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Transforming the electricity network

EFFS PPR5

NIC Major Project Progress Report

October 2020 – March 2021

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Contents

1. Executive Summary

The Electricity Flexibility and Forecasting System Project (EFFS or “the Project”) is funded through Ofgem’s Network Innovation Competition (NIC) and has a budget of £4,311,680. EFFS was registered on 28 September 2018 and will be complete by 29 October 2021.

EFFS supports the Distribution System Operator (DSO) transition by developing and trialling a system to plan and dispatch flexibility services in operational timescales. EFFS is split into four workstreams:

1) Forecasting Evaluation and Requirements;
2) Implementation;
3) System and Trials Testing; and
4) Collaboration and Learning.

The Project is working collaboratively with the Scottish and Southern Electricity Networks’ TRANSITION project and Scottish Power Energy Networks’ FUSION project. Together with EFFS these projects are collectively known as the TEF Group. All three TEF projects are coordinating with the Energy Network Association’s Open Networks project.

This report details progress of the Project, focusing on the last six months, October 2020 – March 2021.

1.1. Business Case

There have been no changes to the benefits case to date. For information, the original business case benefits are included in Appendix 1.

1.2. Project Progress

This document is the Project’s fifth six-monthly project progress report and covers progress from October 2020 to the end of March 2021. The fourth progress report, spanning April 2020 to September 2020, covered the finalisation of the EFFS system design and architecture, as well as the internal testing and deployments of Affinity Networkflow and the power flow analysis interface, known as the EFFS Tool, onto WPD infrastructure. Since then, the Project has completed its onsite testing and trials planning phases, which included the following key achievements:

- Completion of System Integration Testing (SIT) of the EFFS system by stakeholders, with focus on input data interfaces, Affinity Networkflow and the EFFS Tool.
- Completion of User Acceptance Testing (UAT) of the EFFS system, with focus on input data interfaces, Affinity Networkflow and the EFFS Tool. The phase culminated with formal acceptance of these products.
- Successful completion of Penetration Testing by a third-party penetration tester of input data interfaces, Affinity Networkflow and the EFFS Tool.
- Completion of Ofgem Project Deliverable 6: Onsite System Testing.
- Production of trials planning documentation, including trials strategy and schedule documents as well as a cooperation plan with the TEF Group.

- Completion of Ofgem Project Deliverable 7: Trials Design and Preparation.
- Commencement of the EFFS trials phase.

1.3. Project Delivery Structure

1.3.1. Project Review Group

The EFFS Project Review Group meets on a bi-annual basis. The role of the Project Review Group is to:

- Ensure the project is aligned with organisational strategy;
- Ensure the project makes good use of assets;
- Assist with resolving strategic level issues and risks;
- Approve or reject changes to the project with a high impact on timelines and budget;
- Assess project progress and report to senior management and higher authorities;
- Provide advice and guidance on business issues facing the project;
- Use influence and authority to assist the project in achieving its outcomes;
- Review and approve final project deliverables; and
- Perform reviews at agreed stage boundaries.

1.3.2. Project Resource

Project resources include a Project Manager/User of the EFFS system in trials and an Information Resources engineer. The Project Manager/User is primarily being supported by AMT-SYBEX resource which includes a Project Manager and three Networkflow consultants. Further resource from PSC Consulting is also providing a Project Manager/Support member. The Flexibility Market Platforms CLEM, EDF PowerShift and Flexible Power are providing ad-hoc resource. National Grid ESO resource is currently to be determined.

1.4. Project Risks

A proactive role in ensuring effective risk management for the EFFS project is taken. This ensures that processes have been put in place to review whether risks still exist, whether new risks have arisen, whether the likelihood and impact of risks have changed, reporting of significant changes that will affect risk priorities and deliver assurance of the effectiveness of control.

Contained within Section **Error! Reference source not found.**7 of this report are the current top risks associated with successfully delivering the Project as captured in our Risk Register. Section 7 provides an update on the most prominent risks.

1.5. Project Learning and Dissemination

Project learning and what worked well are captured throughout the project lifecycle. These are captured through a series of on-going reviews with stakeholders and project team members and are shared with the industry at appropriate points throughout the project lifecycle. The latest learning points from this reporting period are reported in Section 5 of this report.

2. Project Manager's Report

2.1. Project Background

The EFFS project was awarded funding in October 2018 under the 2017 Network Innovation Competition (NIC). It has specified and is trialling the additional system functionality required by a Distribution Network Operator (DNO) to help the transition to DSO as given in the following objectives:

- Enhancing the output of the ENA Open Networks project, looking at the high-level functions a DSO must perform, provide a detailed specification of the new functions validated by stakeholders, and the inclusion of specifications for data exchange;
- Determining the optimum technical implementation to support those new functions;
- Creating and testing that technical implementation by implementing suitable software and integrating hardware as required; and
- Using and testing the technical implementation, which will involve modelling the impact of flexibility services.

The Project Partners involved in EFFS are:

- Western Power Distribution: Project Lead/Funding DNO (licensee);
- AMT-SYBEX: Third Party Lead Supplier; and
- National Grid Electricity System Operator (ESO).

Furthermore, the Project has the following key stakeholders:

- Energy Network Association's Open Networks project;
- Scottish and Southern Electricity Networks, as Project Lead/Funding DNO (licensee) of the TRANSITION project;
- Centrica as managers of the Cornwall Local Energy Market project;
- EDF Energy; and
- PSC Consulting: Developers of the EFFS Tool.

The Project is made up of four workstreams, which support the Project's objectives. These are depicted in Figure 1: EFFS timeline. The blue shaded area represents the reporting period for this project progress report.

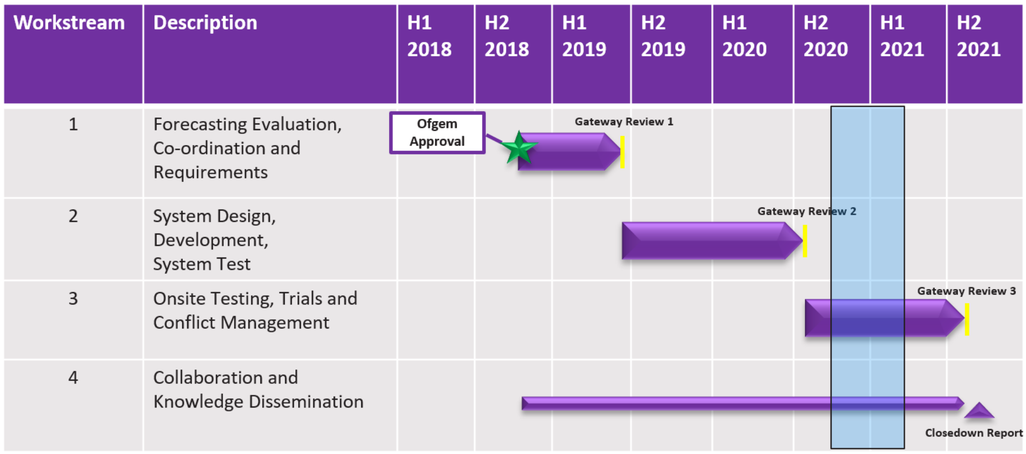

Figure 1: EFFS Timeline

2.2. Project Progress

The Project has progressed well in the last six months despite the challenges posed by the coronavirus pandemic and the intermittent engagement from stakeholders. Project work has been carried out remotely through home-working and communication facilitated via Zoom and Webex. To enable more practical and enduring remote access, the Information Resources team has also implemented a remote access solution for contractors. In this reporting period, the Project completed its onsite testing and trials planning phases, which included the following key achievements:

- Completion of System Integration Testing (SIT) of the EFFS system by stakeholders, with focus on input data interfaces, Affinity Networkflow and the EFFS Tool.
- Completion of User Acceptance Testing (UAT) of the EFFS system, with focus on input data interfaces, Affinity Networkflow and the EFFS Tool. The phase culminated with our formal acceptance of these products.
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2.2.1. Onsite Testing

The onsite testing phase took place between October 2020 – January 2021, following successful deployment of AMT-SYBEX's Affinity Networkflow and PSC Consulting's EFFS Tool onto WPD infrastructure. In preparation for onsite testing, an Onsite Test Approach was created to ensure alignment of expectations between stakeholders for the phase, including details on approach, entry/exit criteria, and roles and responsibilities. A test plan and workbook were also created for each stage of the testing. The documents went through review and approval cycles. These products provided clear instruction for each stakeholder and enabled the Project to manage and document the onsite testing effectively.

