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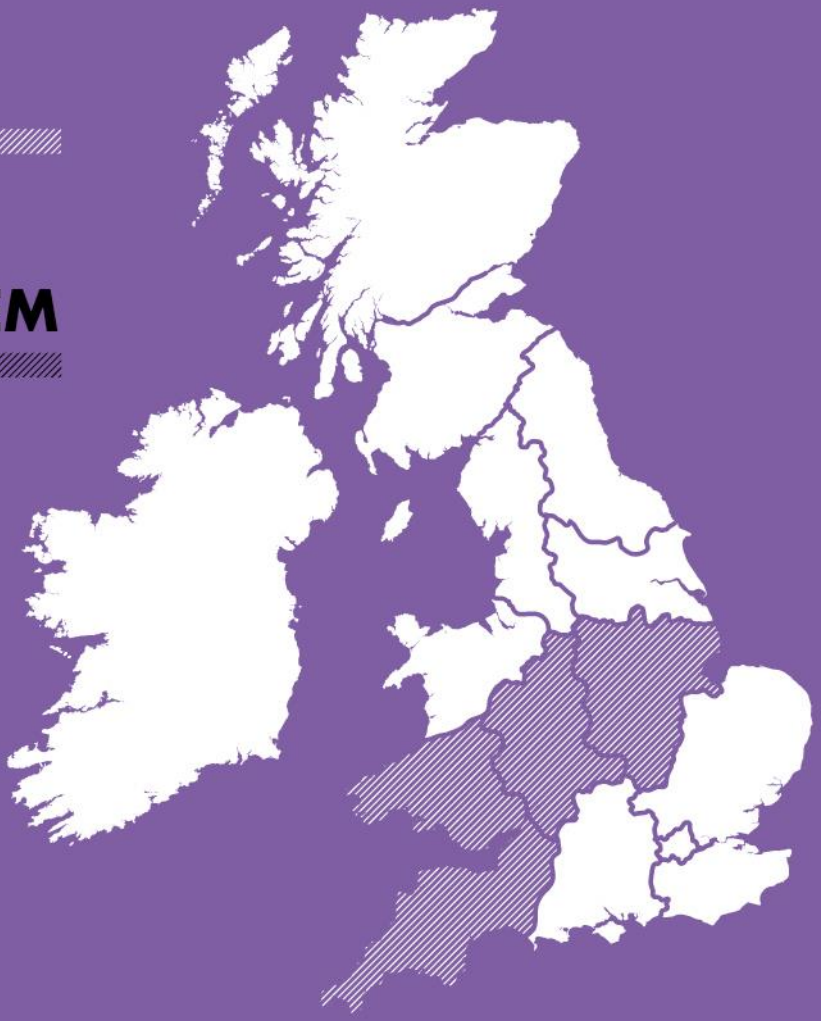
EFFS

ELECTRICITY FLEXIBILITY AND FORECASTING SYSTEM

EFFS

WPD_EN_NIC_003



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System Design: Optimisation

RIIO NIC NETWORK INNOVATION COMPETITION

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	Name	Date
Prepared by:	Michael Pearson	09/10/2019
Reviewed by:	Jennifer Woodruff	09/10/2019
Approved by:	Ben Godfrey	14/10/2019
	Paul Hartshorne	15/10/2019
	Jonathan Berry	16/10/2019
	Sarah Hadfield	22/10/2019

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Telephone +44 (0) 1332 827446. E-mail wpdinnovation@westernpower.co.uk

1 Purpose of this document

The purpose of this design document is to specify how the optimisation requirements defined in the EFFS project's DSO Requirements Specification will be delivered from a functional perspective. This design document forms one of eight system design documents (listed below), namely the optimisation design document. The system design documents complement the System Design Summary Report, which contains an overview each functional area and the relationships between them.

- Forecasting;
- Capacity Engine;
- Service Management;
- **Optimisation;**
- Scheduling;
- Conflict avoidance and synergy identification;
- Market Interface;
- Reporting and Reconciliation.

In accordance with the EFFS Project Direction, this document forms part fulfilment of the Project's fourth deliverable to Ofgem, the 'EFFS system design specification'.

