurred by the Energy Partner in the provision of the Services.
4.3 The Energy Partner shall calculate the Charges for each month in accordance with Schedule 2 and, at the end of each month, the Energy Partner shall be entitled to issue its invoice to WPD for the Charges incurred in that month.
4.4 Each invoice must: (a) contain all the following information: (i) the Site(s) where the Services have been carried out; (ii) the period to which the invoice relates; (iii) the Energy Partner's details for payment; (iv) the Payment for the period of the invoice, excluding VAT; and (v) any other information that WPD may reasonably request; and (b) be sent to: Western Power Distribution, Accounts Payable, Elliott Road, Prince Rock, Plymouth, Devon, PL4 0SD, (c) be dated the date that it is issued.
4.5 All payments shall be released by WPD by the end of the month following the month of the date of the Energy Partner's invoice. Payment by WPD shall be without prejudice to any claims or rights, which WPD may have against the Energy Partner and shall not constitute any admission by WPD as to the performance by the Energy Partner of its obligations under this Agreement. Prior to making any such payment, WPD shall be entitled to make deductions or deferments in respect of any disputes or claims whatsoever with or against the Energy Partner.
4.6 All sums payable under this Agreement shall be exclusive of VAT. WPD shall pay an amount equal to such VAT to the Energy Partner in addition to any sum or consideration on receipt of a valid VAT invoice from the Energy Partner.
4.7 If WPD fails to pay to the Energy Partner any undisputed amount payable by it under this Agreement, the Energy Partner may charge WPD interest on the overdue amount from the due date up to the date of actual payment at the rate of 2% per annum above the base rate of the Bank of England. Such interest shall accrue from day to day and shall be compounded annually.
4.8 WPD may, without limiting any other rights or remedies it may have, withhold or set off any amounts owed to it by the Energy Partner against any amounts payable by WPD to the Energy Partner under this Agreement.

**5. Confidentiality**
Except with the consent of the disclosing party or as required by law, a court order or by any relevant regulatory or government authority or to the extent that information has come into the public domain through no fault of the receiving party, each party shall treat as strictly confidential all commercial and technical information relating to the other party received or obtained as a result of entering into or performing this Agreement including but not limited to information which relates to the provisions or subject matter of this Agreement, to any other party or to the negotiations of this Agreement.

**6. Anti-Bribery**
The Energy Partner shall not engage in any activity, practice or conduct which would constitute an offence under the Bribery Act 2010 and shall promptly report to WPD any request or demand for any undue financial or other advantage of any kind received or offered by the Energy Partner in connection with this Agreement.

**7. Force Majeure**
Neither party shall be deemed to be in breach of this Agreement, or otherwise be liable to the other, by reason of any delay in performance or non-performance of any of its obligations under this Agreement to the extent that such delay or non-performance is due to an event beyond the reasonable control of that party.

**8. Termination**
8.1 Either party may by notice in writing immediately terminate this Agreement, if the other party commits a material breach of this Agreement which in the case of a breach capable of remedy shall not have been remedied within 30 days of the receipt of a notice identifying the breach and requiring its remedy.
8.2 All rights and obligations of the parties shall cease to have effect immediately on termination of this Agreement except that termination shall not affect: (a) the accrued rights and obligations of the parties at the date of termination;

(b) the continued existence and the validity of the rights and obligations of the parties under clause 5; and (c) any provisions of this Agreement necessary for the interpretation or enforcement of this Agreement.

**9. Dispute Resolution**

9.1 Subject to sub-clause 9.3, if a dispute arises out of or in connection with this Agreement, the parties shall: (a) within 30 days of written notice of the dispute being received by the receiving party in good faith seek to resolve the dispute through negotiations between the parties' senior representatives who have the authority to settle it; and (b) not pursue any other remedies available to them until at least 30 days after the first written notification of the dispute.

9.2 The appointed representatives shall use reasonable endeavours to resolve the dispute. If the dispute is not resolved in accordance with this clause, either party may propose to the other in writing that the matter be referred to a non-binding mediation. If the parties are unable to agree on a mediator either party may apply to the Centre for Dispute Resolution (CEDR) to appoint one.

