Scottish & Southern Electricity Networks

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Moving to a smart future

Electricity Network Innovation Competition SSEN005

Project Close Down Report
15th September 2023

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Scottish & Southern Electricity Networks

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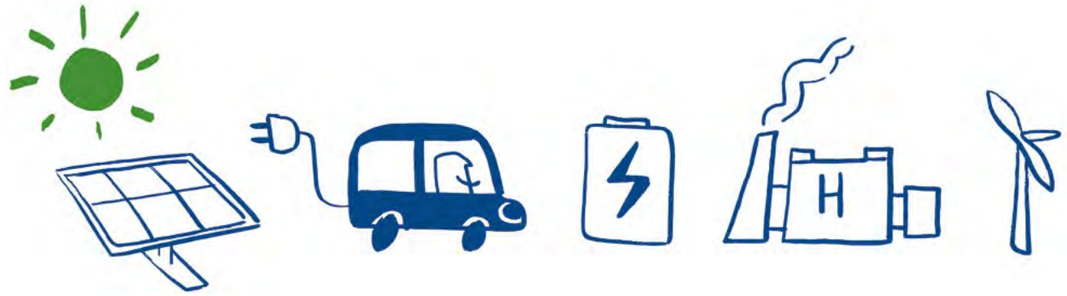
Project Background

Below is the summary of the project, extracted from the Network Innovation Competition (NIC) submission document (2017)[1].



The Great Britain (GB) network continues to evolve, and there is a clear need for networks to become more flexible, enhance operations and allow new technologies and new market models, such as Peer-to-Peer (P2P) trading, to emerge.

The 'fit-and-forget' approach of traditional network operation relied on predictable energy use and production that matched that use; this paradigm is no longer relevant. The transition to a Distribution System Operator (DSO) has the potential to bring significant benefits to customers; it also brings a range of new, complex challenges, unintended consequences and risks for market participants, new entrants, and the network licensees.

The Energy Networks Association (ENA) Open Networks Project (ON-P)[2] is focussed on defining the Distribution Network Operator (DNO) transition to a DSO model. It has been endorsed by UK Government's Smart Systems and Flexibility Plan which called for 13GW of flexibility by 2030[3].

Based on the intermediate outputs of ENA ON-P, Project **TRANSITION** (**TRANSITION**) was submitted as an Ofgem Electricity NIC funded project led by Scottish & Southern Electricity Networks (SSEN) in conjunction with project partners Electricity Northwest (ENWL), CGI, Origami and Atkins.

The **TRANSITION** NIC project gained Ofgem funding as part of a collaboration agreement between **TRANSITION** (SSEN project) and two other NIC projects: Electricity Flexibility and Forecasting System (EFFS)[4] led by National Grid Electricity Distribution (NGED)[i] and Project FUSION[5] led by SP Energy Networks (SPEN), all three projects collectively known in the industry as T.E.F.

[i]Formally called Western Power Distribution

TRANSITION's aim is to inform on the design for DSO systems and a flexibility marketplace facilitated by the DSO, mainly by:

Informing design requirements for the Neutral Market Facilitator (NMF) and Whole System Coordinator (WSC) platform

Developing the roles and responsibilities within the marketplace

Developing the market rules required for the trials

Implementing and testing the concept of the systems by means of trials in Oxfordshire

To carry out the above, **TRANSITION** developed and ran a programme of trials in Oxfordshire in collaboration with Project Local Energy Oxfordshire (LEO)[6], a project funded through the UK Industrial Strategy Challenge Fund.

Both **TRANSITION** and LEO had objectives that were closely aligned and when combined, significantly, enhanced the overall learning.

2

Executive Summary

Electricity networks will be a key enabler of the Net Zero transition. In December 2021, all DNOs submitted their investment plans to Ofgem for RIIO-ED2 (ED2), the price control period from April 2023 to March 2028[7]. They confirmed their 'flexibility first' approach, aiming to unlock available capacity for customers through flexibility services and flexible connections.

For example, SSEN's ambition is to deliver over £460m of benefits through procurement of 5GW of flexibility (including flexible connections) over the ED2 period[8].

This investment will enable networks to economically deliver a future energy system with high levels of renewables and electrification of demand, and the DSO functionality will be vital to mobilising and delivering this work.

Since the project was awarded funding, there has been discourse within industry on the role of the DSO within the future energy value chain, with Ofgem issuing two consultations[9,10] on the topic in 2023. Within the context of this evolving Net Zero policy landscape, **TRANSITION** has been working to test and validate flexibility markets operating on the distribution network, and develop the tools, systems, data sets, and associated processes required to support them.