The onsite testing phase was structured into two iterative test stages: SIT and UAT. SIT was coordinated by the WPD project manager and executed by WPD, AMT-SYBEX and PSC Consulting to validate that the software components are combined and interact as required on WPD infrastructure. The scope focused on WPD input data interfaces, AMT-SYBEX's Affinity Networkflow product and PSC Consulting's power-flow analysis interface, the EFFS Tool. The testing was split into 9 sub-modules. Figure A2 in the appendix displays an overview of the interfaces tested during SIT.

Each module was first tested separately using real or simulated input data. The output from each module was compared against the expected results as per original design documentation. Finally, a full end-to-end test cycle was performed on the system.

In total 50 tests were executed in relation to Affinity Networkflow, all of which passed. 9 medium/low defects were raised during SIT, which were resolved at the AMT-SYBEX development centre and fixes deployed to the WPD infrastructure. The test stage culminated in the production of a SIT Exit Report, which was reviewed and approved, and enabled the Project to move into the UAT stage.

The second stage of onsite testing was UAT, which was coordinated and executed by WPD on the EFFS system, with third-line support from AMT-SYBEX and PSC Consulting. UAT was split into a front-end user test, back-end user test. Figure A3 in the appendix provides an overview of this. The front-end user test focused on modules 1, 2, 3 and 4 as described in Figure A1. Here, the user replicated data input that determined if constraints are apparent and whether flexibility services are required. The user then performed the back-end user testing, focusing on modules 5, 6, 7, 8 and 9 as described in Figure A1. Here, the user replicated data input that will determine how the system will select the appropriate flexibility service to resolve a constraint.

There were 7 defects identified with User Acceptance Testing (UAT), all of which have since been resolved. The recommendation from the completion of the UAT phase was that the Exit Criteria have been met and the solution is suitable to move into trials after the project's trials planning phase has been completed.

2.2.2. Examples of test evidence

Cleansing Raw Time Series Data

The screenshot in Figure 2 highlights the EFFS Tool cleansing raw time series data which is exported as daily from WPD's Network Management System. Raw time series data is cleansed to check for either bad / missing data or illogical values that will need resolving before it can be processed further. This ensures that the data will be of a good quality and format that is suitable to be passed to Networkflow for forecasting purposes. In principle, the tool will perform the following checks:

1. Derive real power (MW) and reactive power (MVAr) using voltage (V) and current (I) values and typical power where the former are absent from the data.
2. Check the sign convention between the SCADA values in the raw time series file and the PSS/E values for load and generation and apply a scaling factor of either +1 or -1.

3. Statistical analysis will be used to identify the typical maximum and minimum load and generation values from the provided historic data and assume an additional margin/factor.

The specific parameters will be determined during the initial processing of the full historic datasets as part of a tuning exercise. The real and reactive power values will be compared to those limits and, if exceeded, will be considered as abnormal values which require replacing using one of the following methodologies:

a) If a single missing value is identified for a certain HH step, an interpolation between the previous and next valid HH measurements will be considered.
b) If a significant number of HH values are missing, such as for an entire day then these will be based on the same time step and day of the week.

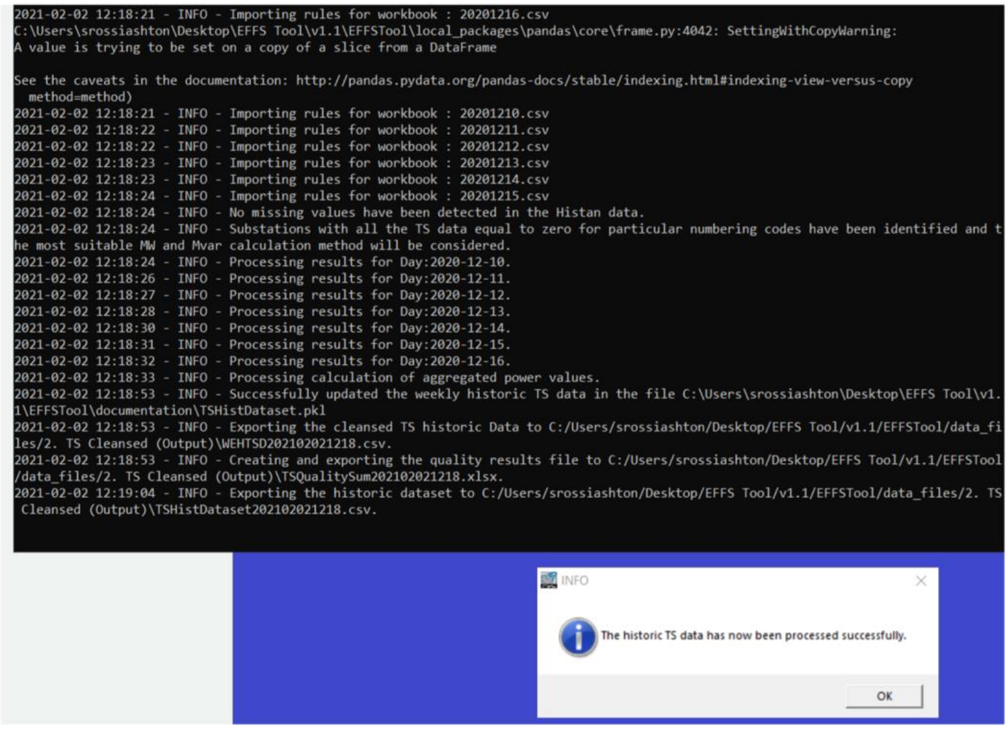


Figure 2: Raw time series data being cleansed successfully by the EFFS Tool.

Forecasting

An aspect of the on-site testing was the testing of Networkflow forecasting functionality. Figures 3-5 provide an illustrative insight into this testing. Figure 3 displays a screenshot of the trial sites that forecasts were produced for.

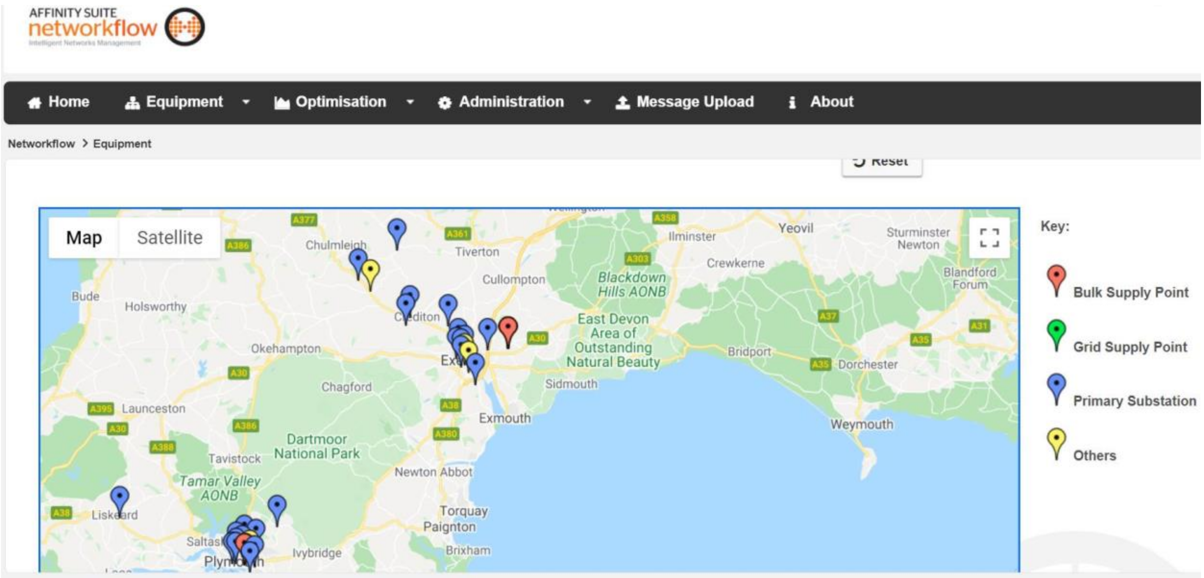


Figure 3: Networkflow screenshot of trial site locations

The inputs to a forecast were historic load and weather data and forecasts were then scheduled in Networkflow. Once a forecast was run, the actual values were loaded into Networkflow for comparison with the forecast to assess accuracy, see Figure 3 for an example (orange = forecast, green = actual).