2 Executive summary

The optimisation function in EFFS will be supported by an Optimisation module in AMT-SYBEX's Affinity Networkflow[1] product. The Optimisation module is a linear algorithmic solver that enables optimisation for a number of procurement and dispatch factors, such as cost. Optimisation is performed in EFFS at the point when flexibility services are procured or dispatched. It assumes there are more services offered/available than are required by the DSO and that there is benefit in optimising the selection on a combination of financial and non-financial metrics. The Optimisation module will run for each Flexibility Management Zone (FMZ) set up in the system, assuming they align to a BSP. It will assess all potential "Available Flexibility" services against each "Required Flexibility" service.

Commercial optimisation i.e. the process of getting maximum value across multiple Flexibility Platforms whilst ensuring the service requirements are fulfilled, is the key focus of optimisation in EFFS. To reflect the dispatch principles defined for WPD's Flexible Power platform, EFFS will consider fairness and the minimisation of non-delivery of a service as optimisation criteria. While there is a lack of complete interoperability across Flexibility Platforms in terms of timelines and process, which are a condition required for carrying out cross platform optimisation, EFFS will optimise across platforms where possible

[1] https://www.amt-sybex.com/networkflow/

3 Glossary

Term	Definition
BSP	Bulk Supply Point
CLEM	Cornwall Local Energy Market
CMZ	Constraint Management Zone
Constraint	For EFFS purposes this refers to thermal network constraints (as opposed to voltage constraints)
DSO	Distribution System Operator
EFFS	Electricity Flexibility and Forecasting System
ESO	Electricity System Operator, i.e. the role carried out by National Grid ESO that includes national system balancing and frequency control
Flexibility platform	See Appendix 1 for details
Flexible Power	WPD branding for flexibility services and the name used to refer to the platform to deliver the procurement of flexibility services
FMZ	Flexibility Management Zone, a generic term within the AMT-SYBEX Networkflow application to describe an area where flexibility will be managed (equivalent to CMZ)
HH	Half Hourly electricity metering
kW	Kilowatt
Minimum dispatch response lead time	Defined by the Energy Network Association in "Open Networks Project DSO Service Requirements: Definitions", as 'Activation Period'
Minimum procurement response lead time	Defined by the Energy Network Association in "Open Networks Project DSO Service Requirements: Definitions", as 'Bidding Period'
Networkflow	Proprietary software suite developed, licenced and maintained by AMT-SYBEX relating to the management of flexibility services for electricity networks.
PSS®E	Transmission planning and analysis software provided by SIEMENS
Service types	Types of peak shaving flexibility services that will be supported by EFFS (namely pre-fault constraint management, post-fault constraint management, restoration support) See 'WPD EFFS_System Design_Service_Management' for details.
Utilisation Payment	A payment made for the dispatch of flexibility services
User	Users of the EFFS system are anticipated to be:

Term	Definition
	• **Forecaster and flexibility co-ordinator** up until the real time management, dispatch and monitoring. Note: both these roles do not currently exist but are required, as they do not map onto an existing business function. The flexibility co-ordinator role will have a very similar skill set to that of an outage planner, whereas the forecaster role will require individuals with a mathematical / statistical background and possibly some programming experience. • **Control engineer** for real time dispatch and monitoring of the network. • **System administrator** system and interface support, maintenance of master data, data cleansing.
WPD	Western Power Distribution

4 Related documents

Ref	Document title	Version	Date issued	Prepared by	Location
1	Revised_EFFS_FSP_Redacted_v2	2.0	06/07/2018	EFFS	Link
2	WPD_EFFS_DSO Requirements Specification_v1.0	1.0	24/05/2019	EFFS	Link
3	System Design Summary Report	2.0	25/10/2019	EFFS	Link
4	WPD EFFS_System Design_Market Interface	2.0	25/10/2019	EFFS	Link

5 System overview

5.1 Core functions overview

Figure 1 below is a diagrammatic representation of the functional areas within the EFFS project. The area that is the subject of this document is circled in red.

