T.E.F. Stage Gate 2020

Collaboration Report

February 2020
Version 1.0

Contents

Executive Summary

Three flagship demonstrator projects are facilitating Great Britain's efficient and timely smart grid transition. The projects were awarded funding through the 2017 Network Innovation Competition (NIC), yet due to their combined aim of supporting the smart grid transition, Ofgem stipulated that the three must align to ensure good value for money. Through an initial collaborative phase in early 2018, the three projects formed the partnership most commonly referred to as T.E.F., an acynonym of the three project names:

Figure 1 : T.E.F. project partners and colour key

Through the inititial collaborative assessment, a number of alignment opportunities and cost savings were identified. A plan was put in place to aid coordination of activities during the mobilisation phases with a checkpoint put in place 18 months into each project. This checkpoint is refered to as the Stage Gate, providing an opportunity to reflect on past activities and provide evidence of ongoing alignment and savings. This document is designed to cover all topics agreed to during the initial collaboration phase, allowing Ofgem to assess progress and direct future activities. Ahead of any submission to Ofgem, the initial agreement stated that the ENA Open Networks Project (ON-P) had to be given the opportunity to review, with the Steering Group approving its release. On Thursday the 20th February 2020, the ON-P Steering Group unanimously approved submission of this document to Ofgem for their assessment.

The T.E.F. partnership is pleased to present this document to Ofgem, believing it satisfies requirements and justifies progression of all three projects with no modification. A summary of each topic covered in this document is provided in the remainder of this section, presenting the benefits of collaboration and additional value added.

Industry Relevance *- Covers the topics of Policy alignment, Industry Impact Assessment and ENA Open Networks Project.*

In anticipation of the uptake in low carbon technologies (LCTs), Ofgem and Government are responding through a series of policy changes and reforms which will help ensure the energy system is fit-for-purpose in the future. T.E.F. is well-aligned with all these policy aims. Alignments have been made to ensure consistency (or, where prudent, deviation) of approach to enhance overall leaning from the T.E.F. projects.

Alongside developments in government policy, the electricity industry has begun to test and trial innovations to support the DSO transition. From the results of T.E.F, more standardised flexibility approaches can be developed for industry, helping the industry transform learning into meaningful change.

When the collaboration was formed, alignment with the ENA Open Networks Project was deemed key if T.E.F. was to reach its full potential. Throughout 2019, T.E.F. interacted with specific Products to enhance outputs. Yet in 2020, there is an apparent opportunity for T.E.F. to play a more active role, coordinating to reduce barriers to innovation and potentially avoid costs of path correction later.

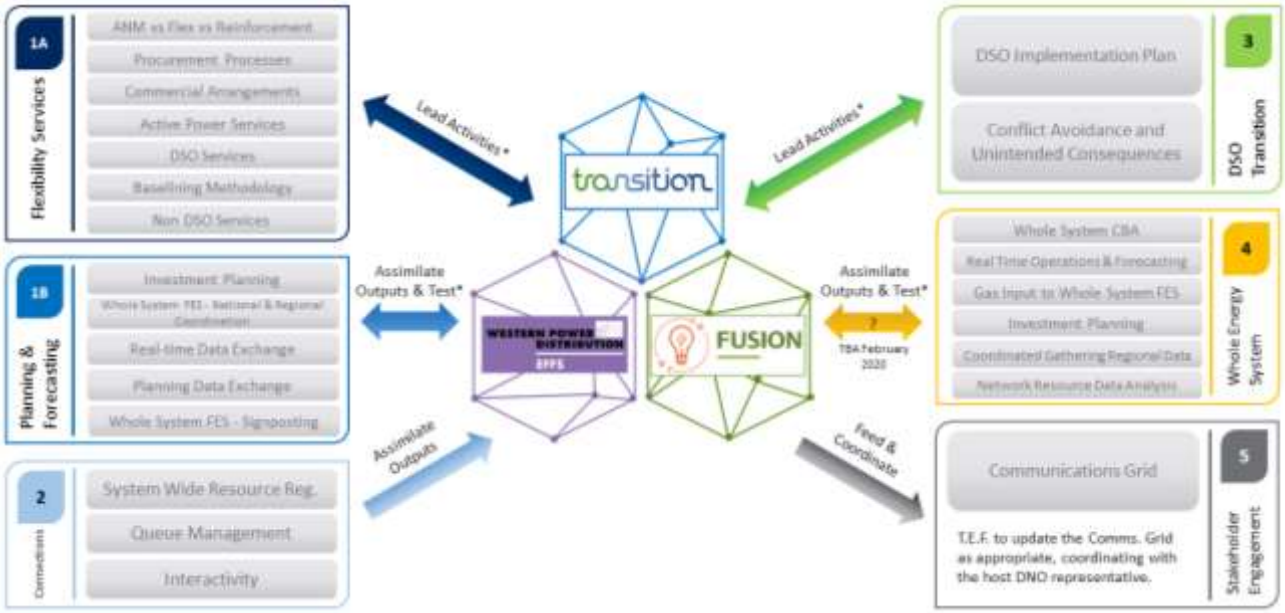

Figure 2: T.E.F. 2020 touchpoints with the ENA Open Networks Project

Now that the DSO demonstrator projects are more mature, T.E.F. proposes to directly test outputs and in some cases lead elements of Product activities. The figure conveys a summary of the ON-P workplan and is discussed further in Section 2.3.

Stakeholder Engagement *- Covers the topics of Requirements Definition, Stakeholder Feedback and Peer Review*

Given the highly dynamic and evolving nature of the energy sector, the T.E.F. projects were scoped to enable close engagement with relevant industry stakeholders. Project programmes enable adaptability to stakeholder feedback, maximising learning outcomes for their duration. Each of the T.E.F. parties have engaged in hosting various internal and external workshops with multiple stakeholders facilitating diverse industry representation. These have allowed T.E.F. to develop a coherent and consistent view, incorporating wider industry perspective whilst minimising stakeholder fatigue.

Thus far this approach has supported development of functional DSO specifications, establishment of strengths or weaknesses in market rules and validation of site selection and trial design work completed to date. Key learning from stakeholder events is shared and discussed at T.E.F. meetings for consideration in each project and in designing future workshops.

Value to Customers *– Covers the topic of New Knowledge*

T.E.F. has successfully delivered on its collaboration commitments across all three projects to date, helping enhance overall learning and consumer benefits. A robust strategy is in place to enable this to continue for the remaining duration of T.E.F., with Figure 3 illustrating a summary view of the focus areas.

Figure 3: T.E.F. Collaboration overview

Each focus area signifies where joint efforts have enhanced proposed outputs, or introduced new learning, only achievable through the support of the T.E.F. partners. The collaboration will not remain static, with new areas identified and discussed during the regular correspondence between the project teams.

Trial Deployment *– Covers the topics of Deployment Costs and Risk Analysis*

The first 16 months have seen significant solution design progress across the board, with requirements for the core development areas derived and high-level designs produced. The three projects have provided insight of such designs at various junctures since commencement, supporting cross pollination of ideas while mindfully maintaining organic development based on objectives set out in the individual NIC submission documents.

Subsequently, common format context diagrams (see Figure 14) have been produced illustrating core building blocks on test for each project, expediting comparison and deeper conversations during the development process. The process has supported ongoing risk management and informed the procurement approach for the higher cost tenders, avoiding unnecessary duplication during the upcoming deployment phase.

Business Case

Taking all other sections into account, the Business Cases have been reviewed by each project, supported by an independent consultancy. The original T.E.F. business cases were justified, as proven by the original approval to proceed given by Ofgem. Thus, recent

collaboration activities have only served to enhance alignment and overall knowledge generated. In addition to enhanced outputs, the collaborative activities have resulted in financial savings, offering much stronger value for money. All projects have verified that they are progressing to the budget and programme set during the T.E.F partnership creation, with £148.9k of new savings also being realised. Such improvements in value for money have only been achieved through the ongoing collaboration activities, voluntary contributions and commitment to maintain, if not increase, learning across all topics.

The current and planned work by T.E.F. projects is set to deliver learning needed for the industry to make informed decisions, facilitating an efficient and smooth transition to a smart grid model. The T.E.F. partnership believes all requirements have been satisfied and that the three projects offer significant value for money in this field. Hence it is the recomendation of the four electricity network licensees directly involved that the projects progress without delay or modification.

For greater detail on the outputs discussed and more please visit the T.E.F. projects websites where you can also find details on how to contact the relevant team:

Project	Website
TRANSITION	https://ssen-transition.com/
EFFS	https://www.westernpower.co.uk/projects/effs
FUSION	https://www.spenergynetworks.co.uk/pages/fusion.aspx

Table 1: T.E.F. Project Websites

1 Introduction

1.1 T.E.F Collaboration

The unprecedented collaboration between three flagship demonstrator projects, supported by the Ofgem Network Innovation Competition (NIC), facilitates Great Britain's efficient and timely transition to smart grid architecture. This partnership is widely referred to as T.E.F., the acronym formed from the three projects involved:

Figure 4: T.E.F. project partners and colour key

To date, the projects have together output far more than their contracted deliverables, enabled in part by the commitments set out when T.E.F. was first formed. While such commitments set the initial path, the level of engagement has grown organically during the first year of development with current and planned work between T.E.F. projects set to deliver the learning needed for the industry to make informed decisions.

Importantly, to maximise relevance of outputs, T.E.F. has proposed to lead particular product elements within the ENA Open Networks Project and have formed significant interactions with other key industry projects such as from the Energy Revolution (InnovateUK), Power Forward (BEIS & NRCan) and FleX (BEIS) challenges. The T.E.F. collaboration has and is expected to continue to deliver more than the sum of the individual projects. Together they broaden and deepen the learning needed to facilitate transition to a low carbon economy.

Figure 5: Stacked value of the three projects achieved only through coordinated delivery

Figure 5 summarises some of the industry actors, network voltage levels, market models and systems featuring within the combined T.E.F. delivery programme, highlighting the project deemed to add the greatest value in each case. Viewing features in the above format demonstrates the unique benefits each project brings and that coordinated delivery significantly strengthens the quality and coverage of tangible outputs.

In addition to enhanced outputs, the collaborative activities have resulted in financial savings, offering our customers much stronger value for money. Historic savings, made at the time of T.E.F. creation, are described in full within the *T.E.F. Compliance Document* s[1&2]. However, joint development in the area of forecasting throughout the first 18 months has resulted in further savings identified. TRANSITION has been able to realise a further £98.5k saving with the full amount being returned to the customer at the end of the project. Such improvements in value for customers' money have only been possible through collective development and alignment work which EFFS and FUSION have actively supported.

Some similar efficiencies have been achieved through alignment with internal IT development work. At this stage, TRANSITION can commit to a further £50.4k saving today through said IT efficiencies, bringing the newly identified T.E.F. collaboration savings total to £148.9k. T.E.F. shall continue to explore the potential for similar opportunities until the end of the projects.

Thus, T.E.F. Projects have reduced the NIC funding requirement by £2.48 million[1&2] (including the newly identified £148.9k) since receipt of initial Project Directions in January 2018. This has only been achievable through the ongoing collaboration activities and voluntary contributions that have been delivered with a marked commitment to maintain, if not increase, learning across all topics.

[1] https://www.ofgem.gov.uk/system/files/docs/2018/10/nic_2017_compliance_document_v2_public_1.pdf

[2] https://www.ofgem.gov.uk/system/files/docs/2018/10/fusion_compliance_doc.pdf

1.2 Document Purpose

This document is designed to offer an overview of the collaboration activities to date, demonstrating that the commitments made by TRANSITION, EFFS and FUSION in the *T.E.F. Compliance Document* are being fulfilled and that the need for each project is at least as great as that defined during the original bid phases.