9.3 Nothing in this clause shall prevent any party from having recourse to a court of competent jurisdiction for the sole purpose of seeking a preliminary injunction or such other provisional judicial relief as it considers necessary to avoid irreparable damage.

**10. General**

10.1 This Agreement (and any appendices attached to it) sets out the entire agreement and understanding between the parties and supersedes all prior agreements, understandings or arrangements (whether oral or written) in respect of the subject matter of this Agreement.

10.2 To the extent that any provision of this Agreement is found by any court or competent authority to be invalid, unlawful or unenforceable in any jurisdiction, that provision shall be deemed not to be a part of this Agreement, it shall not affect the enforceability of the remainder of this Agreement nor shall it affect the validity, lawfulness or enforceability of that provision in any other jurisdiction.

10.3 The rights, powers and remedies conferred on either party by this Agreement and the remedies available to either party are cumulative and are additional to any right, power or remedy which it may have under general law or otherwise.

10.4 Either party may, in whole or in part, release, compound, compromise, waive, or postpone, in its absolute discretion, any liability owed to it or right granted to it in this Agreement by the other party without in any way prejudicing or affecting its rights in respect of that or any other liability or right not so released, compounded, compromised, waived or postponed.

10.5 The Energy Partner acknowledges that it has entered into this Agreement in reliance only upon the representations, warranties, conditions and promises specifically contained or incorporated in this Agreement and, subject to clause 10.6, WPD shall have no liability to the Energy Partner in respect of any other representation, warranty, condition or promise made prior to the date of this Agreement, unless it was made fraudulently, or implied into this Agreement.

10.6 Nothing in this Agreement shall limit or exclude either party's liability for death or personal injury caused by its negligence, or the negligence of its employees, agents or subcontractors; its fraud or fraudulent misrepresentation; and any other liability which cannot by law be excluded or limited.

10.7 No single or partial exercise, or failure or delay in exercising any right, power or remedy by either party shall constitute a waiver by that party of, or impair or preclude any further exercise of, that or any right, power or remedy arising under this Agreement or otherwise.

10.8 No announcement concerning the terms of this Agreement shall be made by or on behalf of either party without the prior written consent of the other, such consent not to be unreasonably withheld or delayed.

10.9 Nothing in this Agreement or in any document referred to in it or in any arrangement contemplated by it shall create a partnership or joint venture between the parties or render a party the agent of the other, nor shall a party hold itself out as such (whether by an oral or written representation or by any other conduct) and neither party shall enter into or have authority to enter into any engagement, or make any representation or warranty on behalf of, or pledge the credit of, or otherwise bind or oblige the other party.

10.10 This Agreement may be executed in any number of counterparts and by the parties on separate counterparts, but shall not be effective until each party has executed at least one counterpart. Each counterpart, when executed, shall be an original of this Agreement and all counterparts shall together constitute one instrument.

10.11 Any notice to either party under this Agreement shall be in writing signed by or on behalf of the party giving it and shall, unless delivered to the party personally, be left at, or sent by prepaid first class post or prepaid recorded delivery to the address of the party as set out on the front page of this Agreement or as otherwise notified in writing from time to time. A notice shall be deemed to have been served at the time of delivery, if delivered personally, or 48 hours after posting.

10.12 No term of this Agreement is enforceable pursuant to the Contracts (Rights of Third Parties) Act 1999 by any person who is not a party to it.

10.13 This Agreement and any dispute, claim or obligation (whether contractual or non-contractual) arising out of or in connection with it, its subject matter or formation shall be governed by the laws of England and Wales.

10.14 Subject to clause 9, the parties irrevocably agree that the courts of England and Wales shall have exclusive jurisdiction to settle any dispute or claim (whether contractual or non-contractual) arising out of or in connection with this Agreement, its subject matter or formation.

This Agreement has been signed on the date stated as the "Date of Agreement" on the front page of this Agreement.