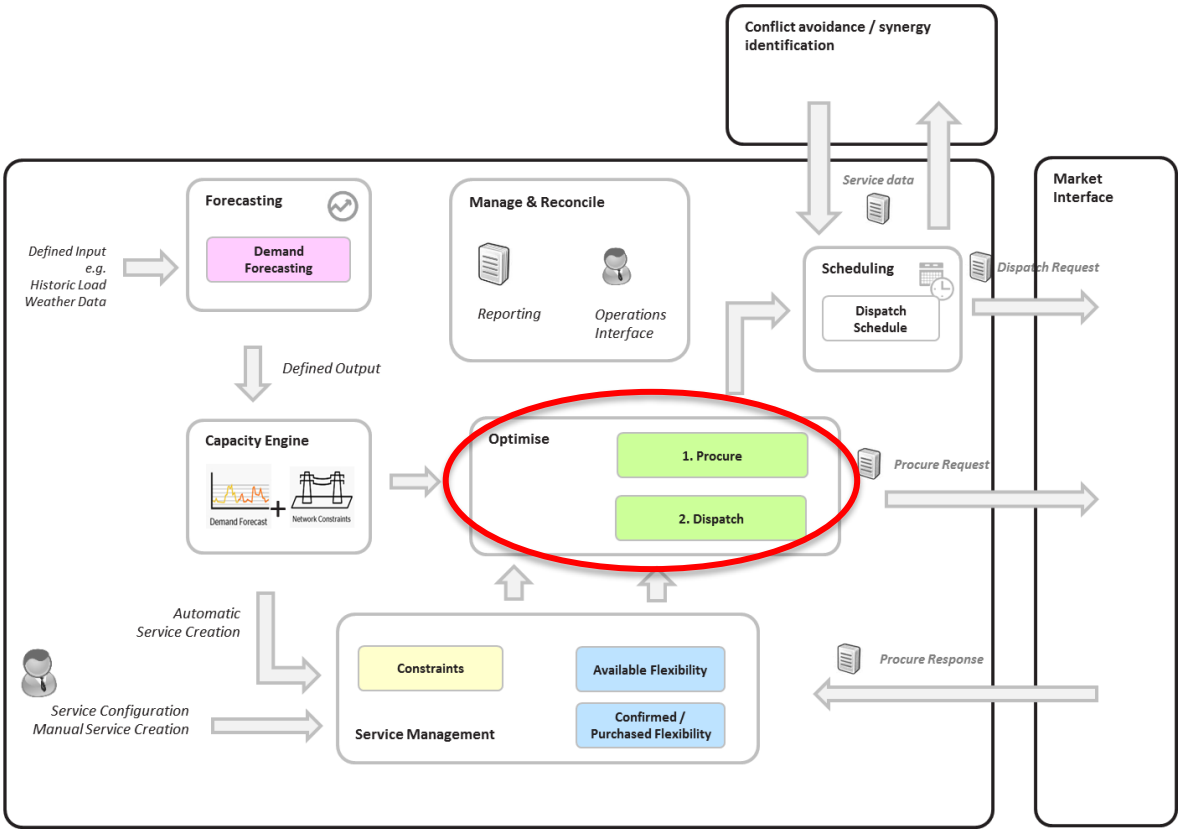

Figure 1: EFFS core functions

6 Optimisation

Optimisation is applied as part of EFFS when flexibility services are procured, reserved/utilised or dispatched. The optimisation function assumes there are more services offered/available than are required by the DSO and that there is benefit in optimising the selection on a combination of financial and non-financial metrics.

6.1 Scope

In scope	Out of scope
• Optimisation to support the procurement of flexibility services in order to meet a flexibility requirement; • Optimisation that will assess all requirements for flexibility and provide an optimised solution; • Optimisation of the dispatch of flexibility services in EFFS service register; and • Optimisation of flexibility services provided by WPD's Flexible Power platform and EDF's PowerShift platform.	• Network optimisation; • Validation of the optimisation output using Power Flow analysis; • Optimisation of the scheduled constraint and restoration support service type; and • Optimisation of flexibility services by Centrica's Cornwall Local Energy Market (CLEM) platform. As there is no feedback loop to select optimal assets at the platforms runs as an auction.

Table 1: Scope for optimisation

6.2 Description

The optimisation function in EFFS will be supported by an Optimisation module in AMT-SYBEX's Affinity Networkflow product. The Optimisation module is a linear algorithmic solver that enables optimisation for a number of procurement and dispatch factors, such as cost. The solver enables the configuration of parameters by users to give credence to the priority of optimisation based on the process they are used in. The Optimisation module will run for each Flexibility Management Zone (FMZ) set up in the system, assuming they align to a Bulk Supply Point (BSP). It will assess all potential "Available Flexibility" services against each "Required Flexibility" service.