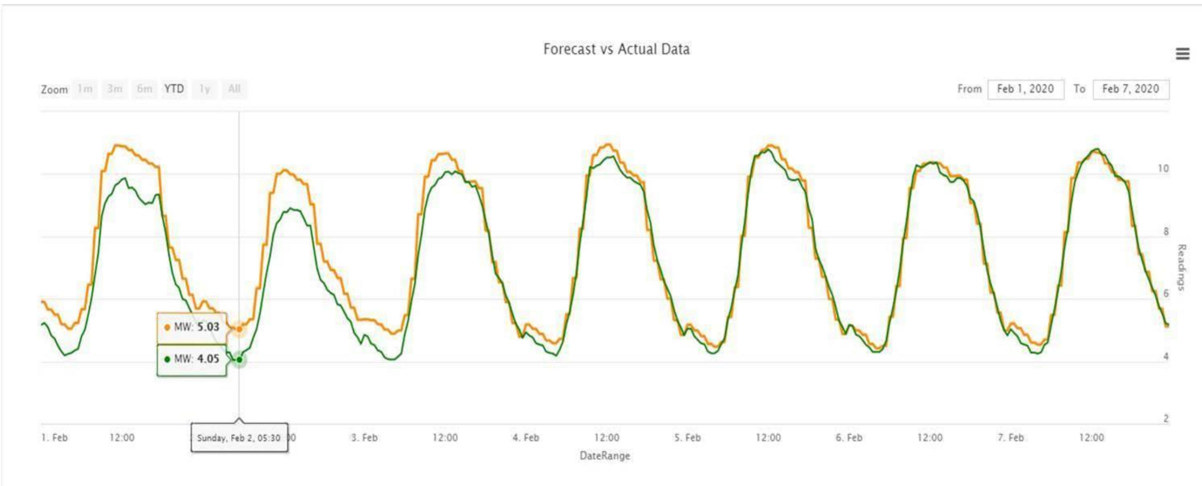


Figure 4: Networkflow screenshot of forecast vs actual values

The forecast data were then fed into the power flow analysis process, supported by the EFFS Tool, to identify any constraints and requirements for flexibility. Below is a set of flexibility requirements successfully loaded into Networkflow as an output from power flow analysis.

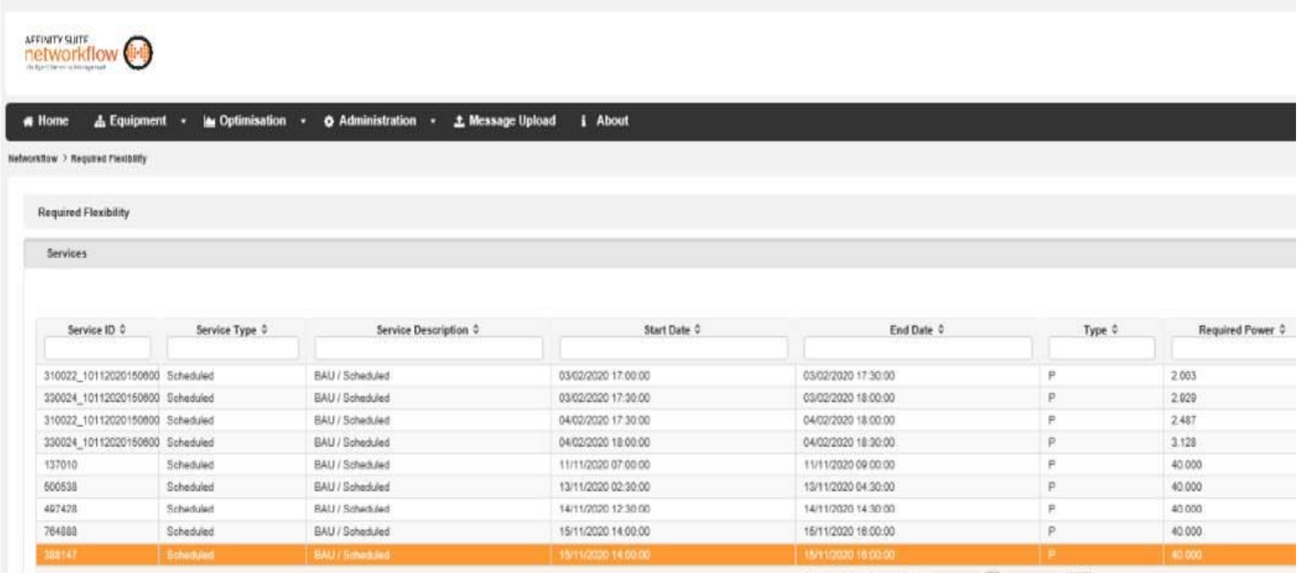


Figure 5: Networkflow screenshot of forecast vs actual values

Export of bid information to the market platforms

Figure 6 is an example of the contents of a file outputted by Networkflow to be ingested by a flexibility market platform (in this case CLEM). This file serves to communicate flexibility requirements to resolve the constraints identified in the EFFS Tool's power flow analysis.

Transaction Type	Publish Requirements
Transaction ID	2.02012E+19
Transaction Datetime	2020-12-16T10:17:56.982Z
Network Location	W98NN9MDX0
Service Type	Secure
HH Datetime	2020-12-28T10:30:00Z
Power Requirements	10
HH Datetime	2020-12-28T11:00:00Z
Power Requirements	10
HH Datetime	2020-12-28T11:30:00Z
Power Requirements	10
HH Datetime	2020-12-28T12:00:00Z
Power Requirements	10

Figure 6: A screenshot of the CSV file outputted by Networkflow to seek flexibility availability from, each of the three market platforms.

Import of bid information from the market platforms

Figure 7 shows the contents of a response file (in this case dummied for testing). It details the availability of flexibility from a market platform. An availability file is expected from each of the three market platforms that Networkflow has been configured to interact with. The contents of these the files will be processed in aggregate by the Networkflow optimisation engine to fully resolve the constraints identified by the EFFS Tool's power flow analysis.

Transaction type	Procurement Response
Transaction ID	2.02E+19
Transaction Datetime	2020-12-15T10:44:01.351Z
Network location	437360
Service type	Secure
HH Datetime	2021-01-10T17:00:00Z
Power available	80
Asset ID(s)	437360
MPAN(s)	1.00E+12
Actual market procurement payment	15
HH Datetime	2021-01-10T17:30:00Z
Power available	80
Asset ID(s)	437360
MPAN(s)	1.00E+12
Actual market procurement payment	15

Figure 7: A screenshot of the CSV file generated by each of the market platform to communicate to Networkflow the availability of its assets to participate in flexibility.

2.2.3. Trial Planning

The Project is undertaking a 24-week trial which commenced mid-February 2021 and will last until the end of July 2021. The trial areas selected are in the WPD South West licence area, specifically in the areas surrounding Plymouth and Exeter. The rationale for selecting this area is:

- A number of flexibility schemes and platforms operate in this area meaning there is engagement that can be leveraged;
- There are a range of sites, locations and asset types; and
- A switch level network model is in place which is a pre-requisite for power flow analysis and constraint analysis.

The Project's trial phase is made up of three phases:

1. **Initiation (2 weeks)** – commencement of initial trial activities including data preparation, system pipe-cleaning and a first load over a continuous availability period to check the behaviour of the solution.
2. **Operation (18 weeks)** – execution of operational trialling of the system under a variety of loads (normal and peak conditions). The system will run using live data that can be modified to simulate constraints (as required). This phase will also include trialling of the system beyond current operational capacity. This will involve stress testing to simulate expected scenarios for 2030, where much higher volumes connected generation, more challenging load profiles, reflecting future levels of EVs and heat pumps, but also where greater availability of flexibility services are anticipated.
3. **Closedown (2 weeks)** – final extraction and analysis of trial data and evidence to support the closedown report.