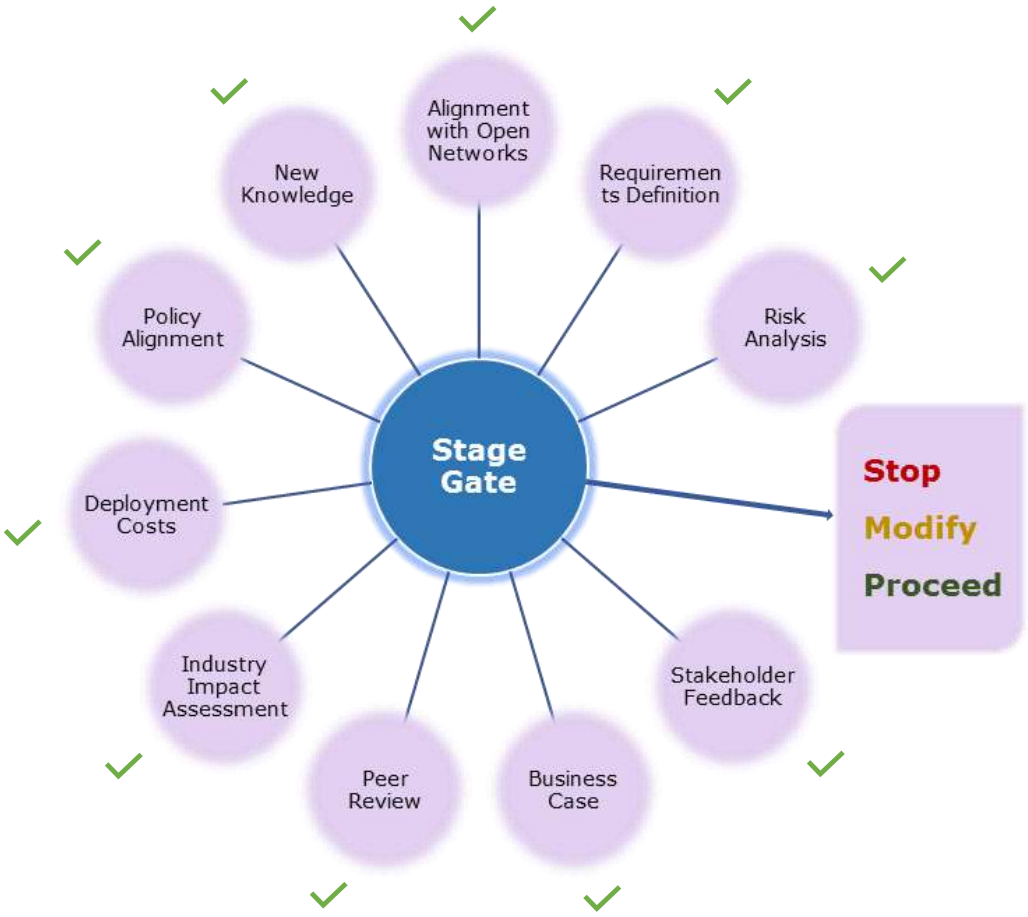

Figure 6: Collaboration Topics identified in the T.E.F. Compliance Document

While the report format is designed to succinctly cover each of the topics originally presented in the *T.E.F. Compliance Document*, shown in Figure 6, the unprecedented level of innovation project collaboration has led to further coordination activities requiring to be included. These are delivering additional learnings supporting definition and testing of Distribution System Operation activities that, in many cases, are now in greater need of testing (to prove the business case for investment) than anticipated in 2017 when the business cases were derived.

2 Industry Relevance

Given the highly dynamic and evolving nature of the energy sector, the T.E.F. projects were scoped and programmed to enable close engagement with relevant industry stakeholders and initiatives and, where practicable, ensure adaptability to industry changes to maximise learning outcomes. This has proved to be a prudent approach, as the energy system continues to rapidly evolve. Industry has responded to this change with various policy initiatives and innovation programmes which are relevant to the ongoing direction of T.E.F.

The three drivers of decarbonisation, decentralisation and digitalisation are transforming the energy landscape, alongside continuing technological advances and economic and political changes. Great Britain has the opportunity now to make sure it has the systems and capabilities in place to support the secure, sustainable and efficient delivery of energy in the decades to come. This opportunity underpins the motivation behind and the challenges addressed by T.E.F.

2.1 Policy Alignment

In anticipation of the technological advances associated with greater uptake in low carbon technologies (LCTs), Ofgem and Government are responding to these changes through a series of policy changes and reforms which will help ensure the energy system is fit-for-purpose in the future. T.E.F. is well-aligned with all of these policy aims. Alignments have been made to ensure consistency (or, where prudent, deviation) of approach to enhance overall leaning from the T.E.F. projects.

Figure 7: Sample of policy documents, thought papers and insights T.E.F. have incorporated

A selection of the common topics discussed in recent policy documents, thought papers and strategies has been compiled, with the core themes discussed in relation to the T.E.F. projects being presented in the proceeding sub sections.

2.1.1 ***DSO Reform***

Ofgem published a position paper on Distribution System Operation in August 2019, describing their strategic outcomes for DSO reform that influence policy development and the ENA Open Networks Project (ON-P) to which T.E.F. is aligned. T.E.F. is exploring in detail the coordination and conflict of interest issues highlighted by Ofgem as a potential issue for the flexibility market. This will be through development, testing and trialling of a range of market models for a broad range of actors. This will be both through physical trials as well as simulated trials across different license areas including ENWL's license.

Ofgem identified a significant gap between trialled and current business as usual practices (BaU). Across the three projects, T.E.F. will further the development of each of the five key DSO enablers, proving their business case to support adoption into BaU:

- Forecasting and planning enablers
- Network monitoring and visibility enablers
- Flexibility trading enablers
- Flexibility dispatch and control enablers
- Data exchange enablers

As an example, EFFS has already generated learning and algorithms related to forecasting, and how to integrate this into the distribution network company's business. T.E.F. will inform the least regrets path and key enablers identified by Ofgem to enable flexibility and DSO transition.

2.1.2 ***Flexibility procurement***

In Ofgem and BEIS's Open letter to ENA Open Networks in July 2019, they highlight the following requirements to facilitate successful flexibility market operation:

- standardisation and transparency of flexibility procurement across network and system operators;
- provision of clear information on current and future system needs;
- improving the availability of network information in an interoperable format by setting out a clear roadmap for data transparency; and
- Taking into account recommendations from the Energy Data Taskforce.

Ofgem's Future Insights Series paper on Flexibility Platforms in Electricity Markets[3] then sets out the six primary tasks for Flexibility Platforms providing grid services. Coordination, Flexibility Procurement and Dispatch & Control are identified as crucial to delivering flexibility products and likely to act as anchor tasks for the development of platforms. The other three tasks, Platform Transaction Settlement, Platform Market Services and Analytics & Feedback are considered to be supporting services to delivering flexibility into the system. Four potential market models are defined, and advantages and disadvantages are explored, including potential regulatory issues.

[3] "Future Insights Paper 6 - Flexibility Platforms in electricity markets" (2019)

T.E.F. is working on delivering innovative solutions specifically for the three prioritised tasks for DSO identified by Ofgem (Coordination, Flexibility Procurement and Dispatch & Control) and will significantly advance learning on how to implement these. T.E.F. will also inform the other three tasks.

2.1.3 ***Network charging and access reform***

The significant code review on network access and charging is assessing and updating how network capacity is allocated and used to ensure that costs to consumers as a whole are minimised. This should provide price signals to consumers that are more reflective of the costs they impose on the system and networks. The ongoing work in this area is being closely considered by T.E.F.

TRANSITION is working with ElectraLink to define a high-level licence and regulatory roadmap and methodology framework for future change proposal impact assessments, identifying potential barriers to DSOs. This will set out principle methodologies and key considerations based on DCUSA; CUSC; BSC and REC assessment.

2.1.4 ***Energy data***

Ofgem is considering the implementation of a standard interoperability data format consistent across networks to enable data sharing. They have indicated that the initiatives listed above point to the common information model (CIM) as a promising format for distribution energy system data interoperability. At present, TRANSITION is considering how CIM can be incorporated into the future platform to remain consistent with the intention of industry.

T.E.F. is taking on board the five recommendations of the Energy Data Taskforce and will be considering in detail how data (and methodology) transparency and visibility can be implemented for the flexibility market models and platforms developed. We will also provide feedback to industry on learning and any challenges and barriers. Recommendations from the Energy Data Taskforce have been actioned in part for the development of the Local Energy Oxfordshire (LEO) Minimum Viable Scheme1 (MVS). TRANSITION is facilitating the first LEO trial by providing portable monitoring equipment, design support and trial design input thus far and will advance through future tests. FUSION, through its use of USEF, is also supporting the implementation of a transparent and standardized methodology for data sharing and generating relevant learnings with the wider T.E.F. group.

2.2 Industry Impact Assessment

Alongside developments in government policy, the electricity industry has begun to test and trial innovations to support the DSO transition. However, some material gaps remain, T.E.F. is able to address a number of these.

2.2.1 ***GB Flexibility Tenders***

GB DNOs are at various stages of developing flexibility tenders, testing the use of online flexibility marketplaces to find service providers. It should be noted that the approach to defining service requirements and costs has varied widely and these are implemented in

a more bespoke way rather than through a full, business ready flexibility platform/s. There is still no standardised market model or market platform.

Learning is being shared by all DNOs through Open Networks. All three T.E.F. DNOs are currently trialling some form of market platform, the learnings of which are informing the deployment and further development of such platforms in their respective T.E.F. projects. TRANSITION is using a developed version of the PicloFlex platform in trials as part of the LEO partnership as well as testing other marketplace platforms such as those testing within the BEIS FleX and Power Forward Challenges. These are a key component in a more holistic flexibility platform that performs a wider range of network, commercial and market functions as described in the Future Insights paper. SPEN is using the PicloFlex market platform as part of its ongoing flexibility auctions, the learnings from which will inform the competitive procurement and integration of a third-party platform for FUSION. EFFS will interface with three third party platforms, namely Centrica's Cornwall Local Energy Market platform, EDF Energy's PowerShift platform and WPD's Flexible Power platform.

2.2.2 ***GB Smart Grid Demonstrations***

T.E.F. is directly collaborating with several other initiatives which are progressing well and providing learning back into T.E.F.:

- **Project Local Energy Oxfordshire (LEO)** is exploring how local renewables, electric vehicles (EVs), battery storage, vehicle-to-grid (V2G) technology and demand side response can provide flexibility services. This will enable testing of the DSO models (flexibility models and markets) being assessed in TRANSITION. The collaborative project LEO draws together a diverse set of stakeholders in a £40m programme of innovation and demonstration. This will significantly enhance the learning from TRANSITION at no additional cost to customers. At this stage, collaboration is progressing well having recently run a series of basic trials to identify key learning points with network monitoring and dispatch signals (via SMS). The learnings of these trials will be incorporated into future trials and where appropriate shared with T.E.F.
- **Cornwall Local Energy Market (CLEM)** - Centrica's Distributed Energy and Power business is building a local energy market in Cornwall which will test the role of flexible demand, generation and storage via a new virtual marketplace. Western Power Distribution (WPD) is developing the software that will allow them to identify constrained areas of the network and buy flexible energy demand or generation from the Local Energy Market platform. Delivered in partnership with the local distribution network operator Western Power Distribution, alongside National Grid ESO and Exeter University. This is enhancing the learning from EFFS as the trial area selected are due to location of previous customer recruitment with CLEM.

Also, since bid submission, a number of active and completed innovation projects have delivered findings that have informed and enhanced the scope and learning from T.E.F.

2.2.3 ***International Initiatives***

There are a number of recent and relevant international initiatives on distribution system operation with decentralisation and decarbonisation. The "Best Practice Report – Market

Facilitation of DSO"[4] report published on the TRANSITION website on 31st May 2019 provides further details. The report reviewed international experience of future electricity market facilitation to help inform the approach to market facilitation in the British electricity market.