For EFFS, the optimisation function will be run as part of two separate business processes:

1. **Procurement**
   During the procurement process, each requirement for flexibility will be submitted to a Market Platform (see Appendix 1 for EFFS definition), which may then respond with one of more services that meet the requirement. Where there are more services than needed to meet the requirement, Procurement Optimisation will be used to select which services to procure.

2. **Dispatch**
   During the dispatch process, each requirement for flexibility will be compared to the "Procured Flexibility" in the same FMZ. Where there are more services than needed to meet the requirement, Dispatch Optimisation will be used to determine which services to dispatch.

Commercial optimisation i.e. the process of getting maximum value across multiple flexibility platforms whilst ensuring the service requirements are fulfilled, is the key focus of optimisation in EFFS. To reflect the dispatch principles defined for WPD's Flexible Power platform, the following considerations have been applied to the optimisation criteria:

- Fairness; and
- Minimising the risk from non-delivery of service.

6.3 Assumptions

The following assumptions have been made during the design of the optimisation function:

- Costs for the delivery of a flexibility service will be captured as part of the Service Management process;
- The available flexibility services are fixed for the period of optimisation/analysis (i.e. they are not withdrawn or changed); and
- Pre-procured flexibility is already taken into consideration and is not required for Networkflow to Optimise as it is reflected in the load/ generation values used within PSS®E[2] (see 'Section 6 of the WPD EFFS_System Design_Capacity Engine Specification for further details). Failing to do so would likely lead to overestimation of requirements and unnecessary additional procurement. Similarly, where services are already confirmed to be reserved or dispatched this will be reflected in the process to optimise these processes.

6.4 Solution

6.4.1 Pre-requisites

The pre-requisites for the optimisation function stem from service management and capacity engine:

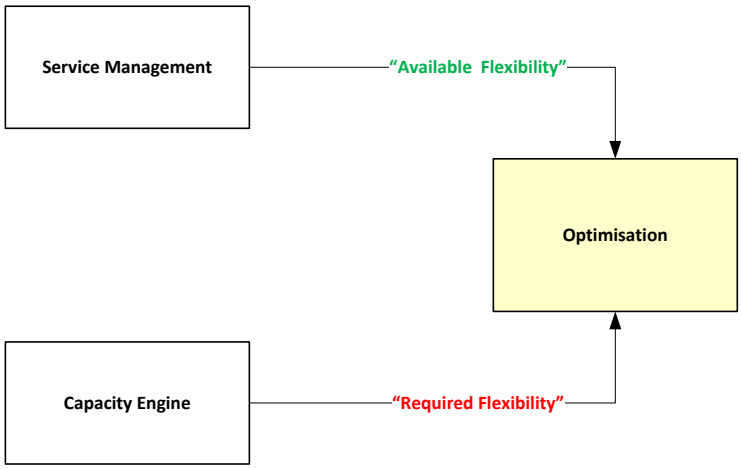

Figure 2: EFFS optimisation inputs

Service management

Service management will provide details of all "Available Flexibility" for the optimisation solution. Prior to an optimisation run taking place, it is assumed:

[2] https://new.siemens.com/global/en/products/energy/services/transmission-distribution-smart-grid/consulting-and-planning/pss-software/pss-e.html

- All “Available Flexibility” is defined in the service register database;
- Services have been validated to ensure that all parameters are correctly populated based on the service type;
- Each service is correctly associated to an FMZ; and
- Any outstanding procurement / market interaction process has been completed and the status of the service has been updated.

Capacity engine

Capacity Engine will provide details of all “Required Flexibility” from the optimisation solution. Prior to an optimisation run taking place it is assumed:

- Forecasts for a BSP / FMZ have been run through the Capacity Engine and “required flexibility” services have been created; and

- Services have been validated to ensure that all parameters are correctly populated based on the service type.

6.4.2 Input

The optimisation solution requires the following inputs:

- Flexibility service bids (either at the stage of procurement or dispatch) received from flexibility platforms as part of the EFFS processes (see ‘WPD EFFS_System_Design_Market_Interface’ Specification for details);

- Service requirements as defined via the service management process (see ‘EFFS System_Design_Service_Management’ Specification for details); and

- Optimisation configuration rules as per sections 6.4.5 and 6.4.6

6.4.3 Output

The optimisation function will produce the following output:

- The chosen services and associated delivery profiles that best satisfy the identified constraints as per the specified optimisation parameters. This output will be for the full Half Hourly (HH) profile of energy requirements that a service consists of rather than per individual HH.