2.2.4. Trial Methods

Forecasting Approach

A key requirement for the EFFS project is to accurately forecast flexibility requirements over various timeframes. The output from forecasting is then inputted into constraint analysis to establish flexibility requirements. A forecasting algorithm was developed to forecast over different time horizons, namely:

- Day ahead;
- Week ahead;
- Month ahead; and
- Six months ahead

The Project will run forecasts over these operational time horizons for different periods, assessing the accuracy and effectiveness of the forecasts over time and per forecast time horizon. The primary operational process developed for the trials involves flexibility procurement on a weekly basis, with week ahead forecasts running each week to determine flexibility requirements for the following week. In addition to measuring the effectiveness of forecast time horizons the trial will also test which forecast features, such as historical weather data to inform the load profiles, are effective for each substation within the trial area. As substations present different localised behaviour, the trial will look to find what is the most optimal features for each substation to get the best results based on the localisation each the substation based on the default features recommended when the forecast algorithm was developed. For example, predictions for substations with higher penetration of renewables may be more accurate when using weather data. Ongoing feeds of historic load and weather data will be fed into the process to support this assessment of forecast features.

The output of the forecasting of the trials will demonstrate the effectiveness of the forecasts per time horizon based on the Mean Average Percentage Error (MAPE). The MAPE is the chosen accuracy metrics for measuring the quality of the predicted values vs the actual values. In addition, document the effectiveness of forecast features based on substation areas.

Constraint Analysis Methods

During the trials, the EFFS tool will receive all the defined input data and the forecasting load and generation data and perform PSSE load flow studies to calculate asset loading in the regions of interest. The results of the power flow analysis are checked against a user defined threshold value to identify assets with a loading above the user defined threshold limit for each HH period and identify system constraints and the associated flexibility requirements.

The key aspects of constraint analysis include identification of network constraints under normal running arrangement and under outage conditions (including planned and post-fault network outages), and the simulation of active network management (ANM) scheme. The system then goes on to calculate flexibility requirements for resolving network constraints as well as sensitivity factors of the assets.

Consideration of planned network outages

Planned network outages refer to outages which are scheduled to take place for particular time periods. During each simulation these will be considered as the starting system configuration rather than the intact system. In order to accurately represent the planned outages the following details will be provided on a regular basis:

- Asset(s) to undergo the outage;
- Time when outage is expected to start and finish.

Consideration of unplanned network outages

Post-fault outages refer to network configurations that occur after a fault has occurred and the necessary fault clearing actions have been completed. These fault clearing actions include isolating the faulted network asset as well as automated inter-tripping schemes to reconfigure the network. These contingencies may result in a constraint in the WPD network for which a flexibility service provider could be considered and avoid the disconnection of any load in line with the ENA P2-7 requirements.

Consideration of ANM Activity

Active network management schemes are implemented within the WPD distribution network in the areas where there are known multiple constraints. Frequently, ANM schemes maintain the system within operational limits in quasi real-time by applying the curtailment of wind or solar generation. WPD utilises a Last In First Out (LIFO) arrangement for their existing ANM schemes, i.e. the first non-firm generator to be curtailed under a constraint event is the last non-firm generator to connect to the network or added to an ANM scheme. At this stage, the control logics associated with WPD's ANM customers under the LIFO arrangement are not available within the PSSE model. Therefore, the simulation of ANM activity will be conducted based on a simple rule which is to curtail the generation output of an ANM customer to the minimum level when there is a local constraint in the proximity of the ANM customer.

Identifying Constraints

The high-level steps of the code developed for identifying cable thermal violations for each HH step are as follows:

- Retrieve the loading of all the lines / cables in the region of interest;
- Identify lines / cables with branch MVA flows greater than the user defined threshold defined in percent of the summer MVA rating.

The high-level steps of the code developed for identifying transformer thermal violations for each HH step are as follows:

- Retrieve the loading of all the transformers in the region of interest;
- For each transformer determine if the power is flowing from HV to LV (forward power) or LV to HV (reverse power);
- For transformers with forward power, identify transformers with branch MVA flows greater than the user defined threshold defined in percent of the cyclic plate rating;
- For transformers with reverse power, identify transformers with branch MVA flows greater than the user defined threshold defined in percent of the reverse power rating.

Thermal violations are then combined to calculate network constraints that will be utilised in the flexibility services calculations.

Contingency Analysis

Since full contingency analysis for every time step can take a significant amount of time, a methodology has been implemented to reduce the number of contingencies being studied. The methodology accounts for analysis of the most critical contingencies to ensure compliance. It also follows a dynamic approach because it is not possible to apply a general rule as to which contingency will be the most critical due to the changing load and generation profiles on a weekly basis. The high-level steps of the code developed for identifying the most critical contingencies are as follows:

- Run load flow studies for the weekly extreme scenarios covering all the contingencies to identify the worst contingencies;
- Check whether any network constraint has been identified:
  - If there are no network constraints, the process ceases since it is expected that no constraints exist and so there is no need for a flexibility service.
  - If there are network constraints, record all the contingencies and check whether a further contingency reduction is applied by the user:
    - If there is no further reduction, proceed with the calculation of the constraints and sensitivity factors for the following week.
    - If there is further reduction, select the most critical contingencies that result in the highest branch loading and then proceed with the calculation of the constraints and sensitivity factors for the following week. The maximum number of critical contingencies to be selected is directly defined by the user.

Procurement and Selection of Services

The Project has three requirements for the Procurement and Selection of Services, namely:

- Measuring of asset response times;
- Validating that the selection of flexibility assets by the software is optimal; and
- Validating the expected operating costs of flexibility services.

Measuring asset response times

Each asset is instructed by the respective market platform ahead of time to dispatch flexibility for a period of time. To measure the asset response times the project will obtain data from the flexibility providers, such as flexibility dispatch time, and compare this to the service start date and time. This would inform if the asset began dispatch for flexibility began at the actual start of the service and if there was any delay or substantial failure. The output of this analysis would show how effective flexibility assets are in responding to flexibility requests when instructed to deliver services.

Validating the selection of flexibility assets by the software is optimal

After market bids are received the software used by the project will run optimisation to find the most optimal bid for the requirement(s). This is achieved through several different parameters such as asset reliability and these inform the optimisation logic to select the lowest cost service based on the selected parameters being met.

To measure how optimal the software is the project will perform analysis of the available flexibility inputted into the optimisation against the optimisation selection. The analysis would validate that the correct selection has been made by analysing the:

- The cost of flexibility for each MW;
- The sensitivity factor of the substation versus the flexibility location; and
- The parameters used in the optimisation.
    - There are 27 parameters used in the optimisation process[1].

The project will also look to evaluate the optimisation parameters as specified in the design phase of the project. This will assess the effectiveness of each parameter based on in real world scenarios. This will establish which parameters are deemed most important or relevant given the (lack of) liquidity available to the project or what will be useful in the future.

This will be achieved using a range or combination of specific parameters while performing procurement optimisation. This will be done using a combination of two environments, the first being the actual trials environment and then a test environment to then compare different options without impacting the procurement process.

The output of the analysis will demonstrate how optimal the software is at optimising the procurement of flexibility and which optimisation parameters hold most relevance. This will be demonstrated using live scenarios but also conducting academic studies.

[1] See System Design: Optimisation at https://www.westernpower.co.uk/downloads-view-reciteme/64081

Validating the expected operating costs of flexibility services

A key element to the trial is being able to measure the expected operating costs of running Flexibility Services in the Open Networks Scenario World-B[2]. Throughout the work and analysis taken the project will gather data related to the costs of a DSO operating flexibility services. This should take into consideration:

- Cost of actual flexibility purchased;
- Resource required to operate the process; and
- Overheads associated with managing the process.

The output of the analysis would demonstrate the expected running costs to operate flexibility services outlined in the ENA's Open Networks World-B.