To meet the ten project objectives and complete the project deliverables (see **Section 4**) **TRANSITION** conducted a programme of trials comprising Market and Technical Trials (Project Trials) in Oxfordshire with increasing commercial and technical complexity, see **Figure 1**.

As shown, **TRANSITION** has not only met the project objectives and deliverables but exceeded them by delivering additional learnings through collaborating and responding to emerging findings, policy, and regulation.

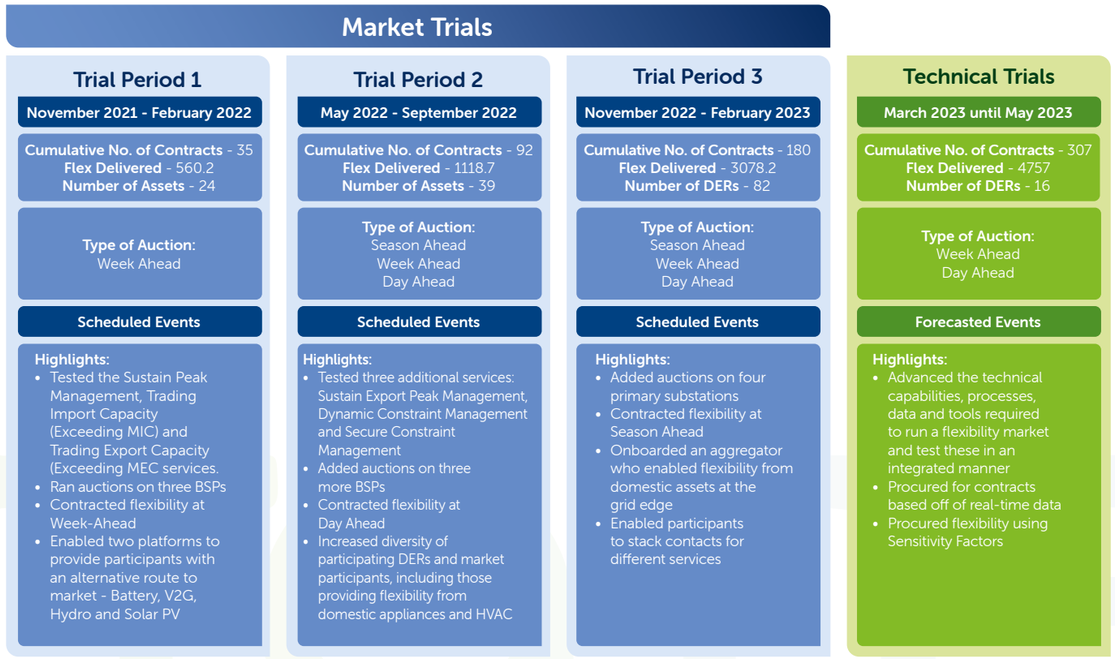


Figure 1: TRANSITION Project Trials

The Market Trials were run in conjunction with Project LEO, a socio-technical innovation project that aimed to demonstrate a functioning Smart Local Energy Systems (SLES). These two projects brought together technical operation and delivery to develop and test the fundamentals of running a flexibility market using two categories of services: DSO-Procured services, to relieve network constraints through the delivery of flexibility; and DSO-Enabled services[ii], to improve the efficient use of existing capacity through either the trading of import or export capacity between network users or the use of flexibility to manage loading on a constraint. In doing so, the Market Trials helped **TRANSITION** to develop and test:

- **Market Design Arrangements -** to devise the services, roles and responsibilities, market rules and mechanisms to enable DSO flexibility markets and share these with industry.
- **Contractual Arrangements -** to provide the contractual documents to enable markets for both DSO-Procured and DSO-Enabled services.
- **Price Evaluation Methodology -** to determine a ceiling price for flexibility when it is used to defer investment in reinforcement for a period of more than one year.
- **NMF -** to provide a user interface portal for DSO interaction with market participants, enabling them to Register, Contract, Deliver, and Settle DSO-Procured and DSO-Enabled services.

The Technical Trials enabled the project to advance the technical requirements, capabilities, processes, data, and tools needed to run a flexibility market and test these in an integrated manner, in particular:

- **System Architecture and Data -** to develop the structure for the sub-component DSO systems and manage the automated data flows between them to test forecasted events[iii].
- **System Co-ordination -** to enable the automatic selection of contracts for dispatch whilst considering the ability of Distributed Energy Resources (DERs) to resolve the constraint via the Power System Analysis (PSA) tool.
- **Network Model -** to provide an accurate representation of the physical network to study the resulting power flows (via the PSA tool) under different scenarios.
- **PSA tool -** to calculate the anticipated power flows under different near-term topology changes and forecast scenarios.