6.4.4 Optimisation process

Optimisation will operate at the level of procurement and dispatch. Networkflow will contain a service register of all procured and dispatched services. In relation to procurement in particular, the optimisation will take into consideration the available services in the service register that are not confirmed in addition to the procurement request.

6.4.5 Optimisation timelines

EFFS will optimise as per the timelines for each service type per flexibility platform described in 'WPD EFFS_System_Design_Market_Interface'. Optimisation will consider all flexibility requirements for a week at a time for procurement, to allow for a holistic view of the operational week and also to allow the maximum number of activations parameter (PAR-15) to be enforced, and a day at a time for dispatch.

In addition, the time definition of a week will run from Monday 00:00 to Sunday 24:00.

6.4.6 Optimisation parameters

The optimisation solution will have a number of parameters that will be used across service types and processes. The below table contains the parameters available to a user to feed into the optimisation processes and the initial values to be associated with these. The determining of what parameters to use in what process such as procurement or dispatch will be determined by the configuration from a user such as what parameters will be used or not used in the optimisation.

There are two optimisation processes that relate to the different stages of the EFFS flexibility service life cycle: procurement and dispatch. The project will focus on a limited number of parameters to be utilised in the trials by the optimisation process at any one time from the available parameters below. The determining of what parameters to use will be defined in the build phase and can be changed during the trial.

Parameter ID	Parameter	DSO requirement spec ref	Data type	Units	Mandatory Parameter	Pre-Fault Constraint	Post-Fault Constraint	Notes and initial values
PAR-01	Reservation payment	6.4.5.4 6.5.5.5	NUMBER(4)	£/MW per HH.	Y	Y	Y	Initial value '0'. Due to the uncertainty around how procurement and payments will operate this value has been initially set to zero until such times as there is clarity to how procurement payments will operate in the market. This is equivalent to the reservation fee used by the ESO/DSO for certain services, and it not envisaged that any services to be supported by EFFS will have this.
PAR-02	Utilisation payment	6.4.5.6 6.5.5.7	NUMBER(4)	£/MWh	Y	Y	Y	Initial value £999 this is a maximum value per MWh. The utilisation payment is the price per MWh of delivery.

PAR-03	Bids for less than the full contiguous required period of flexibility services are permissible	6.4.5.7 6.5.5.19	Boolean	Boolean	N	Y	Y	It is assumed that this parameter can generate huge numbers of permutations of offerings that need to be presented to the optimiser engine. This would need to take account of how many different ways the shorter offering can be fit into the event assessment window i.e. for a 4 HH event a 3 HH contiguous offering can be fitted in in 2 ways and so on. If it then has to assess every permutation for the various contributing offerings against each other, then can create a massive loop of optimiser runs.
PAR-04	Bids for less than or more than the energy offered in each HH period within the full contiguous required period	6.4.5.8 6.5.5.20	Boolean	Boolean	N	Y	Y	
PAR-05	Non-contiguous bids are permissible	6.4.5.9 6.5.5.21	Boolean	Boolean	N	Y	Y	It is assumed that this parameter in non-linear and creates problems with the optimiser therefore will not be considered as part of the trial.

PAR-06	Cherry pick only some HH and/or portion of capacity	6.4.5.10 6.5.5.22	Boolean	Boolean	N	Y	Y	This parameter enables cherry picks of the HH that the DSO feels is better suited to their requirements. However, It is assumed that this parameter in non-linear and creates problems with the optimiser therefore will not be considered as part of the trial.
PAR-07	Minimum bid size	6.4.5.12 6.5.5.8	NUMBER(4)	MW	Y	Y	Y	Pre-Fault Constraint Management = 0.1MW. Post-Fault Constraint Management = 0.1MW. Restoration Support = 0.1MW. Enables the DSO to have the ability to limit bids to those received are of practical use in terms of size. All service instances of the relevant type will be validated against this criterion.
PAR-08	Maximum bid size	6.4.5.13 6.5.5.9	NUMBER(4)	MW	Y	Y	Y	Pre-Fault Constraint Management = 49. Post-Fault Constraint Management = 49. Restoration Support = 49. Initial value set to 49MWh as this is the largest theoretical