Universal Smart Energy Framework (USEF) is a universal, standardised market-based framework. USEF turns flexible energy use into a tradeable commodity available for all energy market participants, separate from (but in coordination with) the traditional electricity supply chain, to optimise the use of resources. FUSION is applying USEF in trials, testing the standards, principles, interactions, and requirements for information exchange between certain market participants. A due diligence exercise carried out by FUSION showed that there is a close fit between USEF and both the current market design and the likely direction of future market design in GB. Project FUSION has been leveraging international best practice for USEF implementation by engaging with the 'USEF foundation' and the Dutch DSO – 'Alliander'. The key learnings gathered from Alliander's own flexibility trials were shared with the T.E.F. group.

2.2.4 ***T.E.F. Addressing the Gaps***

From the results of T.E.F, more standardised flexibility approaches can be developed for industry. The various market models and types of flexibility being trialled will help to inform what can be standardised and what is more bespoke, to ensure that the flexibility platforms developed are fit for purpose and can be efficiently interfaced with back-end systems. This will help transform learning into meaningful change. The interoperability of technologies is also being considered. Setting up appropriate market rules is important to achieve whole-system coordination through price-based competition in a safe and scalable way.

DSO Functionality: EFFS is working to earlier delivery timescales than TRANSITION, FUSION and the Open Networks project due to project programming and some background work progressing at-risk whilst T.E.F. was being formed by Ofgem. EFFS was thus able to develop some DSO functionality definitions and achieve early engagement from stakeholders. By demonstrating useful outputs to stakeholders to ensure continued participation, and to ensure that the outputs from EFFS are sufficiently accepted by stakeholders, has substantially reduced the risk of Open Networks reaching significantly different conclusions.

Market Models: TRANSITION has held three Market Rules Simulation events to validate market models and consider rules/conflicts with a wide range of actors. This has involved T.E.F. to support learning by developing a basic set of market rules which will govern the planned trials in Oxfordshire. The rules were tested and refined during the series of Market Rules Simulation events which included attendance by several DNOs. The USEF Implementation Plan developed for the FUSION project has taken the USEF market model

[4] Refer to the Library section of TRANSITION website www.ssen-transition.com

and tailored it to provide a version that aligns with the GB market today and tests those elements that are perceived to add the most market value.
T.E.F. has also closely engaged on trial strategy and planning to share best practice and identify areas of staggered learning. For example, EFFS are exploring conflict avoidance and unintended consequences in depth during trials. Outputs such as analytical rules on offers and decision making (not purely price driven) will inform TRANSITION trials enhancing overall learning.

Market Platforms: The development of market platforms is ongoing for FUSION and TRANSITION and there has been significant collaboration on functional requirements and market engagement although the platform requirements are materially different enough to warrant a separate procurement exercise. EFFS will continue to encourage EDF platform development to reflect Flexible Power platform features.

2.3 Open Networks Alignment

When the collaboration was formed during 2018, alignment with the ENA Open Networks Project was deemed key if T.E.F. was to reach its full potential. Throughout 2019, T.E.F. has maintained an eye on the ON-P as a whole, interacting with specific Products to enhance outputs and re-align design, requirements or terminology.

Common principles in 2020, where the ON-P takes a notable step forward in scope, should reduce barriers to innovation and potentially avoid costs of path correction at a later date. However, now that the DSO demonstrator projects are more mature, T.E.F. proposes to take engagement to a new level in 2020, directly testing outputs and in some cases leading elements of Product activities. Figure 8 conveys a summary of the ON-P workplan and proposed interface with TRANSITION, EFFS and FUSION.

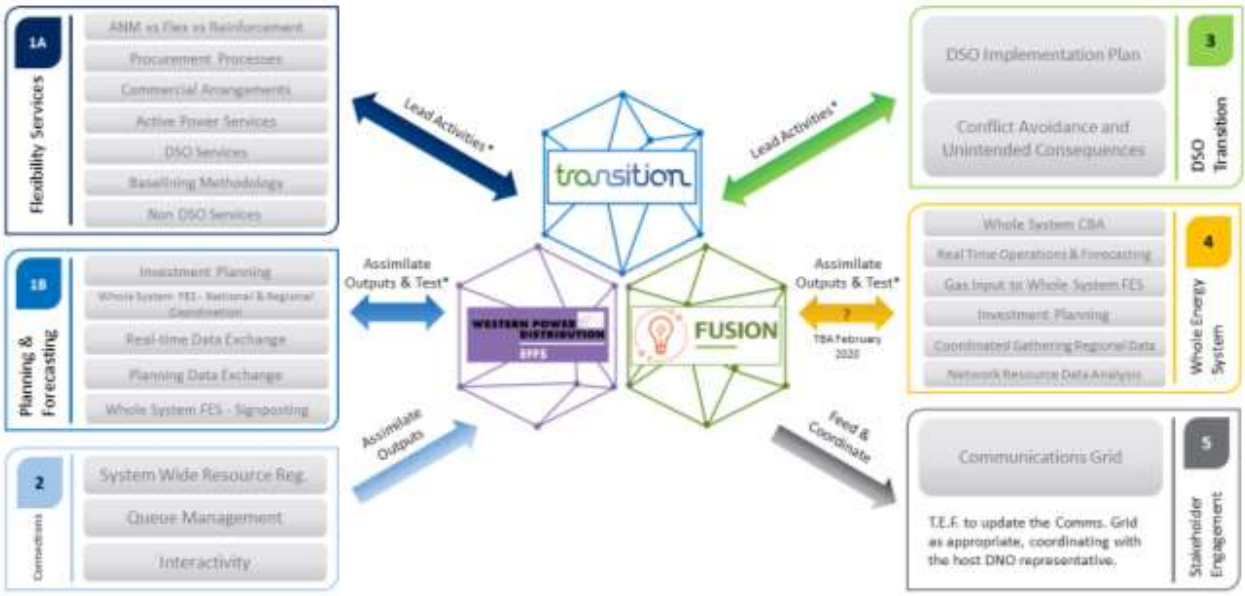

Figure 8: T.E.F. 2020 touchpoints with the ENA Open Networks Project

The T.E.F. group shall seek to lead particular activities under a Product Element in the *Flexibility Services* and *DSO Transition* workstreams, delivering required outputs through planned development (including direct input as T.E.F. into the DSO Implementation Plan) and testing where applicable to do so as Ofgem Network Innovation Competition Projects. This aligned approach to problem solving should allow for a step change in learning, using the T.E.F. projects to consider the needs for RIIO-ED1 and RIIO-ED2 smart grid architectures. Such is key in the de-risking of investment across the energy industry and proving the business cases for full smart grid transition.

The Energy Revolution, BEIS FleX and Power Forward Challenges also contain projects that could potentially support or directly input into planned activities. T.E.F. will aid engagement with such projects where practicable, yet Open Networks Workstream Representatives and or Product Leads are expected to take ownership of such engagement.

3 Stakeholder Engagement

3.1 Stakeholder Feedback

The T.E.F collaboration recognises the need to take a coordinated approach to stakeholder engagement in order to minimise the risk of stakeholder confusion or fatigue, maximise the quality and relevance of all deliverables, and save costs for events and materials. For example, T.E.F. have committed to using common language and definitions (in line with the ON-P Glossary), aligning timing of tenders and supplier engagement, and use of common graphics and materials where possible for engagement. By streamlining the number of events, this provides efficiency for stakeholders too.

The T.E.F. projects have many stakeholders in common but also some that are project specific. Examples of common key stakeholders are;

- ENA Open Networks project, Ofgem, BEIS, other DNOs, general customer base, National Grid ESO, Flexibility service providers, Aggregators and market platform operators, Suppliers and Industry consultants.

As many industry bodies and wider stakeholders are represented on ENA working groups and projects, it is prudent for the T.E.F. team to engage via the ENA where practicable. While this incorporates all ENA working groups and projects, there is focus on the Open Networks Project (ON-P) project as it leads the transition to a DSO which all three projects propose to test elements of. Further details of the engagement with the ON-P has been covered in Section 2.3 and will not be duplicated here.

3.1.1 ***Dissemination Events***

Each of the T.E.F projects has held events in order to elicit feedback from stakeholders in a direct and dynamic fashion, which has also provided an excellent method to develop closer relationships with stakeholders. These events have been co-ordinated and agreed by T.E.F. in order to ensure that each project has the opportunity to input into the other project's events and maximise synergies.

Figure 9: TRANSITION, EFFS and FUSION communicating T.E.F. partnership and wider collaborations

In addition, the T.E.F. collaboration has been disseminated and promoted at project events in order to extend the reach and increase visibility of this collaboration.

3.1.2 ***Market Development Workshop & Consultations***

One key benefit to the T.E.F. collaboration is that the other T.E.F. partners have been included in the consultation/workshops to ensure their input is taken on board and to achieve alignment of thinking where relevant. Below are examples of key stakeholder consultation activities that have taken place and how these activities have benefitted from the T.E.F. collaboration:

FUSION – Public consultation on the adoption of USEF in GB

Description: An 8-week public consultation process launched on 8th July 2019, in which stakeholder feedback was solicited in response to the 'Consultation Document' hosted on the FUSION website as given in Table 1.

Aim: To ensure that the USEF GB Implementation Plan reflected the needs and concerns of the wider GB industry.

Approach: The first step was the development of a Due Diligence (DD) study to identify the innovative elements of the USEF framework that could add value to the GB market, and that could potentially be trialled in the FUSION project. Next, a Consultation Document was developed which distilled the findings of the DD study into a set of 14 key questions, the responses to which would be used to shape the GB USEF Implementation Plan. Both documents were published on the FUSION website and an 8-week Open Consultation process was announced, during which time SPEN held two stakeholder engagement events in London and Glasgow to raise participant awareness and encourage responses. The results of this Open Consultation exercise and its impact on the USEF Implementation Plan were published in reports available on the FUSION website.

Benefits of T.E.F. collaboration: the T.E.F. partners provided comprehensive feedback on the structure and content of Consultation Document. Through their familiarity with FUSION and the GB flexibility market subject matter – they were able to provide valuable insights and recommendations to ensure that the Consultation Document was tailored to maximise the relevant industry learning outcomes.

TRANSITION – Market Rules Simulation series

Description: stakeholder exercise testing market rules developed by TRANSITION.

Aim: primary objective to test and find weaknesses in the basic market rules, developed by TRANSITION, so they can be addressed before they are used in field trials next summer.

Approach: round table interactive sessions held with multiple stakeholder groups (internal and external) including Project LEO and industry stakeholders such as suppliers, aggregators and platform providers. Further events will be held in 2020 to develop the appropriate Market Rules & Use Cases.

Benefits of T.E.F. collaboration: the T.E.F. partners provided detailed feedback on content during the events, shared experience of flexibility services and market models, providing additional value through their understanding of TRANSITION, and their own projects.

Learning generated for the Market Rules can be incorporated into all T.E.F. projects ahead of the trial phase. FUSION has subsequently run a Market Rules event, internal to SP Energy Networks, based on the TRANSITION series.

3.1.3 ***T.E.F. Workshops***

Each of the T.E.F. projects has adopted a different workshop breakdown and schedule dependent on the relevant project plan, objectives and deliverables. However, a key unifying factor has been the consistent involvement of the T.E.F. group and as many relevant stakeholders as possible and as wide as industry perspective as possible.
Key examples of events are listed below:

- EFFS WS1 held a series of workshops to define functional DSO requirements with attendance from T.E.F., National Grid ESO, ENA ON-P, UK Power Networks, Northern Power Grid and Centrica.
- T.E.F. Initial Trials Planning Workshop to present and validate the T.E.F. projects' current thinking and future plans regarding their respective trial phases.
- TRANSITION Market Rule Simulation Series involving multiple stakeholders.
- FUSION held a number of workshop events (developing technical specification for IT solution to facilitate trial) with SPEN business SMEs.
- EFFS WS2 engaged with and agreed with WPD SMEs in order to complete system design.
- FUSION in collaboration with EA Technology, ran a workshop with diverse industry representation to compare the USEF model with the Smart Grid Architecture Model (SGAM) future worlds.
- TRANSITION Site Selection workshops, in collaboration with LEO WP2 and WP3.