Conflict Avoidance

The Project set out to engage with NGESO at an early stage and through detailed discussions it was found that a bespoke API to identify and resolve constraints would not be able to be developed as the majority of NGESO flexibility services are not planned so would not be subject to a 'world B' conflict avoidance approach where there is a reliance on advance visibility of services by both parties. However, the project will still seek to develop a process to assist in conflict avoidance. Using the data from the trials we will aim to finalise a more manual process. The project is therefore unable to specify and build an automated solution for conflict avoidance with NGESO.

Nevertheless, the project has developed a process to assist in conflict avoidance in the trials. NGESO have shared the assets for flexibility services within the EFFS trial area. If any services are procured by EFFS using these assets, then this will be flagged and shared with NGESO. Both parties will assess any impact and determine what corrective action is required (if any).

Stress Testing

A key requirement for the trial is to stress test the solution by mirroring the future energy scenarios predicted in 2030. This exercise will be a laboratory exercise given the current running arrangements are not mature enough to produce real world results that the future energy scenarios predict. The project will aim to test each of the following future energy scenarios[3] below:

- Steady Progression;
- Consumer Transformation;
- System Transformation;
- Leading the Way.

[2] World B: Coordinated DSO-ESO Procurement and Dispatch - https://www.energynetworks.org/industry-hub/resource-library/open-networks-2018-ws3-14969-ena-futureworlds-aw06-int.pdf

[3] For more information please see ESO's Future Energy Scenarios in this link https://www.nationalgrideso.com/future-energy/future-energy-scenarios/fes-2020-documents

Through using the processes developed in the trial described in the previous sections the project will simulate for a Bulk Supply Point in the trial area:

- Forecasting demand and generation;
- Analyse constraints over the network;
- Request flexibility from market platforms;
- Optimise flexibility from market responses.

This will be achieved by simulating the predicted load profiles for these years and then running the respective processes described above to mirror future energy scenarios. The outcome of this analysis would highlight any potential learning that could be gained from managing higher volumes and more volatile load profiles. In addition, measure how performant the system was with significantly larger volumes of flexibility services.

2.3. Benefits Management

As part of the trials planning phase, the Project carried out a review and validation exercise for each of its benefits to ensure these were still valid and considered in the planning process. Details of this are below:

Benefit 1 – Deferral or avoidance of traditional reinforcement.

At its simplest this may be calculated by identifying the savings obtained from using flexibility services to meet network load growth requirements, as an alternative to reinforcing the network using CAPEX investment i.e., traditional reinforcement. However, such a calculation needs to take account of the deferral time of each investment scheme, thereby requiring an understanding of how long such a deferral may push out the time horizon of the eventual need to conventionally reinforce.

As part of the ENA's Open Network project, work undertaken by Baringa included the common evaluation methodology, which details how decisions are made to choose the most suitable solution to meet network needs between traditional network reinforcement and procuring flexibility services. This has identified a methodology which will enable all DNOs to follow a consistent process to identify which areas of a network could benefit from the use of flexibility, and where it would be less beneficial. For example, sections of network where load growth is predicted to be very high or is likely to rise very rapidly and therefore where it would not be appropriate to make use of flexibility. The EFFS project will study the work done using this methodology to identify what benefit exists within the trial areas and then expand these finding to calculate the benefits of a WPD or nationwide roll out.

One key component of the EFFS project has been the work undertaken to accurately forecast demand at any nodal point on the network for which flexibility is required. As such this trial will aim to measure both the absolute accuracy of the forecasting and the relative accuracy i.e., that over existing practice if possible.

A further key requirement of the EFFS project is to demonstrate the capability of connecting to a variety of flexibility provision i.e., different flexibility platforms (flex-pools), to demonstrate the capability of being able to select the most competitive provider of flexibility services whichever platform this may come from. Whilst in practice there is still relatively little liquidity in the provision of flexibility across many parts of the network, the project trials aim to connect with flex-pools that offer a competitive provision of flexibility and will undertake to study the benefits of such, if sufficient data is available.

In addition, the EFFS project undertook to identify and demonstrate the best process by which flexibility would be identified, managed, and used. This includes making best and most efficient use of resources. As such the project trials will look to identify what level of resources is required to operate most effectively, and how this compares to previous practice where appropriate.

Benefit 2 – Additional flexibility in fault restoration.

Using flexibility to help restore the network post-fault, is a service know as Restore. This is an important activity and due to its immense value, network companies will usually pay a premium to service providers who are able to supply flexibility at short notice to help with this. It is therefore important to understand the true value of the Restore service.

All DNOs are set targets for unplanned interruptions under the Interruptions Incentive Scheme (IIS). If network faults result in interruption to customer supplies during normal operating conditions, then DNOs may incur financial penalties, or more accurately fail to benefit from financial incentive payments allowed under their licence. Under the IIS payments may be received for meeting regulatory set targets for both interruptions of supply and the time that supply is lost for, known as Customer Interruptions (CIs) and Customer Minutes Lost, (CMLs). By analysing the CI and CML data it should be possible to identify the benefit of using flexibility as a Restore service.

Benefit 3 – Reduced balancing costs via co-ordination with SO.

Another activity that the EFFS project set out to demonstrate was conflict avoidance with the ESO. The ESO contracts for several services, for example response and reserve, for which they may need to call upon assets embedded within the distribution network. There may be occasions when an asset that the ESO wishes to call upon may conflict with the use that the distribution network operator has. The benefit to the ESO of knowing what the network operator has planned is that it may either take avoiding action, i.e. plan to not call equipment that sits within a flexibility constraint zone, thereby enabling it to be used or remain available to the DSO. It would also be of benefit to the DSO to know what equipment the ESO may want to call in certain circumstances such that it too could take any necessary avoiding action. Whilst the ESO is normally able to call upon equipment connected to any part of the GB system, the DSO is almost certainly reliant upon equipment within or below the locality of the constraint zone and substation group. Hence the benefit is most unlikely to be equally felt.

In-order to measure the benefit of having a whole system approach it will be necessary to record instances of where such conflicts have been avoided or otherwise. These occurrences may be quite limited and may not occur at all during the trial. As such it may be necessary to look more widely to ascertain what the benefit or cost of such conflict may be.

Benefit 4 – Increased / faster connections.

With the use of flexibility, the delivery of many customer connections, including renewable DG, will be able to connect sooner and more cheaply than would otherwise be the case. Historically, connection offers have been made based on a need to build new or replace existing assets to deliver a minimum scheme connection offer. Whereas using flexibility may not involve any time-consuming or costly construction at all thereby speeding the process up.

To calculate the benefit of using flexibility here, the project will study the future scenario and expected connection plans within the trial area to identify which schemes will be able to connect sooner, and at what benefit (or cost) than if flexibility was not operating here on the network.

3. Progress against Budget

Table 3-1: Progress against Budget

Spend Area	Budget(£k)	Expected Spend to Date (£k)	Actual Spend to Date (£k)	Variance to expected (£k)	Variance to expected %
Labour	397	328	259	69	21%
Equipment	58	46	1	45	98%
Contractors	2030	1741	1371	370	21%
IT	630	630	500	130	21%
Travel & Expenses	40	33	28	5	15%
Payments to users & Contingency	82	87	0	87	100%
Other	87	0	0	0	0%
TOTAL	**3339**	**2865**	**2159**	**706**	**25%**

Comments around variance

Spend Area	Comments
Labour	A minor variance in labour due to lesser than anticipated WPD Project Management charged.
Equipment	To date, no physical equipment has been procured under the project budget.
Contractors	Underspend to date due to a lesser utilisation of forecasting and trial support sanctions.
IT	Underspend to date due to a lesser utilisation of forecasting and trial support sanctions.
Travel & Expenses	Travel expenses have been less than anticipated due to greater use of remote meetings, due to COVID.
Payments to users & Contingency	To date, no contingency or payments to users have been utilised as the AMT CCN002b change request was charged to AMT's contractor sanction.