								generation on the network. All service instances of the relevant type will be validated against this criterion.
PAR-09	Minimum bid duration	6.4.5.14 6.5.5.10	NUMBER(4)	Minutes	Y	Y	Y	Pre-Fault Constraint Management = 30 minutes. Post-Fault Constraint Management = 30 minutes. Restoration Support = 30 minutes. Enables the DSO to have the ability to limit bids to those received are of practical use in terms of duration. All service instances of the relevant type will be validated against this criterion.
PAR-10	Maximum bid duration	6.4.5.15 6.5.5.11	NUMBER(4)	Minutes	Y	Y	Y	Pre-Fault Constraint Management = 1439 minutes. Post-Fault Constraint Management = 1439 minutes. Restoration Support = 1439 minutes. Initial value set to 1439 minutes (or 23hrs and 59 minutes) as this is the longest theoretical time generation can deliver in a day.

								All service instances of the relevant type will be validated against this criterion.
PAR-11	Minimum procurement response lead time	6.4.5.16 6.5.5.1	NUMBER(4)	Minutes	N	Y	Y	Initial value 30 minutes. This is the minimum amount of time a bid response can be received back. All service instances of the relevant type will be validated against this criterion.
PAR-12	The system will capture minimum dispatch response lead time	6.4.5.18 6.5.5.3	NUMBER(5)	Minutes	N	Y	Y	Pre-Fault Constraint Management = closer to real time (15mins) Post-Fault Constraint Management = real time (postfault; 15mins). Restoration Support = real time (postfault; commencement of service). The minimum time a provider requires notification to dispatch flexibility. All service instances of the relevant type will be validated against this criterion.

PAR-13	Maximum ramping period	6.4.5.19 6.5.5.4	NUMBER(5)	Minutes	Y	Y	Y	Pre-Fault Constraint Management <= 15 minutes. Post-Fault Constraint Management <= 15 minutes. Restoration Support = 0. This is the maximum amount of time a provider requires to ramp up the asset/s to deliver the required flexibility. All service instances of the relevant type will be validated against this criterion.
PAR-14	Minimum full activation period (i.e. the minimum continuous block of HH services an asset must provide)	6.4.5.20 6.5.5.12	NUMBER(4)	Minutes	Y	Y	Y	Pre-Fault Constraint Management = 30 minutes. Post-Fault Constraint Management = 30 minutes. Restoration Support = 30 minutes Initial values set to 30 as the is timing of a HH period. All service instances of the relevant type will be validated against this criterion.
PAR-15	The system will capture maximum number of activations (per day, per week)	6.4.5.22 6.5.5.14	NUMBER(3)	Numeric	Y	Y	Y	Initial Value per day '12' and per week '48'. This limits the number of times a provider is called per day. All service instances of the relevant type will be validated against this criterion.

PAR-16	Minimum number of participants to fulfil power / energy requirement per event as a service parameter.	6.4.5.23 6.5.5.29	NUMBER(1)	Numeric	N	Y	Y	Initial Value = '1' This allows the DSO to spread the risk of non-delivery by ensuring no single party has responsibility to deliver all the flexibility in a half hourly period. This parameter would be used by the optimisation process. All service instances of the relevant type will be validated against this criterion.
PAR-17	Maximum number of participants to fulfil power / energy requirement per event as a service parameter.	6.4.5.24 6.5.5.30	NUMBER(2)	Numeric	N	Y	Y	Initial Value = '99' This would allow the optimisation process to limit the number of providers contributing towards the flexibility in a half hourly period. If this is not required, setting this to a high value will remove its impact on the optimisation process. All service instances of the relevant type will be validated against this criterion.
PAR-18	Minimum percentage of energy in the HH sourced from 1 asset to fulfil energy requirement	6.4.5.23 6.5.5.31	NUMBER(1)	Numeric	N	Y	Y	Initial Value = '0' This would allow the optimisation process to limit the number of providers contributing towards the flexibility in a half hourly

								period. A similar effect could be achieved by specifying larger values for the minimum bid size, so it may be that this field is not used in practice. If this is not required, setting this to a low value will remove its impact on the optimisation process. All service instances of the relevant type will be validated against this criterion.
PAR-19	Maximum percentage of energy in the HH sourced from 1 asset to fulfil energy requirement	6.4.5.26 6.5.5.32	NUMBER(1)	Numeric	N	Y	Y	Initial Value = '1' equals 100%
PAR-20	Availability windows (i.e. actual HH values for which the service is available)	6.4.5.35 6.5.5.13	TBC	TBC				Included for future proofing. Not expected to include in EFFS may be reviewed in the trials.
PAR-21	Reliability factor for an organisation	6.4.5.27 6.5.5.15	TBC	TBC				Included for future proofing. Not expected to include in EFFS may be reviewed in the trials.
PAR-22	Reliability factor for an asset	6.4.5.28 6.5.5.16	TBC	TBC				Included for future proofing. Not expected to include in EFFS may be reviewed in the trials.