3.2 Defining DSO Functional Requirements

Each of the T.E.F. parties has engaged in hosting various internal and external workshops and meetings with multiple stakeholders and diverse industry representation. These have allowed T.E.F., as a collaboration, to develop and present a coherent and consistent view as well as draw on a wider industry perspective whilst minimising stakeholder fatigue. This has supported the development of functional DSO specifications, establishing strengths and weaknesses in market rules and in validating site selection and trial design work completed to date.

For example, the initial trial-planning workshop was run jointly and has provided increased visibility and alignment of trial-planning for all three projects which will improve trial design and outcomes. The TRANSITION Market Rule Simulation Series involved multiple stakeholders and led directly to a more efficient identification of potential conflicts and synergies to inform trial design. Joint work on forecasting and procurement has also supported value add through the collaboration. Future collaboration on network and IT/OT adaptation requirements, processes and lessons learnt, although to an extent this will be specific to each licensee, will be highly beneficial to the projects.

Key learning from stakeholder events is shared and discussed at T.E.F. meetings for consideration in each project and in planning and designing future workshops, on market trials for example.

3.3 Future Stakeholder Engagement Plans

Future engagement plans are discussed and planned at T.E.F. meetings to ensure that opportunities to maximise learning and knowledge dissemination from workshops and events are not missed. T.E.F. meetings will continue to include a regular review of the Open Networks WS5 Comms plan to identify opportunities to co-ordinate engagement. The financial savings reflected in the reduced EFFS budget within the T.E.F. collaboration report are still expected to be gained via a shared dissemination event between SSEN, SPEN and WPD. Refer to Section 5.3 for additional efficiencies identified by TRANSITION.

Figure 10 provides a high-level view of the T.E.F. timeline until closedown. Through Figure 11 the detail of planned T.E.F. activities in 2020 is clearly visible. The timeline highlights the degree of collaboration across a wide range of project aspects and respective stakeholder engagement. Further collaboration is planned as the T.E.F. projects progress.

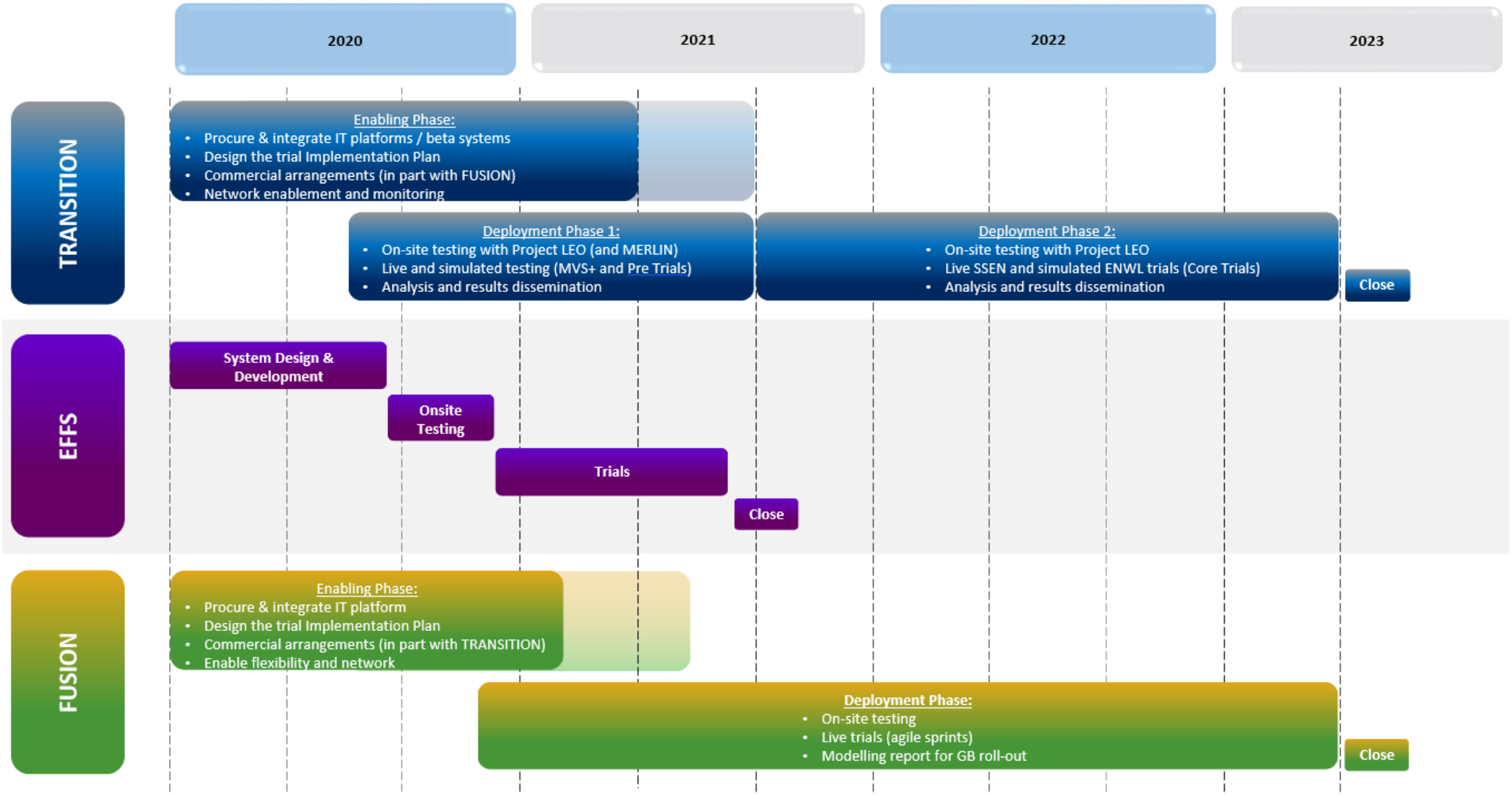

Figure 10: T.E.F. Timeline

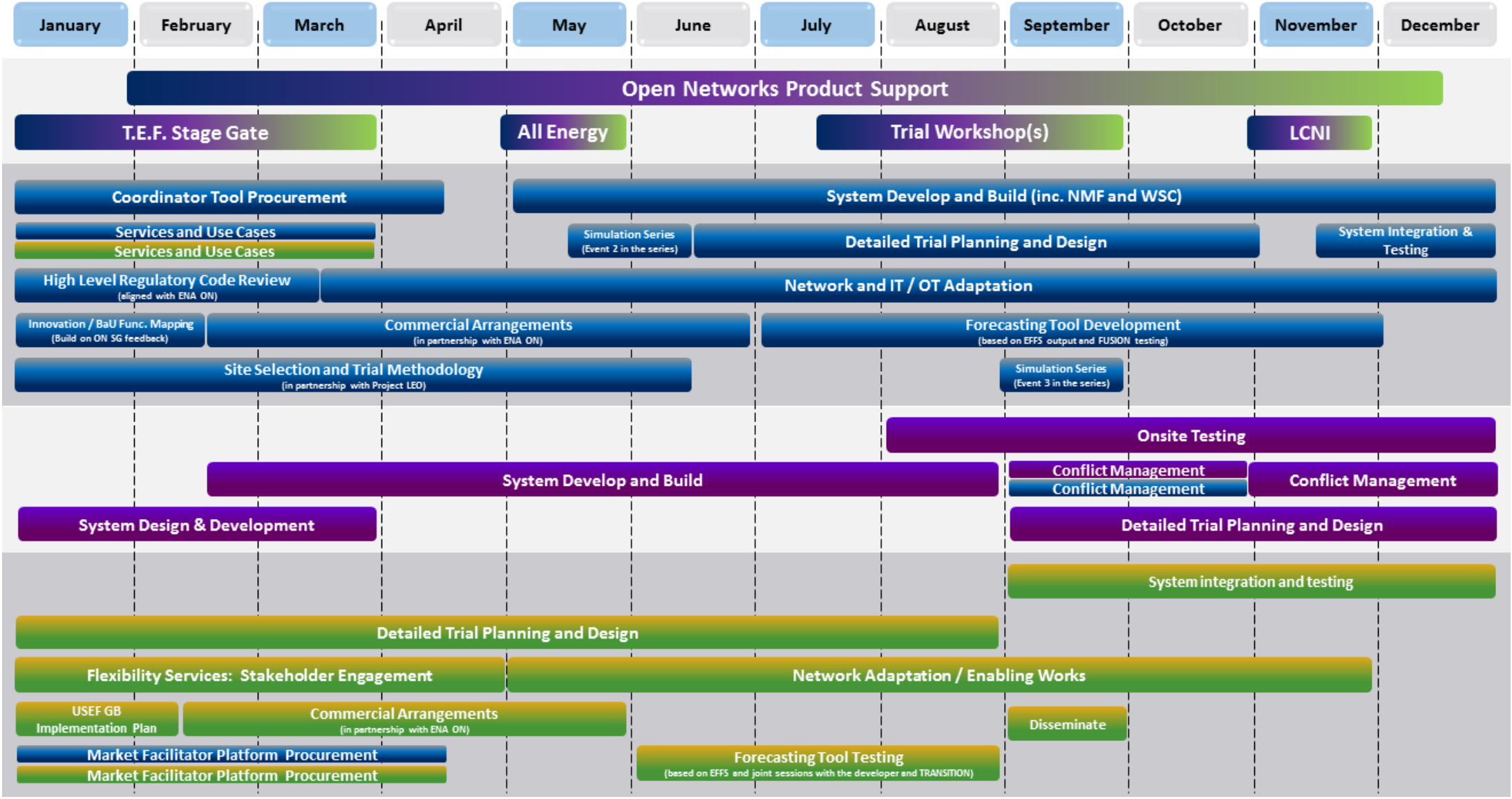

Figure 11: T.E.F. 2020 Timeline

3.4 Peer Review

The T.E.F. collaboration has provided significant value through enabling enhanced peer review. During the initial stages of the collaboration, a peer review framework was developed and implemented to facilitate this. At a strategic level, the framework supports full transparency and visibility of activities across the T.E.F. projects. It provides the opportunity to assess further potential for sharing in the development and deployment phases of each project.

Each of the three projects has included additional collaboration activities including cross-project peer reviews of project output requirements. Please refer to section New Knowledge 4.2 for more details of the area where peer reviews have taken place.

This has supported the release of efficiencies in forecasting and joined-up procurement activities for example. Collaborative workshops are held on output requirements, trial planning and various other project tasks, providing the opportunity for peer review and input and supporting validation of approach.

Peer review includes the review of selected outputs and published documentation by all T.E.F. partners, focusing on ensuring that deliverables are consistent, mitigating any duplication and supporting the identification of further opportunities for collaboration. This also assures both the quality and that a wide range of inputs and views are considered.

For selected knowledge dissemination activities, T.E.F. partners have provided peer review of proposed structure and content as well as identifying relevant stakeholders for invitation. This also includes active engagement in dissemination event such as workshops and webinars, providing feedback and supporting preparation of responses to stakeholder feedback, where relevant and appropriate. The approach taken aims to maximise the sharing of key learning from T.E.F. with stakeholders and encourage informed and constructive feedback.

4 Value for Customers

4.1 Collaboration Overview

Ofgem funding for TRANSITION, EFFS and FUSION was granted on the condition that licensees collaborate and coordinate, reduce the risk of unnecessary duplication, improve delivery efficiency and ensure the projects provide complementary learnings. The governance arrangements for achieving this are outlined in the Figure 13. Each of the three projects will remain individually responsible for compliance with their Project Direction and the requirements of the NIC Governance document.