4. Progress towards Success Criteria

The project has made the following progress towards the Success Criteria:

Ref.	Project Deliverable	Deadline	Evidence	NIC funding request (100%)	Status
1	Mobilisation Exit Report	Project Direction 17/12/18 WPD plan 18/03/19	A mobilisation exit report will be produced, including evidence of: • Forecasting partner tender accepted • Collaboration agreements signed • Detailed plan with breakdown by project work stream and milestones • Project staff mobilised • Workplaces set up • Governance structure in place • Project Mandate/Charter Agreed • Project Initiation Document signed off • Co-ordination plan developed with any other successful DSO related NIC bid to minimise overlap.	10%	Complete
2	Output from the forecasting	Project Direction 08/04/19 WPD plan 05/07/19	Publication of report showing forecasting options evaluated and selected options. Presentations at conferences and workshops to disseminate output.	6%	Complete
3	Development of requirements specification for DSO functionality	Project Direction 15/04/19 WPD plan 12/07/19	Production of requirements specification document outlining for DSO functionality, common protocols and approach to supporting these functionalities. Electricity Networks Association (ENA) and stakeholder collaboration strategy document (delivered a fixed period of time following publishing of ENA workshop output). Letters of support from key stakeholders (e.g. ENA Working Group) outlining agreement with specification document.	9%	Complete
4	Development of EFFS Design Specification document	Project Direction 15/07/19 WPD plan 16/10/19	Production of set of Design models and documents outlining specific EFFS functionality and approach to delivering this functionality. Report detailing review of functional specification document at key stages.	15%	Complete
5	Implementation and System Delivery	Project Direction 20/07/20 WPD plan 19/10/20	Build and delivery of the completed EFFS system, including technical design package release, deployment and configuration and system handover.	3%	Complete

Ref.	Project Deliverable	Deadline	Evidence	NIC funding request (100%)	Status
6	Completion of on-site system testing	Project Direction 02/11/20 WPD plan 01/02/21	Test report demonstrating completion of on-site testing to required standards; includes integration, user acceptance, operational and performance testing. Supply of additional supporting documentation evidencing this claim, to include test plans, scripts, exit reports and screenshots. Report detailing completed user training.	22%	Complete
7	Trials design and preparation	Project Direction 30/11/20 WPD plan 01/03/21	Strategy document outlining trials approach and methodology, detailing approach to plant, system operations, supplier / aggregator and tandem operations trials. Co-operation plan showing how duplication with other DSO NIC projects has been avoided and, if possible, how testing between projects will be carried out.	31%	Complete
8	Trials – execution and knowledge capture	Project Direction 01/06/21 WPD plan 31/08/21	Completion report demonstrating outcomes of trial phases alongside test scripts, exit reports etc. Letter of support from external stakeholders and partners confirming completion of project trial phase and acceptance of results.	2%	On track
9	Gateway reviews	Project Direction 26/03/19 20/05/20 07/06/21 WPD plan 25/06/19 19/08/20 06/09/21	Delivery of gateway report at the end of Workstream 1, Workstream 2 and Workstream 3, detailing progress against the project benefits and costs.	2%	Gateway review 1 – complete Gateway review 2 – complete On track
Common Project Deliverable					
N/A	Comply with knowledge transfer requirements of the NIC Governance Document.	End of Project	1. Annual Project Progress Reports that comply with the requirements of the Governance Document. 2. Completed Close Down Report which complies with the requirements of the Governance Document. 3. Evidence of attendance and participation in the Annual Conference as described in the Governance Document.	N/A	In progress

5. Learning Outcomes

Based on the learning gathered during the requirements, design, build and testing phases of EFFS we plan to explore the following further within the trials:

- Originally, we intended to explore the impact of the restore service on the P2/6 standards and inform the P2/6 review. However, the regulatory landscape has changed (the P2/6 review has concluded, and the standard has been superseded by P2/7), so this learning objective is no longer relevant. However, we will explore conceptually how the use of flexibility services can support system restoration and the P2/7 standard.

- From discussion with NGESO most of the flexibility services they use are not specific to a location (such as frequency response services) or planned in timelines that align with EFFS (such as STOR). Therefore, the number of conflicts that can be identified by the DSO ahead of time as part of the conflict avoidance process is likely to be limited. As part of the proof of concept to be carried out during the trials the expectation is that the ESO would be in the best position to identify potential conflicts if given advance visibility of the DSO service schedule. This still aligns to the ENA 'World B' position that EFFS assumes but given the service timelines the ESO is most suited to identify the conflict based on data shared by the DSO.

- During the early phases of the trials lack of current market liquidity has caused issues whilst calculating constraints in power flow analysis. Because of the limited number of available flexibility assets we have been unable to calculate sensitivity factors in order to define constraints and flexibility requirements. As a resolution an increased number of assets will be included in the network model used for power flow analysis. This is in progress, but the availability of flexibility resources is something that should be considered for similar exercises in future.

- It has been observed that the EFFS Tool behaved differently on a Virtual Machine than it did when tested on a hardware machine on preliminary testing. This is likely down to memory and processor utilisation by the virtual machine. This is something to be aware of when testing developments in future projects. The local Python packages (namely Pandas) were older versions on the EFFS Tool's virtual machine than the hardware machine on which preliminary testing took place. This caused some setup delays and different package libraries on different WPD machines is something to be considered when testing developments in future projects.

6. Intellectual Property Rights

A complete list of all background IPR from all project partners has been compiled. The IPR register is reviewed on a quarterly basis. New foreground IPR has been generated by EFFS project in the following areas:

- System Integration Exit report
- User Acceptance Testing report
- Trials Strategy Document
- Trials Schedule Document
- TEF Cooperation Plan
- Trials Data Specification

7. Risk Management

Our risk management objectives are to:

- Ensure that risk management is clearly and consistently integrated into the project management activities and evidenced through the project documentation;
- Comply with WPDs risk management processes and any governance requirements as specified by Ofgem; and
- Anticipate and respond to changing project requirements.

These objectives will be achieved by:

- ✓ Defining the roles, responsibilities and reporting lines within the Project Delivery Team for risk management;
- ✓ Including risk management issues when writing reports and considering decisions;
- ✓ Maintaining a risk register;
- ✓ Communicating risks and ensuring suitable training and supervision is provided;
- ✓ Preparing mitigation action plans;
- ✓ Preparing contingency action plans; and
- ✓ Monitoring and updating of risks and the risk controls.

7.1. Current Risks

The EFFS project risk register is a live document and is updated regularly. There are currently 9 live project related risks. Mitigation action plans are identified when raising a risk and the appropriate steps then taken to ensure risks do not become issues wherever possible. In Table 7-1, we give details of our top five current risks by category. For each of these risks, a mitigation action plan has been identified and the progress of these are tracked and reported.

Table 7-1: Top five current risks (by rating)

Details of the Risk	Risk Rating	Mitigation Action Plan	Progress
There is a risk that Flexible Power may be unable to provide resource to assist with Switch Level Analysis and Service Selection Validation causing a reduction in learning and/or a lesser ability to trial dispatch.	Major	Continued engagement with Flexible Power	Risk increasing
There is a risk that National Grid ESO may be unable to support the conflict avoidance management process of EFFS in the trials.	Moderate	Early engagement (plus regular communication) of National Grid ESO to support resource bookings and scheduling. Provision of detailed trials planning to National Grid ESO to inform and reiterate scope requirements.	Risk reducing

There is a general risk from the COVID-19 pandemic that team members could be off due to sickness and that remote access arrangements are less effective than direct, on-site access.	Moderate	Use of webinar facilities (MS Teams, Skype, Zoom, GoToWebinar) to hold virtual meetings. Temporary use WebEx for remote access to enable activities on WPD environment.	Risk steady
There is a risk that the Project may struggle to implement the 2030 FES scenarios, which the project has opted to use to simulate the stress testing objective, due to: • The system not being functionally designed to accommodate these scenarios; • The system not being performant with these volumes; and The Project being unable to mock-up and source data in order to create these scenarios.	Minor	Production of an early conceptual design / proof of concept in the trials initiation stage to flush out issues early, especially around data and performance.	Risk steady
There is a risk of cyber attack due to potential system vulnerabilities.	Minor	Implement all recommendations made during penetration testing and continue to engage with WPD Cybersecurity team	Risk steady

Table 7-2 provides a snapshot of the risk register, details graphically, to provide an on-going understanding of the project's risks.