PAR-23	Reliability factor for a market	6.4.5.29 6.5.5.17	TBC	TBC				Included for future proofing. Not expected to include in EFFS may be reviewed in the trials.
PAR-24	The system will allow the percentage of over procurement / dispatch of energy per peak shaving event to be configurable.	6.5.5.23	BOOLEAN	Boolean				Included for future proofing. Not expected to include in EFFS may be reviewed in the trials.
PAR-25	Where the outcome of all optimisation criteria is equal the system will choose the asset that was used less recently. If this factor does not differentiate then the choice of asset will be as close an approximation of random as can be created.	6.5.5.18	TBC	TBC				Included for future proofing. Not expected to include in EFFS may be reviewed in the trials.
PAR-26	The system will auto accept all bids where no cost is incurred.	6.5.5.27	BOOLEAN	Boolean				Included for future proofing. Not expected to include in EFFS may be reviewed in the trials.

PAR-27	The system will allow the percentage of over procurement / dispatch per flexibility platform to be configurable.	6.5.5.24	TBC	TBC				Included for future proofing. Not expected to include in EFFS may be reviewed in the trials. Note: this is to manage non-delivery for a whole platform, so to mitigate the risk of platform X not delivering the expected flexibility services you would increase the over procurement dispatch for platform Y accordingly. This would also decrease as the number of flexibility platforms used increases as a single platform's failure has less impact.

Table 2: Optimisation parameters

6.5 Changes since DSO requirements document baselined

Within the EFFS trial we have opted to drop the 'Arming' signal exchange as outlined in the previous phase for two main reasons. The first is that it is deemed to be unnecessary within the timescale of the purchase procedure as being tested within EFFS. In the majority of cases the procurements from the marketplaces will take place just a week ahead of the required delivery from the participants and they will be making their submissions to the marketplace within such close proximity to real time that it is not deemed to improve the reliability of the service being procured. It will in fact add unnecessary exchanges of data that potentially elevate the barrier to entry by any participants without offering any real benefit to the service model. The greater concern however is that by calling this an 'Arming' signal it is most likely to undermine the clarity of the understanding that has been developed in relation to the BAU services that are already operational within the WPD Flexible Power 'Secure', which provide a scheduled 'pre-fault flexibility' service.

7 Contact

If you have any questions relating to this document, please use the following points of contact:

Future Networks Team:

Western Power Distribution,
Pegasus Business Park,
Herald Way,
Castle Donington,
Derbyshire
DE74 2TU

Email: jwoodruff@westernpower.co.uk

Appendix 1: Definition of flexibility platform

'Flexibility Platform' is a term used throughout this document and is deliberately generic due to the current lack of cross-industry consensus on what this role entails and the differences between the existing platforms. Whilst it is not the purpose of EFFS to specify how these platforms will operate, the project makes various assumptions about what functions they will perform throughout the document. For ease of reference these are collated in the table below. Please note that this list is not an exhaustive; it is an overview of assumed flexibility platform capabilities and their relationship to EFFS.

Function	Carried out by flexibility platform?	Required by EFFS?
Interface for registering flexible resources	Yes	Yes
Allows buyers and sellers to match their requirements	Yes	Yes
Communication with flexibility resources	Yes	Yes
Dispatch of flexibility resources	Yes	Yes
Commercial optimisation	Yes	No, as EFFS will use multiple platforms therefore needs a cross platform view
Conflict avoidance with other parties	Yes	No, as EFFS will use multiple platforms therefore needs a cross platform view
Synergy identification with other parties	Yes	No, as EFFS will use multiple platforms therefore needs a cross platform view
Settlements (payment of flexibility providers)	Yes	Yes
Measurement of flexibility providers performance	Yes	Yes

Table 3: Flexibility platform functions