Following project commencement, we have carried out a more detailed assessment of touchpoints with Open Networks in 2019 and 2020. This has also informed the shared areas of learning across the three projects.

Figure 12: T.E.F. Collaboration overview

Up to this Stage Gate, T.E.F. has successfully delivered on its collaboration commitments across all three projects, helping enhance overall learning and consumer benefits. We have a robust strategy in place that will enable this to continue for the remainder of the duration of T.E.F. with Figure 12 illustrating a summary overview of focus areas. Each signifies where joint efforts have enhanced proposed outputs or introduced new learning only achievable through direct collaboration between and wider support of the T.E.F. partners. The collaboration will not remain static, with new areas identified and discussed during the regular correspondence between the project teams.

4.1.1 ***Governance***

The following governance structure has been agreed and adopted by the T.E.F. group.

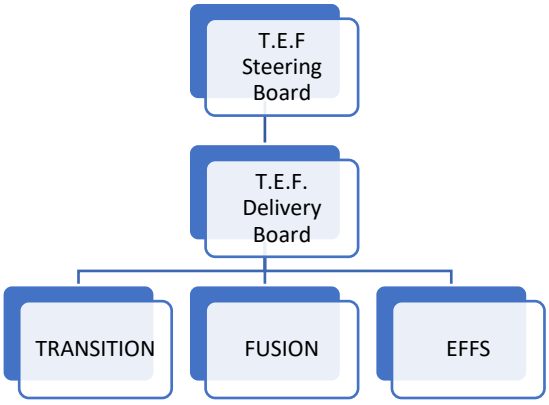

Figure 13: T.E.F. governance structure

The T.E.F. Delivery Board meet face to face on a monthly basis to discuss and coordinate specific project activities, review shared learnings and risks, and align activities. This consists of the leads for each T.E.F. project from SSEN, ENWL, SPEN and WPD and supporting staff, all of whom have committed to support close collaboration between projects. This regular meeting has proven to be beneficial with a significant amount of learning shared at every meeting.

The T.E.F. Steering Board periodically meet face-to-face to discuss project collaboration, alignment and risks at a more strategic level. In addition, all three projects hold regular review meetings with the Ofgem NIC Project Officer.

There is commitment from T.E.F. to support individual and combined project events and a collaborative T.E.F. SharePoint site has been set up by SSEN. Key project documents are uploaded to, and are being actively managed by, the T.E.F. group.

In order to facilitate collaboration activities, the T.E.F. collaboration teams identified key workstreams to further explore the core DSO competencies:

- Governance
- Programme alignment and Stage Gates
- Stakeholder and industry engagement
- Forecasting
- Trials

These workstreams have formed the basis on which collaboration efforts have been undertaken, and around which meetings and workshops have been held.

In the interest of preventing duplication within this document, full details of collaboration activities, both completed to date and future works, can be found in the document sections relating to stakeholder and industry engagement (section 3), forecasting (section 4.2.1) and trial planning (section 4.2.4).

4.1.2 ***Collaboration Conclusion***

Ensuring appropriate collaboration across T.E.F. has and will continue to enable us to achieve efficiencies and deliver best value to the customer. The three T.E.F. projects have developed and implemented a framework for collaboration that has helped to drive value for consumers across the projects. This collaboration framework provides clearly defined roles and responsibilities and regular engagement (at both working and strategic level) to help facilitate collaboration. Specifically, collaboration has helped the projects to find efficiencies relating to aspects of procurement and the development of forecasting techniques. In general, this collaborative approach has led to a wide range of shared learning across all three projects as outlined in section 4.2.

4.2 New Knowledge

While the bulk of the learning from the T.E.F. projects is expected to be generated during their trial phases, the T.E.F. projects have already generated new knowledge which has been shared between the projects and with wider stakeholders.
During the Requirements phase the main focus of the projects has been:

- TRANSITION project has published several deliverables on the project specific website (see Table 1 for website link) which provide analysis of roles and responsibilities for market facilitation, flexibility services and system requirements in a DSO world. This documentation has provided new knowledge to form a basis for the Neutral Market Facilitator and Whole System Coordinator development and trials in Oxfordshire.
- EFFS has published project outputs which provided new DSO related knowledge specifically around Forecasting Evaluation, Data Exchanges and DSO System Design.
- The FUSION project has published project outputs to the industry, which provide new knowledge specifically on the benefits of implementing USEF in GB and the flexibility market value in East Fife.

Further details of the new learning created by the projects to date are summarised below. In addition, each project has published documentation on their project website, refer to Table 5 for relevant link.

4.2.1 ***Forecasting***

Three methods were investigated as part of the EFFS forecasting evaluation phase; Auto-Regressive Integrated Moving Average (ARIMA), Long Short-Term Memory Artificial Neural Networks and Extreme Gradient Boosting (XGBoost).

The key outcomes established within this part of the EFFS project include the following:

A. **Model performance**: For the majority of test cases, Extreme Gradient Boosting outperformed the other methods tested (ARIMA and Long Short-Term Memory).

B. **Forecasting at different voltage levels and substation types**: A series of techniques were applied to GSP, BSP, Primary, Load and Generation customers across multiple time horizons.

C. **Testing and adoption of EFFS forecasting algorithms.** The Python books produced by EFFS were assessed by SPEN engineers to determine their suitability and applicability for use on the SPEN network. SPEN was able to de-construct the EFFS system and take and apply the features, algorithms, approaches and techniques to an existing in-house forecasting project, WaNDA. This has allowed SPEN to greatly enhance an existing forecasting system that will now be directly connected to Project FUSION. SSEN and ENWL have also begun assessing the Python books, building on the analysis conducted by FUSION.

4.2.2 ***Solution Design***

EFFS: during the system design phase of EFFS, changes to the requirements were identified during design activities and technical discussions with WPD subject matter experts. Learning included Forecasting Analysis for lower voltage levels, Power Flow Analysis related to ANM schemes, uniform interfaces for flexibility platforms, definition around a common set of Use Cases/Services, requirement for an 'Arming' signal, visibility of services in PowerOn, and visibility of market prices for control room users. These design challenges, and the options to resolve them have been incorporated into the EFFS system design to provide a logical, indicative view of what is technically possible, alongside the original requirements. This provides T.E.F with an example of such a system and how it might function.

Further learning is expected to be generated from work that is currently in progress to finalise the detailed system design, ahead of the trial execution. This will include algorithms to identify data quality issues, algorithms to substitute representative data where good quality data is not available and learning on the extraction of future network states from switching schedules.

TRANSITION: The key learning from TRANSITION relates to the Neutral Market Facilitator (NMF) and Whole System Coordinator (WSC). TRANSITION published the "Neutral Market Facilitator Requirements Specification" on the project website on 31st May 2019, and the "Whole System Coordinator Requirement Specification" on the 18th September 2019. These documents identify the requirements for the NMF and WSC, two key functions to enable a flexibility market.

The NMF/WSC High Level Design "High Level Solution Design", published on 19th November 2019, provides a high-level view of the components and interactions needed to achieve the objectives of the project in alignment with the Ofgem Future Insights Report on Flexibility Platforms in Electricity Markets.

FUSION: during the requirements phase FUSION has produced several reports focussing on the USEF market models, specifically – 'USEF Due Diligence Report' detailing how industry stakeholders believe USEF would best be deployed within the GB context. The 'USEF Consultation report' identified innovative aspects of USEF, the implementation of which in GB would offer significant contributions to the development of standardised DSO processes in GB. 'USEF Implementation Plan' provides a detailed plan for the implementation of these USEF features within the FUSION trials and the associated learning objectives and contributions to the wider industry.

4.2.3 ***Services/Markets***

FUSION: has produced a report, which provides a comprehensive evaluation of the flexibility market in East Fife and shares the methodology used in that analysis. It identifies the challenges to implementing a local flexibility market in that area and provides recommendations for next steps.

TRANSITION: The project has held several iterations of Market Rules Simulation Events. These are a round table stakeholder exercise with the primary objective to test and find weaknesses in the basic market rules, developed by TRANSITON, so they can be addressed before they are used in field trials. To date events have been held with TRANSITION and LEO participants, and wider industry stakeholders. The project is developing a further series of events for 2020. In addition, the project published the "Services in a Facilitated Market" report on the TRANSITION website which identifies what flexibility services may be deployed in a future facilitated market. TRANSITON and FUSION are jointly developing the services into a series of use cases with the ON-P.

EFFS: DSO requirements for flexibility service data exchange - EFFS has proposed a set of data items (based on the 4 service types defined by the ENA Open Networks) to support data exchanges relating to flexibility services. While the SGAM defined by the ENA ON-P provides a high-level view of the types of data exchanges required to support the procurement and dispatch of flexibility services, this had not previously been defined to the level of agreeing data items. This has provided an additional level of detail and understanding for how the data exchange related to flexibility services will work in practice. This has therefore enhanced the learning of the SGAM for use by T.E.F.

4.2.4 ***Trial Planning***

T.E.F.: The partners held an 'Initial Trials Planning' workshop in June 2019 to present and validate the T.E.F. projects' current thinking and future plans regarding their respective trial phases. Further Trial Workshops are planned for 2020, to develop thinking and ensure alignment.

TRANSITION: TRANSITION published the "TRANSITION Site Selection Methodology" report on the website which evaluated SSEN's network against a set of criteria to establish areas for DSO trials. Learnings have been shared with T.E.F. partners, and further development works are ongoing in conjunction with the LEO collaboration in Oxfordshire. ENWL are developing a specification for simulated trials in the Greater Manchester area which increase the learning without the requirement for physical installations.

EFFS: EFFS is developing a trial programme focussing on Devon and Cornwall. This is leveraging previous customer recruitment from the Cornwall LEM project.

FUSION: In Q4 2019, FUSION Partners accelerated efforts in trial-planning by implementing a series of four dedicated monthly workshops. These meetings have been fruitful, resulting in a draft implementation plan for the FUSION trials. Distilled summary updates are regularly shared at T.E.F. meetings.

5 Trial Deployment

5.1 Trial Planning & Design

Each project trial programme will aim to demonstrate the operation of software and validate the functional requirements, business logic and data exchanges associated with a DSO market model under a range of conditions. A number of elements are common to all projects; the investigation of these elements using different locations, market models, customers, and software will inform a wide range of possible future DSO outcomes.

The combined high-level aims of the trials across all three projects are:

- to quantify the relative benefits of various market models and assess their suitability;
- to demonstrate the system functionality in practice and learn about the practicalities of operation.
- to evaluate local flexibility capacity and extrapolate to national markets; and
- to test emerging scenarios from the Open Networks project and Ofgem.

Further objectives have been taken into consideration in each DNO's trial design methodology, refer to Table 2 below.

Collaboration with Open Networks is also influencing trial design. We recognise the importance of an agile trial approach. To reflect and adapt to latest thinking and relevance, trial design will be altered to suit a changing landscape. The inclusion of simulated trials in the ENWL licence area, unlike physical trials, are not dependent on seasons or trial participants and allow for more variables to be analysed to understand flexibility in networks with a wider range of characteristics.