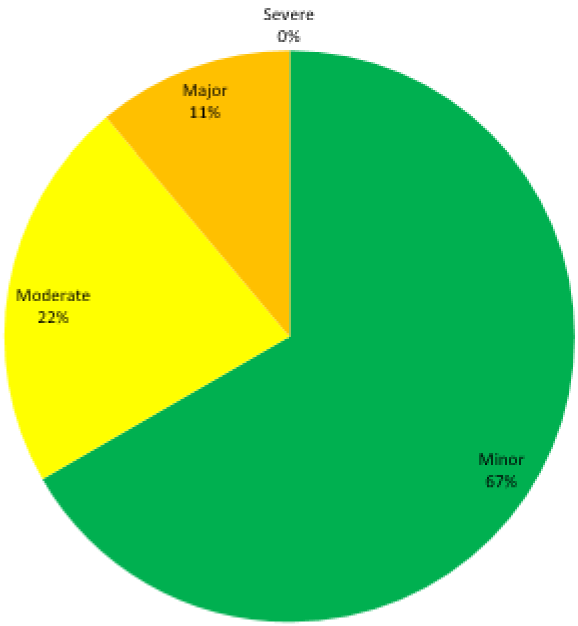
Table 7-2: Graphical view of risk register

Likelihood = Probability x Proximity						
	Certain/Imminent (21-25)	0	0	0	0	0
	More likely to occur than not/Likely to be near future	0	0	0	0	0
	50/50 chance of occuring /Mid to short term (11-15)	0	0	0	0	0
	Less likely to occur/Mid to long term (6-10)	0	0	2	1	0
	Very unlikely to occur/Far in the future (1-5)	6	0	0	0	0
		1. Insignificant changes, re-planning may be required	2. Small Delay, small increased cost but absorbable	3. Delay, increased cost in excess of tolerance	4. Substantial Delay, key deliverables not met, significant increase in time/cost	5. Inability to deliver, business case/objective not viable
		Impact				

	Minor	Moderate	Major	Severe	
Legend	6	2	1	0	**No of instances**
Total	9				No of live risks

Table 7-3 provides an overview of the risks by category, minor, moderate, major and severe. This information is used to understand the complete risk level of the project.

Table 7-3: Percentage of risk by category



7.2. Update for risks previously identified

Descriptions of the most significant risks identified in the previous six-monthly progress report are provided in **Error! Reference source not found.** with updates on their current risk status.

Table 7-4: Risks identified in the previous progress report

Details of the risk	Previous risk rating	Current risk rating	Mitigation Action Plan	Progress
There is a risk that there may be a lack of availability of WPD project teams (business and IT) to support the project.	Major	Minor	Early engagement of business stakeholders to support resource scheduling. Escalate WPD resource issues to Project Review Group where appropriate.	Increased use of Innovation resource to support trial.
There is a risk that the flexibility platform providers are unable to provide resource or numbers of usable customers to meet project requirements	Major	Closed	Regular calls with providers to ensure that they have good awareness of project requirements.	Closed
There is a general risk that the remote access arrangements in place due to the COVID-19 situation are less effective than direct access. Additionally, there is an increased the probably of project team sickness that could cause delays.	Major	Major	Use webinar facilities (MS Teams, Skype, Zoom, GoToWebinar) to hold virtual meetings. Temporarily use Webex for remote access to support activities on WPD environment.	Discussions have taken place between the project team and WPD IR to consider other alternative arrangements.
There is a risk that the requirements specified by the project are too complex to be delivered within the time and budget of the project.	Major	Closed	Simplifications to be made where possible - removal of visibility of flexibility and dispatch of	Closed

			resources from PowerOn, Third party provision of PSSE tool including data cleansing.	
There is a risk that the Networkflow software solution may not be able to interface to other third-party systems.	Major	Closed	A new semi-automated scripted solution is being developed that will accommodate data exchange at interfaces.	Closed

8. Consistency with Project Registration Document

The scale, cost and timeframe of the project has remained consistent with the registration document, a copy of which can be found here https://www.westernpower.co.uk/projects/effs.

9. Accuracy Assurance Statement

This report has been prepared by the EFFS Project Manager (Sam Rossi Ashton), reviewed and approved by the Innovation Manager (Yiango Mavrocostanti).

All efforts have been made to ensure that the information contained within this report is accurate. WPD confirms that this report has been produced, reviewed and approved following our quality assurance process for external documents and reports.

Glossary

Abbreviation	Term
ANM	Active Network Management
EFFS	Electricity Forecasting and Flexibility System
SIT	System Integration Testing
TEF	TRANSITION, EFFS, FUSION
UAT	User Acceptance Testing

Appendix 1 – On Site Testing Diagrams

The below figures aid the description of the On-Site Testing section (2.2.1).