	TRANSITION	EFFS	FUSION
Market Model	Least Regrets model (complimentary to all DSO Worlds)	DSO Coordinated Dispatch – World B	USEF framework (complementary to all DSO Worlds)
ESO-DSO Interaction	Various	Data exchanges to support conflict identification and resolution.	Considered as part of the USEF framework
Trial Sites	Circa 60 in Oxfordshire and multiple in ENWL area	South-West Network covering Cornwall and Devon	2 in East Fife
Voltage Levels	GSP to LV	33kV and 132kV	33/11kV (Primary)
Flexibility Sources	Wide range of sources and technology types	Flexibility providers associated with the three market platforms.	Aggregators and suitable customers

	TRANSITION	EFFS	FUSION
Forecasting Needs	Peak management and constraint management – different timescales	Half-hour average load and generation forecasts for Primaries and 33kV or 132kV connected customers at various time horizons.	Peak management and constraint management – different timescales
Use Cases	Focussed on wide range of demand and generation services for DSO/ESO/DER	Reinforcement deferral, CML/CI risk management for events during planned outages, network restoration after widespread events.	Focussed on wide range of demand and generation and other services, primarily for the DSO.
Market Platform (Grid Service and/or P2P).	Market Platform specifications developed and procured	Use existing market platforms Flexible Power, PowerShift (EDF), CLEM (Centrica)	Market platform specifications developed and procured
DSO toolset	Whole System Coordinator and Forecasting	Forecasting	USEF framework application within GB, Forecasting, and grid services functionality.
Key Trial Learning	Inform the work of the ON-P on the transition from DNO to DSO based on ON-P market models	Demonstration of system functionality in the real world. Practicalities surrounding forecasting, data exchanges etc.	Deliver a local demand-side flexibility market in GB using the Universal Smart Energy Framework (USEF).

Table 2: Outline trial parameters.

5.1.1 ***EFFS***

The purpose of the EFFS trials phase is to demonstrate that the software and interfaces developed to support DSO functionality, including the forecasting and co-ordination elements, function as intended. It will demonstrate that the system can accurately forecast flexibility requirements over various timeframes and act upon this requirement by communicating with the various flexibility services. The technical implementation for the EFFS trials will involve some new elements being rolled out as BaU, where appropriate, but for some elements a temporary or manual process will provide a more pragmatic solution. This has maintained a healthy balance between making the solution as replicable as possible whilst at the same time minimising costs.

Market Model development for testing during trials: EFFS reflects Future World B, i.e. independent purchasing and dispatch by the DSO and ESO but with data sharing processes in place to identify and resolve conflicts. EFFS is not developing new market models but linking to market platforms that already have established market rules and

processes. The Flexible Power market model details are available from the Flexible Power website. The Cornwall LEM operates via reserve auctions up to three months in advance – though week ahead is expected to be the norm and day-ahead auctions for utilisation. It also supports utilisation only auctions on a day ahead or intraday basis.

Use cases: The use cases for flexibility services will be;

- On a planned basis to defer/avoid reinforcement – flexibility services despatched so that if an outage occurs network limits will not be breached. Covers seasonal peak management and maintenance window extension.
- On a planned basis to reduce the risk from an unplanned outage during a planned outage – flexibility services after an event occurs to reduce CML and CI associated with recovery of the network.
- On an as-required basis, use flexibility services to speed up recovery after exceptionally severe / widespread network issues such as large storms.

Trial Sites: Where possible existing customers/flexibility providers will be used to leverage existing engagement and reduce costs. The trials will be based in WPDs South West licence area. GSP's have specifically been selected in order to leverage the Cornwall Local Energy Market.

Flexibility sources: EFFS will leverage assets associated with the existing market platforms in Cornwall, namely Flexible Power, PowerShift (EDF), CLEM (Centrica)

5.1.2 ***TRANSITION***

The WSC and NMF platforms incorporate complex processes, with various interactions between system components such as markets, business models, network infrastructure, and power system analysis. Robust trials will provide an understanding of the WSC and NMF operation under a range of market models and mitigate risks around practicalities and unintended consequences/conflicts. As well as proving the system, the trial phase will create learning relevant to forecasting the likely benefits of flexibility services and the impact of changing network planning standards.

Market Model: TRANSITION trials are being designed to enable the testing of a number of market models. These may include: *Local Market, Central Market* (managed by a single NMF) and *Commercial Market* (each with their own NMF).

The merits of different market structures relative to each other will be assessed based on costs, management of potential conflicts in value between market participants, the impacts on market participants of operating in such market structures and the identification of other barriers. The is consistent with least regrets path where DSO transition starts with development of DSO-ESO coordination, building upon existing practises whilst delivering Flexibility Commitments and not excluding any other models in the future.
Use Cases: To assess flexibility provider capabilities, each market model will be tested under a set of pre-defined use cases which involve changing the level of demand/generation for a flexibility provider that can/cannot take physical delivery. Use

cases presented in the TRANSITION bid are being further developed by Origami who are producing a more detailed Use Case report which will be published in early 2020.

Trial Areas: Various network locations were considered to identify an area that is representative of the GB electricity distribution network such that the benefits of each market model tested can be extrapolated. The selection criteria included networks with existing flexibility, decentralised generation and multiple network archetypes such as rural and urban. Oxfordshire was selected as the county for trials and further site selection work is ongoing by TRANSITION and project LEO to determine specific areas for trials. In addition, TRANSITION will conduct simulated trials in the ENWL license area to maximise learnings on a different network topology.

Flexibility sources: In partnership with project LEO, the TRANSITION project is assessing potentially trial locations and flexibility assets. Across the Oxfordshire county there are circa 100 assets currently available, mix of technology types and size including heat network, hydro, PV's, battery, DSR.

5.1.3 ***FUSION***

FUSION will deliver a local flexibility market through a universal, standardised market-based framework – The Universal Smart Energy Framework (USEF), to address distribution network congestion issues, and complement national balancing requirements within the existing regulatory framework.

The trial will involve the following activities:

- an open tender for the procurement of flexibility contracts with aggregators;
- operational interaction with aggregators using a cloud-based platform; and
- procurement, dispatch and settlement of demand response and local generation.

During the trial, there will be a process of continual evaluation to identify opportunities for optimising processes. Where appropriate, these will be implemented. At the end of the trial a full evaluation will be undertaken. This will accumulate all experiences from the trial and evaluate the overall business cases for the DNO, aggregators and end-users.

Market Model: Procured through a local flexibility market, allowing multiple aggregators of flexibility within the trial area to submit bids for provision of local network congestion management services. FUSION is adopting the USEF framework which is an opportunity to build on an international framework and test its applicability in the UK context.

Use Cases: FUSION will deliver the following four Case Studies:

a) Insufficient Thermal Capacity within the 33kV Over Head Line Network
b) Insufficient Thermal Capacity at the 33/11kV Local Primary Substation
c) Insufficient Thermal Capacity during 11kV Alternative Running Arrangements
d) Insufficient Thermal Capacity at the Local Secondary Substation

Trial Sites: The St Andrews and Leuchars 33/11kV primary substations in the East Fife region were selected for trials. They are interconnected at 33kV and 11kV level. St Andrews was previously identified as constrained and a number of innovations were

implemented from the Flexible Networks innovation project to add 20% additional thermal capacity.

Flexibility Sources: Flexibility will be assessed on a customer site by site basis to establish the flexibility capacity both in terms of power (kW) and energy (kWh) which reflects the customer's ability to provide the service over a given duration. Only those customers connected under St Andrews and Leuchars Primary Substations, who can provide demand side or generation response, would be considered to participate. FUSION aims to recruit a range of industrial and commercial (I&C) customers across diverse business areas, and domestic customers.

In conclusion, the ongoing T.E.F. collaboration and future trials all have unique components which, when considered holistically, provide a significant step change in understanding how flexibility can best be realised in the transition to DSO. T.E.F has and will continue to collaborate on trial design where possible and appropriate to maximise learning and efficiency with further engagement planned in 2020.

In addition, consistency of trial planning activities and content is achieved by TRANSITION and FUSION having the same project partner focusing on market models and associated rules. This will help to ensure that any areas of potential duplication during the deployment phase are avoided, and area of uniqueness are emphasised.

5.2 System Development & Build

As discussed in Section 4.2.2, the first 16 months has seen significant solution design progress across the board, with requirements for the core development areas derived and high-level designs drawn at varying levels of detail. The three projects have provided insight of such designs at various junctures since commencement, supporting cross pollination of ideas while mindfully maintaining organic development based on objectives originally set out in the individual NIC full submission documents.

To enable projects to efficiently procure and build beta versions of possible Distribution System Operation systems, the T.E.F. Project Delivery Board held focused sessions covering specific aspects of proposed high-level designs. These have allowed the group to clearly understand the originality of each project and where overlap may arise. Importantly, a prescribed level of overlap is necessary to de-risk future investment and facilitate timely transition to a smart grid architecture, yet T.E.F. partners agree it must be transparent and coordinated.

Consequentially, common context diagrams have been produced illustrating some of the core building blocks on test for each project, expediting comparison and deeper conversations during the development process. While Figure 14 is only illustrative and not to scale, the blocks have been drawn to indicate breadth and depth of the primary systems on test; depicted using a darker tone in each diagram. Importantly, these are not system architecture diagrams. Wider business systems in use or those developing through other projects are not directly included, being referred to simply via the ribbon at the top of each diagram.

T.E.F. Stage Gate – Main Document

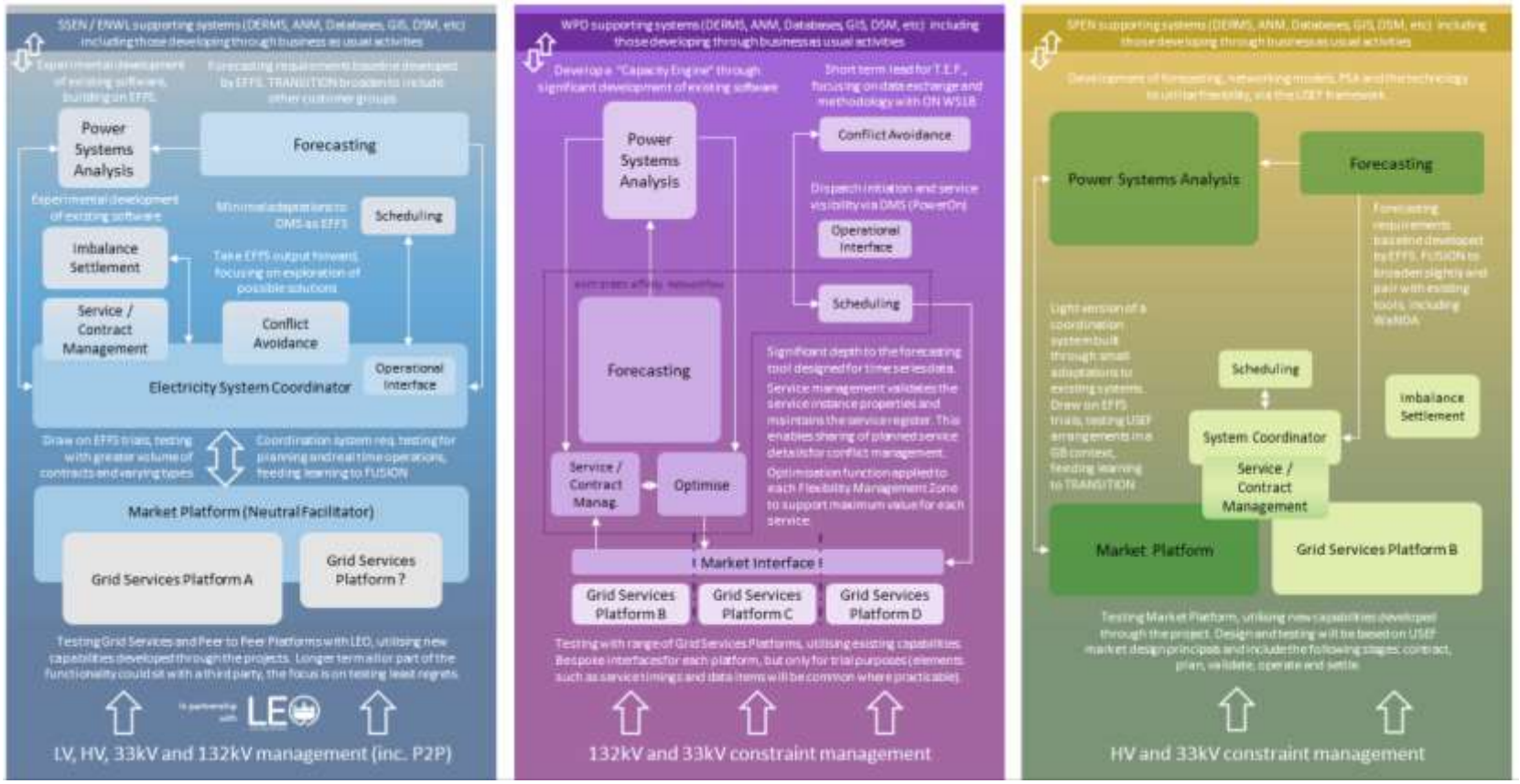

Figure 14: T.E.F. Context Diagrams

TRANSITION: Committed to the development and testing of a market platform and coordination systems to facilitate operation of various emerging smart grid markets. An important feed into these systems is forecasting predictions and simulated results from power system analysis. The latter is expected to be developed, using the likes of Excel Workbooks and new Python scripts to meet requirements. TRANSITION shall then modify where practicable based on analysis of the EFFS component tests and end trials. The forecasting requirements and base algorithms from EFFS have been reviewed internally and now independently by consultancy TNEI (due late February 2020) to derive options for TRANSITION that expedite broad trials with Project LEO. While some further work is needed, a significant further saving of £98.5k can be realised through the integration of EFFS learning. This approach reduces customer investment without compromising on end output.

Coordination is an important unique development under TRANSITION, required to plan and operate an efficient network underpinning a variety of markets for a broad range and relatively high volume of customers. Integration with Project LEO increases complexity, yet significantly enhances the testing opportunity, offering insight into the needs of local energy actors. To mitigate this, requirements have been developed for a system currently known as the Whole System Coordinator (WSC). This tool has been designed to coordinate both inside a single licence area and with its neighbours including upstream transmission networks. These interfaces will be developed at varying levels throughout the project.

TRANSITION proposes to procure a market platform, developing capabilities required to facilitate various new markets in accordance with ON-P direction. The system referred to within TRANSITION as the Neutral Market Facilitator (NMF) tests requirements for a single interface between the DSO, Grid Services Platforms, Peer to Peer Platforms and other emerging actors. While procured and built within the project, the beta version is a function and capability testbed with no preconception of end ownership once the business case is proven and transitions into a business as usual environment. To support this, TRANSITION in partnership with Project LEO is working with a known Grid Services Platform developer and other newer entrants with varying capabilities and indeed interests. The requirements specification and data interfaces on test are publicly available and were shared with BEIS to pass onto the successful BEIS FleX and Power Forward Challenge projects in order to provoke conversation and further collaboration. SSEN is supporting a number of these projects and are committed to open learning in aid of an economic, timely and well-informed transition to a Distribution System Operations model. While there are notable differences in the underpinning market arrangements, rules, customers, technology types, services and use cases, TRANSITION and FUSION have proposed further workshops during the procurement phase to continue avoidance of unnecessary duplication. Additionally, the projects have committed to aligned vendor engagement, reducing fatigue and aiding identification of synergies that could support a joint test (live or simulated) if practicable.

EFFS: Forecasting is a primary focus for EFFS, with enhanced power system analysis and a market interface enabling the 132kV and 33kV constraint management trials. The AMT-SYBEX Affinity Networkflow is being developed for EFFS, providing significant depth to a forecasting tool designed for time series data while incorporating scheduling, 'Flexibility Management Zone' service optimisation and service management. The latter validates the service instance properties and maintains the service register, enabling sharing of planned

service details for conflict management. EFFS has upheld its commitment to be the initial forecasting development lead, delivering a set of requirements and baseline algorithms within a shared set of Python script books. These have been considered by TRANSITION and FUSION, enabling savings committed to in the amended project directions to be realised and further efficiencies identified.

The "Capacity Engine" is being developed through relatively significant development of an existing power system analysis tool. Such development will come ahead of any power system analysis work under TRANSITION, hence learning shall be directly adopted where benefits are identified, aided by the fact both WPD and SSEN both utilise the base software being used. EFFS methodology and results should also support FUSION's proposed work in this area, designed to lead the next stage of development in this area over the coming few years.

EFFS aim to interact with a range of existing Grid Services Platforms via a Market Interface. There will be largely bespoke interfaces for each platform, but elements such as service timings and data items will be common where practicable. This approach promotes the required learning while protecting customer investment by allowing TRANSITION and FUSION to build and test beta market platforms and or facilitators.

FUSION: Seeks to draw on EFFS trial learning, testing USEF arrangements in a GB context, feeding learning to TRANSITION. Systems including forecasting, power systems analysis and the technology to utilise flexibility such as the market platform shall all feature in the FUSION trials. As discussed previously, forecasting is common to all projects, with EFFS taking the initial lead in development. The FUSION team have identified, through testing of the EFFS output to date, an opportunity to meet forecasting needs (at the two Primary Substations included in the trials) through pairing of EFFS developed algorithms with an existing tool known as WaNDA. This approach avoids unnecessary duplication and aligns with the commitment to deliver best value for our customers.

The project proposes to test developed network modelling techniques covering near live network models and power system analysis to increase network understanding and aid management of the increased volumes of local flexible resources expected in a low carbon economy. As the trials are proposing to consider live network models, operational planning and the interaction with active network management (ANM) systems, the breadth of progress is believed greater than the "Capacity Engine" developed under EFFS. However, EFFS learning will set a strong foundation and be reviewed in conjunction with FUSION designs to increase the creation of new knowledge.

FUSION proposes to procure a market platform, developing capabilities within the context of USEF to test in a GB market. Design and testing will be based on USEF market design principals and include the following stages: contract, plan, validate, operate and settle. While there are notable differences in the underpinning market arrangements, rules, customers, technology types, services and use cases, TRANSITION and FUSION have proposed further workshops during the procurement phase to continue avoidance of unnecessary duplication. Additionally, the projects have committed to aligned vendor engagement, reducing fatigue and aiding identification of synergies that could support a joint test (live or simulated) if practicable.

5.3 Deployment Costs

In conjunction with enhanced outputs, the collaborative activities have resulted in deployment cost savings, offering our customers much stronger value for money. Historic savings, made at the time of T.E.F. creation, are described in full within the 2018 Compliance Documents[5&6]. However, new efficiencies have been achieved from alignment with internal IT development work. At this stage, TRANSITION can commit to a previously unidentified £50.4k saving through said IT efficiencies. T.E.F. shall continue to explore the potential for similar opportunities until the end of the projects.

In addition to IT efficiencies, the three projects have and are continuing to explore the potential for further alignment opportunities during design, procure, develop and test phases associated with the T.E.F. core systems, refer to table 3.

Tool or Service	Projects	Collaboration	Benefits
Forecasting Tools	TRANSITION, EFFS and FUSION	• Training data from SPEN • Forecasting Workshops with EFFS and their partners / contractors • Input into requirements • Review / testing of initial EFFS learning	• Exploration of varying approaches and needs • Higher value learning • Savings to the customer of a further £98k via TRANSITION • Wider adoption
Power System Analysis or Coordination Tools	TRANSITION and FUSION	• High Level Design Workshop(s) • PQQ alignment • Joint vendor days • Functionality Mapping	• Reduced stakeholder fatigue • Visibility of focus areas for primary development • Higher value learning • Wider adoption
Market Facilitator / Platform	TRANSITION and FUSION	• High Level Design Workshop(s) • PQQ alignment • Joint vendor days • Use Case coordination	• Reduced stakeholder fatigue • Visibility of commonality • Higher value learning • Enhanced requirement lists

Table 3: Primary Systems / Platforms

[5] https://www.ofgem.gov.uk/system/files/docs/2018/10/nic_2017_compliance_document_v2_public_1.pdf

[6] https://www.ofgem.gov.uk/system/files/docs/2018/10/fusion_compliance_doc.pdf

EFFS have led the Forecasting Requirement process with FUSION and TRANSITION supporting and assimilating outputs. This joint development in the area of forecasting throughout the first 18 months has resulted in TRANSITION realising a previously unidentified £98.5k saving; the full amount of which will be returned at the end of the project. FUSION has assessed internally and applied the EFFS algorithms to an existing tool; WaNDA, while TRANSITION has commissioned independent EFFS forecasting due diligence, outlining the paths which meet TRANSITION and LEO needs. The forecasting efficiency advances the newly identified T.E.F. additional collaboration savings total to £148.9k. Such improvements in value for customers money have only been possible through collective development and pivotal alignment works in EFFS and FUSION.

Market and System Coordination or Power System Analysis tools (with untested functionality) are being explored by TRANSITION and FUSION. As discussed in Section 5.2, significant work has been undertaken to avoid unnecessary duplication and direct development towards the most unique elements of the designs. T.E.F. have completed high level design workshops to align core functionality, ensuring T.E.F. remains focused on developing and testing functionality which is innovative, with as yet no proven business case. To ensure this continues during the procurement phases, TRANSITION and FUSION have aligned the PQQ process where practicable. Systems outlined in Table.2 shall be developed through to 2021, with successful vendors identified for all before the end of 2020. Thus, contracted cost of procured tools shall be communicated in the 2020 Project Progress Report.

The two projects are going through competitive tender processes for the systems in question with joint vendor days proposed. These are designed to reduce stakeholder fatigue and facilitate greater breadth of learning through minimisation of scope overlap. Ahead of the vendor days and next stage in the competitive procurement process, appropriate gap analysis is ongoing and will be discussed at future T.E.F. Delivery Board Meetings to enable requirements to be prioritised and compared.

Following completion of the system procurement processes, TRANSITION and FUSION will enter the build phase, allowing EFFS to feed early learning from their testing with a wider range of Grid Services platforms. A T.E.F. trial Workshop facilitated this approach and further sessions planned in 2020 shall focus on mid-2021 and 2022 trial objectives. This will include an element coordinated duplication deliberately designed into the programme. This is vital to successful verification and validation phases, allowing learning accrued through one group of energy system actors to be compared with another. This approach is employed to maximise results and best support transition to a Smart Grid architecture.

5.4 Risk Analysis

A collaborative approach to risk management is being applied across all three projects, this is implemented as part of overall T.E.F. governance and is working efficiently. Risks were assessed in detail at the Collaboration Agreement stage and a T.E.F. risk register was prepared. Risks are monitored and managed on an ongoing basis using the risk register and best practice project management techniques. The T.E.F. risk management framework specifically includes continuous risk identification; risk evaluation; risk mitigation and contingency measure definition; risk monitoring and control. As there may not be means of reducing or eliminating all risks facing project collaboration, justifiable mitigation responses have been devised and documented to protect T.E.F. project objectives and desired outcomes. Moreover, as T.E.F. progresses, dynamic risks are monitored and reclassified where appropriate to maintain a true reflection of their criticality.

The risk of ineffective T.E.F. collaboration has been strongly mitigated through the ongoing commitment of the three projects to joined-up and coordinated learning outcomes which is enabled by regular T.E.F. meetings and calls at project and activity level, sharing learning, reviews of key documentation.

The most significant ongoing risks and their mitigations are described below:

- **Systems/platforms** – In order to manage the risk that the systems and platforms developed as part of T.E.F. are not robust, relevant and cost effective, technical specifications are shared between T.E.F. partners for feedback. Workshops have been held to help achieve alignment where appropriate and avoid over-prescription. Engagement with the supply chain is also being carried out via joint procurement coordination between SSEN and SPEN with alignment of PQQ questions for the tenders and plans to jointly hold webinars, supply chain events etc.
- **Trial deployment** – If trials are not deployed in a co-ordinated way across the T.E.F. projects, this could result in less effective learning outcomes. Regular trial deployment progress updates are shared as part of T.E.F. governance, as trial programmes are developed. T.E.F. partners are actively involved in individual project trial stakeholder workshops. Specific trials planning sessions have also been held to review approaches and to identify key dependencies and touchpoints in T.E.F. plans, ensuring alignment where appropriate. In partnership with project LEO, the TRANSITION project has commenced preliminary trials in Oxfordshire, the learnings of which will be shared with the T.E.F. partners.
- **Forecasting** - Initially, there was a risk that the T.E.F. projects would not produce collaborative forecasting requirements that were suitable for all three projects. This was to be mitigated by TRANSITION and FUSION projects reviewing and providing feedback on the EFFS forecasting scope.