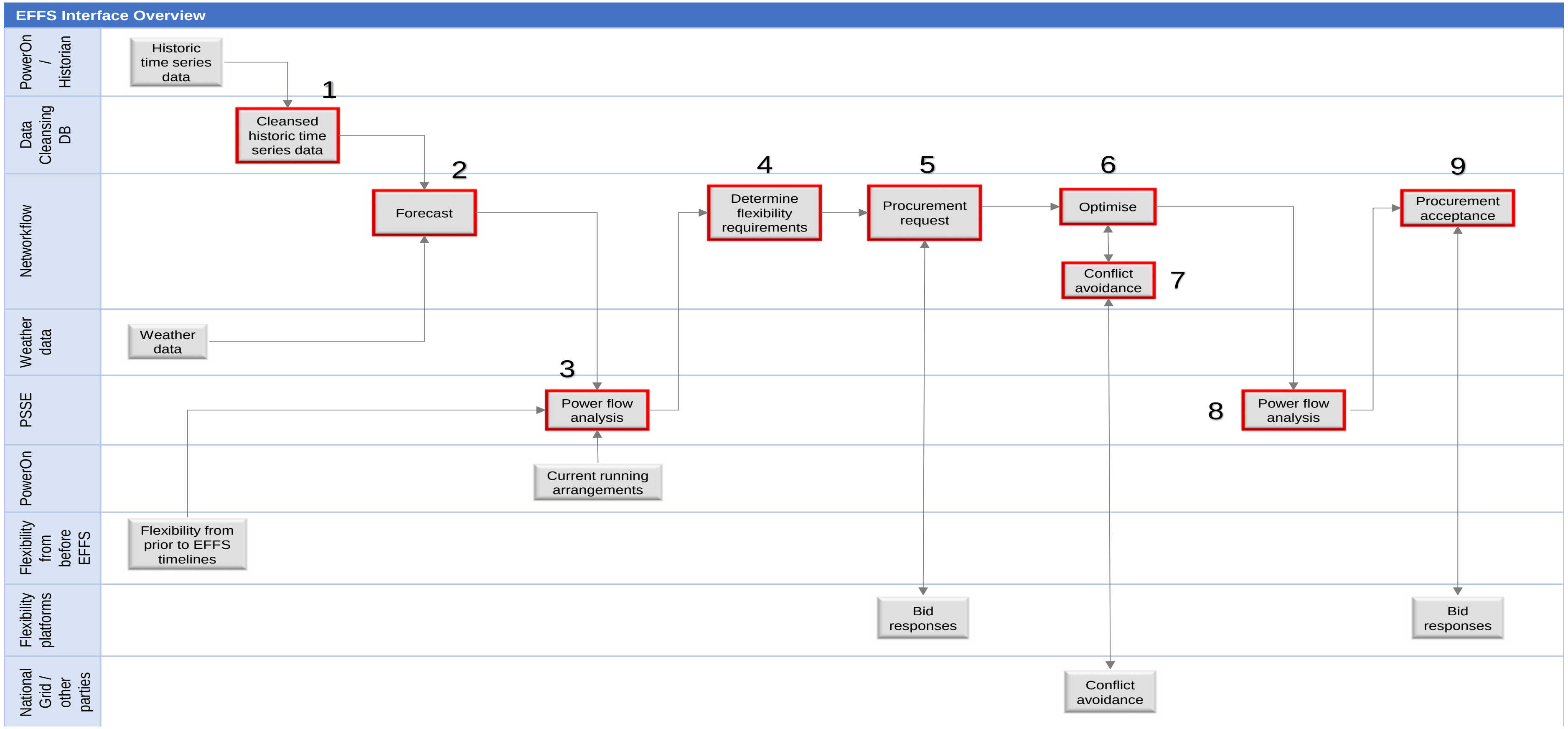


Figure A1: Key EFFS interfaces tested in SIT

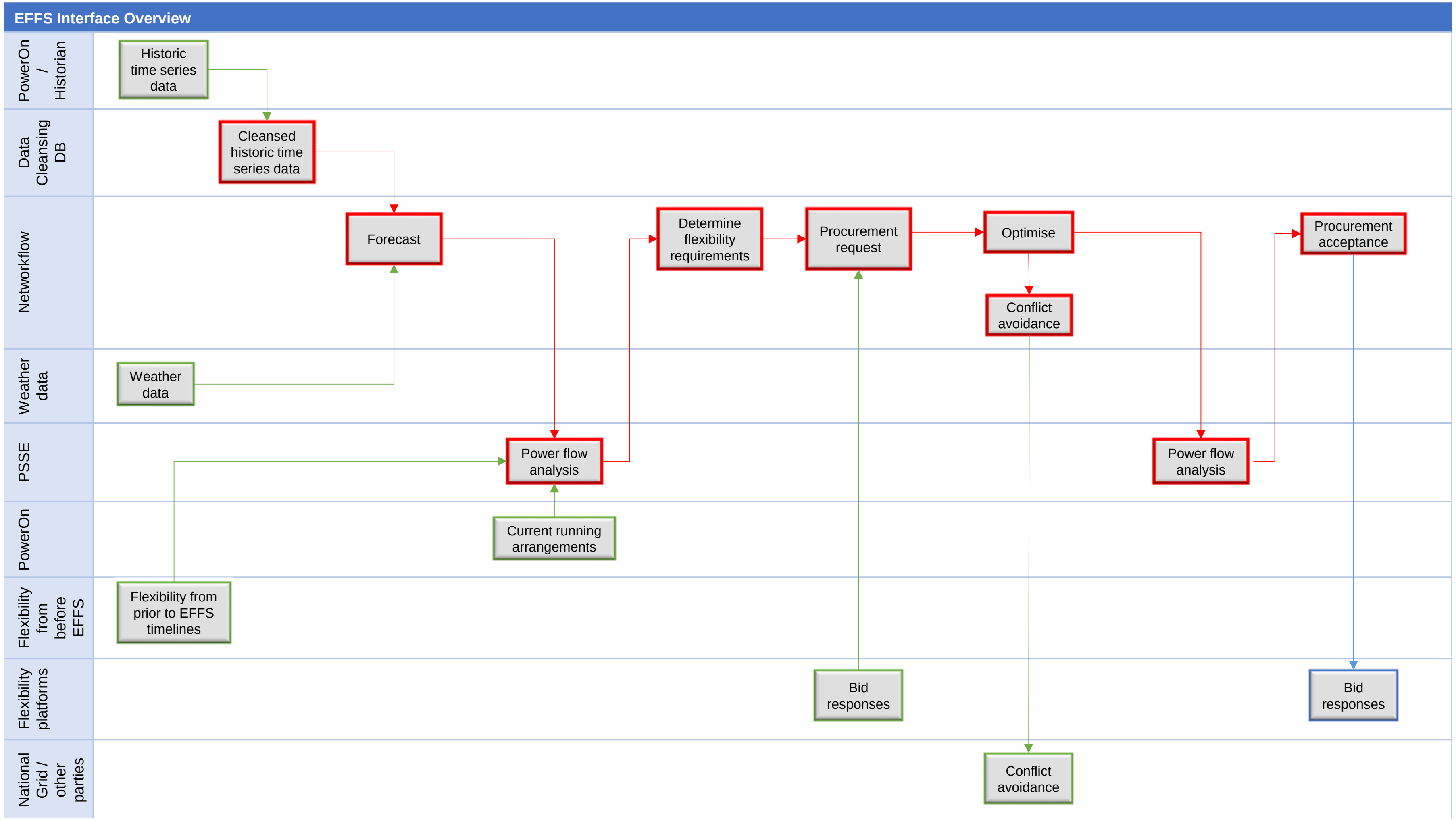


Figure A2: EFFS End-to-End SIT test

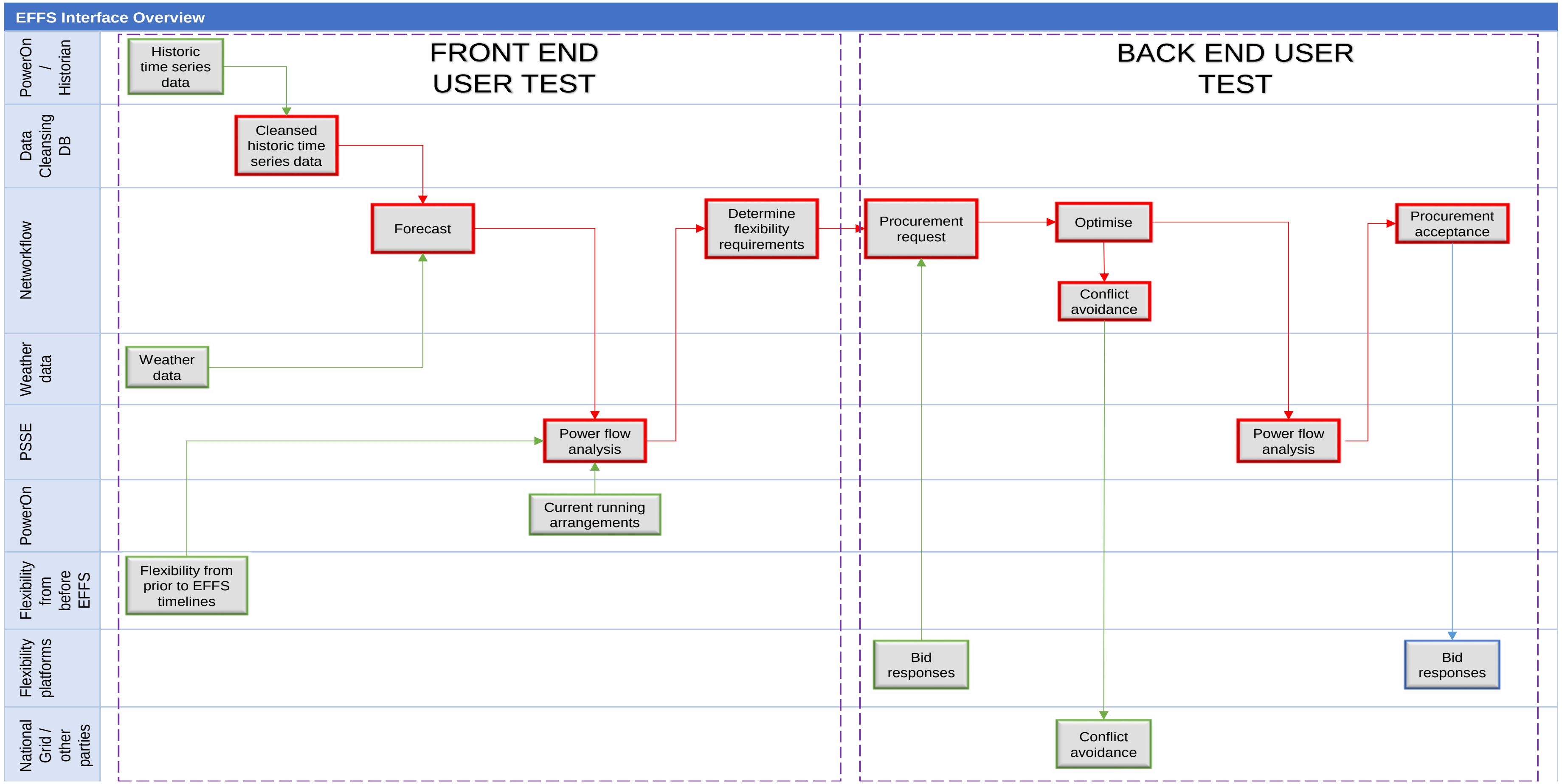


Figure A3: EFFS UAT Overview

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