  As projects have progressed, it is less clear that a single set of requirements will be appropriate for all T.E.F. projects. This recognises the learning gained as projects have progressed and as trial programmes and specification of outputs have been developed in detail. TRANSITION and FUSION projects have both utilised learning from EFFS forecasting algorithms as much as is practically possible.

FUSION has been able to deconstruct the EFFS system and apply the features, algorithms, approaches and techniques to an existing in-house forecasting project, WaNDA into the existing SPEN forecasting system. However, the forecasting requirements that have developed to achieve TRANSITION objectives do differ to an extent, SSEN and ENWL have begun assessing the Python books and will build on the analysis conducted by the FUSION team. This limits the ability and appropriateness of using EFFS forecasting algorithms directly. This risk is being managed on an ongoing basis.

- **ENA Open Networks** – Unsighted changes to the ENA Open Networks project may result in T.E.F. projects carrying out less relevant work. This is being proactively mitigated through stakeholder engagement and communications with Open Networks Steering Board members as well as at Workstream level. During the monthly T.E.F. PDB meetings, a recurring agenda item has been consistently dedicated to a monthly update on recent developments with the ON Project. This has led to T.E.F. proposing a plan for how it intends to deliver relevant learning to the ENA in 2020 (see Section 2). This should ensure that outputs from both T.E.F. and Open Networks will be consistent, aligned and coordinated. T.E.F. is also closely tracking government policy and industry developments, which have provided increasingly strong justification of the T.E.F. business cases since the original project NIC bids and the Collaboration Agreement.

5.5 Feedback Loop (SSEN)

Innovation projects are dynamic with significant learning generated during delivery that then influences the roadmap to the final outputs. There are also many changes taking place in wider industry that directly and indirectly influence the T.E.F. projects. In order to ensure that the planning and deployment of the trials informs and is informed by industry, learning will be actively shared during T.E.F. trials with stakeholders including Open Networks and the wider industry. Feedback can then inform upcoming trials to maximise the value of project outputs.

There is a degree of flexibility built into the trial programmes, where appropriate, to enable this to take place efficiently and align with latest developments in the market. Trial simulations are being undertaken for TRANSITION, in the ENWL license area, and these will build on outcomes from live trials and explore aspects that may be more challenging to test in a live network, broadening learning from trials overall.

Specifically, the feedback loop from trials will interface with the Open Networks 2020/21 product mapping and commitment to delivery of particular elements.

6 Business Cases

6.1 General observations

6.1.1 *Original T.E.F. business case*

In their original NIC submissions, each T.E.F. project submitted a robust business case, supported by a comprehensive Cost Benefit Analysis (CBA).
The approval of all three projects by the Regulator in September 2018 was testament to the coherency and credibility of their respective business cases at that time.

Several benefits were common to the business cases of each of the T.E.F. projects. These included;

1. The **cost savings** through the deferral or avoidance of traditional reinforcement
2. Reduction in **CO_2 emissions** through enabling faster / higher volumes of renewable generation connections
3. The **CML and CI benefits** from the use of flexibility services to support network restoration
4. The **potential revenue** available to customers providing flexibility services.
5. **Cost efficiencies** compared to uncoordinated flexibility operation via reducing the total costs to DSO and ESO
6. **Reduced ESO costs** from DSO-stimulated increase in flexibility provision

The most significant of these anticipated benefits was the cost saving through deferral or avoidance of traditional reinforcement.

6.1.2 *Current T.E.F. business case*

Since the projects were awarded funding, the business case for T.E.F. has only improved. Collaboration between the three projects has led to material cost reductions with no impact on learning outcomes and thus, the ratio of benefits to costs and customer value for money have been further strengthened. Business case highlights can be summarised as follows:

Costs reduced
Project costs and the associated NIC funding requirements have either remained broadly on target or, in the case of TRANSITION, decreased since the original submission, delivering greater customer value. Collaboration activity costs for T.E.F. are being absorbed in each project as the knowledge sharing that is promoted through the collaboration results in efficiencies across a number of areas.

Value added

- T.E.F enables more aligned industry engagement and knowledge-sharing across the three projects, increasing the likelihood of a successful future rollout of the learning outcomes into business as usual.
- T.E.F has also delivered a number of flow-down benefits through more collaborative joint working with ON-P and other industry projects, including;
    - Power Forward,
    - BEIS Flex,

- Energy Revolution Challenge,
- LEO,
- ReFlex and
- ESO.

Relevance reaffirmed

- Ofgem published a position paper[7] on Distribution System Operation and Ofgem and BEIS published an Open letter to ENA Open Networks in the summer of 2019.[8] Alongside Ofgem publications on RIIO2 and Flexibility Platforms, these publications (alongside other recent Ofgem publications on RIIO2[9] and Flexibility Platforms[10]) highlights that the transition to smart grid architecture is more likely today than it was at bid stage.
- Ofgem[11] and BEIS[12] recently articulated in detail their vision of the DSO role, providing increased clarity on direction of policy compared to that which was available at bid stage. This vision aligns closely with the DSO role envisaged in the original business cases.
- Several other developments being implemented at strategic and policy level also support the validity of input assumptions such as;
  - the outputs of the Energy Data Taskforce,
  - the creation of DNO/DSO digitalisation strategies and
  - network charging and access reform.
- The findings of the 2019 Baringa report[13] showed positive business cases for all the Future Worlds, driven primarily by the anticipated savings from deferral or avoidance of traditional reinforcement. This suggested the business cases for the T.E.F. projects have not been undermined by changes in assumed values for reinforcement costs, flexibility service costs or inflation values. Indeed, the cost of flexibility services for ESO has been falling recently, which if reflected in future DSO flexibility prices could improve the number of scenarios where flexibility services were a cost-effective alternative to reinforcement.

[7] https://www.ofgem.gov.uk/publications-and-updates/ofgem-position-paper-distribution-system-operation-our-approach-and-regulatory-priorities
[8] https://www.ofgem.gov.uk/publications-and-updates/open-letter-ena-open-networks-project-ofgem-and-beis
[9] https://www.ofgem.gov.uk/publications-and-updates/open-letter-consultation-riio-ed2-price-control
[10] https://www.ofgem.gov.uk/publications-and-updates/ofgem-s-future-insights-paper-6-flexibility-platforms-electricity-markets
[11] https://www.ofgem.gov.uk/publications-and-updates/ofgem-position-paper-distribution-system-operation-our-approach-and-regulatory-priorities
[12] https://www.ofgem.gov.uk/publications-and-updates/open-letter-ena-open-networks-project-ofgem-and-beis
[13] 'Future World Impact Assessment' (22 Feb 2019 Baringa)

Realisation of benefits accelerated

- Since the projects were awarded funding, GB-wide targets for energy & CO_2 reductions have increased in their prevalence and ambition.
- A significant driver in the value of flexibility is the increase in variable renewable energy in the power system. The incentives arising from these policy changes mean that the business case benefits are likely to be realised earlier and could potentially be greater than originally anticipated.

Market liquidity improving

- The positive business case is subject to the availability of flexibility service providers whom can deliver the services trade.
- At the time of writing, there is no evidence to suggest that distribution-connected flexibility cannot flourish. On the contrary, there has been continued investment in creating flexibility platforms, which has been supported by the BEIS FleX competition.
- Also, while we do not yet have a liquid flexibility market, flexibility procurement rounds recently undertaken by WPD and SPEN have shown a progressive increase in the ratio of services procured to those sought.
- These observations suggest that the risk of insufficient market liquidity is lower today than it was when the T.E.F. projects were originally approved.

6.2 Project-specific observations

The original T.E.F. business cases were justified, with recent collaboration activities only serving to enhance the knowledge generated. To date, the projects have together output far more than their contracted deliverables, enabled in part by the commitments set out when T.E.F. was first formed.

Events and circumstances have only served to strengthen the original business cases. At a project-specific level, all three projects have quantifiably verified that they are progressing according to budget and programme, which serves to further validate the credibility of the financial models used. Details of the ongoing applicability and relevance of individual T.E.F. project business cases are provided below.

	TRANSITION	EFFS	FUSION
Expenditure *(How have the roll-out costs compared to the original submission? What does this mean for the business case?)*	Overall, the outturn of project spending to date is on schedule, with marginally greater costs from external contractors and savings in labour costs. The project had a slower start than originally anticipated whilst finalising the collaboration agreement. This impacted the level of	EFFS project costs to date are within the project budget. The business case for the EFFS project, as an enabler to unlocking future savings via deferred reinforcement, remains valid.	**REDACTED**

	TRANSITION	EFFS	FUSION
	resources available after kick-off. Improved efficiencies and streamlining of activities have resulted in a reduction in the total project cost for TRANSITION since the original submission, improving the business case, saving will be realised at project close down. Despite TRANSITION's actual expenditure remaining broadly on target as anticipated, the project has leveraged added value at no extra cost through its co-ordination with the LEO project.		Overall, the outturn of project spending to date has been broadly aligned with the forecast expenditure, with marginally greater costs as justified in the Project Progress Report. The close approximation of FUSION's actual and forecast expenditures serves to validate the credibility of the assumptions used in the financial modelling, thus reaffirming the validity of the business case.
Programme *(How do the projected implementation dates compare to the original submission?)*	The project deliverables to date have been submitted on schedule, and all future milestones remain on target.	All project deliverables have been delivered to schedule. Milestones 1-4 were approximately 3-4 months later than project direction, and all future milestones are currently anticipated to be completed 3 months later than planned in the project direction. These changes have been agreed with Ofgem and the Project remains on schedule to deliver its remaining Project Deliverables.	Progress to date has been very good. All Project Deliverables are progressing well and are on-track for completion either on or before their contractual due-dates. Those deliverables due in 2019 were all successfully submitted on schedule.

Table 4: T.E.F. Business Case Observations

Consequently, the business cases for the T.E.F. projects are stronger today than when they were originally approved in 2018.

7 Conclusion

The current and planned work by T.E.F. projects is set to deliver learning needed for the industry to make informed decisions, facilitating an efficient and smooth transition to a smart grid model. This is a clear benefit to customers and our wider stakeholders, evidenced by our approval to proceed issued by the Steering Group of the ENA Open Networks Project on Thursday 20th February 2020.

Importantly, to maximise relevance of outputs, T.E.F. recognises it cannot design solutions in isolation. Thus, the projects have offered to lead particular product elements within the ENA Open Networks Project and have formed significant interactions with other key industry projects. These include the facilitation and or partnering with projects from the Energy Revolution (InnovateUK), Power Forward (BEIS & NRCan) and FleX (BEIS) challenges.

In addition to enhanced outputs, the collaborative activities have resulted in financial savings, offering much stronger value for money. All projects have verified that they are progressing to programme set during the T.E.F partnership creation. EFFS and FUSION are progressing on budget, TRANSITION is forecasting an additional saving of £148.9k. Such improvements in value for money have only been achieved through the ongoing collaboration activities, voluntary contributions and commitment to maintain, if not increase, learning across all topics.

The T.E.F. partnership believes all requirements have been satisfied and that the three projects offer significant value for money in this field. Hence it is the recommendation of the four electricity network licensees directly involved that the projects progress without delay or modification.

For greater detail on the outputs discussed and more please visit the T.E.F. projects websites where you can also find details on how to contact the relevant team:

Project	Website
TRANSITION	https://ssen-transition.com/
EFFS	https://www.westernpower.co.uk/projects/effs
FUSION	https://www.spenergynetworks.co.uk/pages/fusion.aspx

Table 5: T.E.F. Project Websites