In addition to the Project Trials, **TRANSITION**, in partnership with ENWL, carried out a series of simulated trials using models of the networks in the Northwest of England[11]. Whereas the physical trials were held on SSEN's network in Oxfordshire, the simulated trials have been carried out using models of ENWL's network, including regions in Greater Manchester. The overall aim of the simulated trials was to explore and produce learning about questions and topics which cannot be reasonably tested within physical trials, such as the impacts of different sources of uncertainty and risk, and how sensitive the optimal or near-optimal decisions about procuring flexibility are to different inputs and market behaviours.

The outcomes from **TRANSITION** have resulted in a significant body of knowledge and eight key messages as summarised in **Figure 2**.

These outcomes, and the learnings gained from developing and implementing them, will be imperative to enabling SSEN's transition to the DSO through either adopting them directly, and/or using them to inform the requirements and specifications for Business as Usual (BaU). Indeed, these have already influenced SSEN's Digital Strategy[12], which highlights the importance of Near Real Time Data Access (NeRDA) and Low Voltage (LV) network monitoring, and will provide an evidential basis for our DSO strategy, due to be published early 2024.

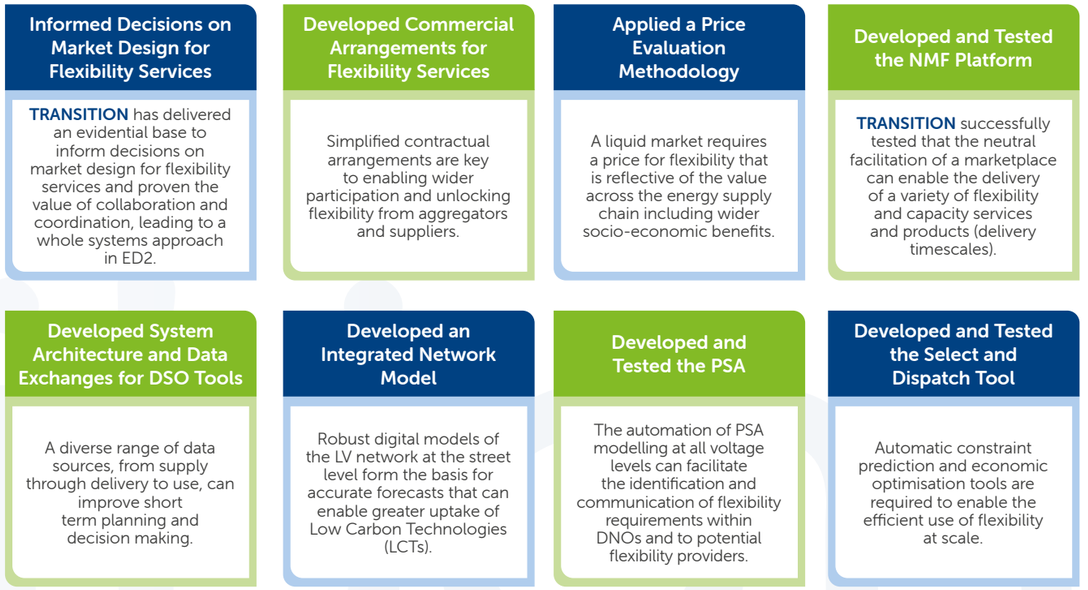


Figure 2: Summary of outcomes and key messages from **TRANSITION**

[ii] Also known as peer-to-peer (P2P) services
[iii] Using the forecasting tool which provided the 10-day ahead demand and generation forecast of the network.

3

Project Details and Outcomes

3.1 Overview

TRANSITION aimed to inform the requirements around neutral market facilitation and system coordination, develop the roles and responsibilities within the marketplace, develop the market rules required for the trials, and implement and test the concepts and systems by means of trials.

Oxfordshire was identified as the preferred county to conduct the Project Trials via the process detailed within the Site Selection Methodology[13].

Further analysis was performed to identify suitable areas of the Oxfordshire network, based on essential criteria identified by the project, the requirements of Project LEO, and the availability of DERs[1]. Ultimately, six bulk supply points and 13 primary substations were identified for use, as shown **Figure 3**.

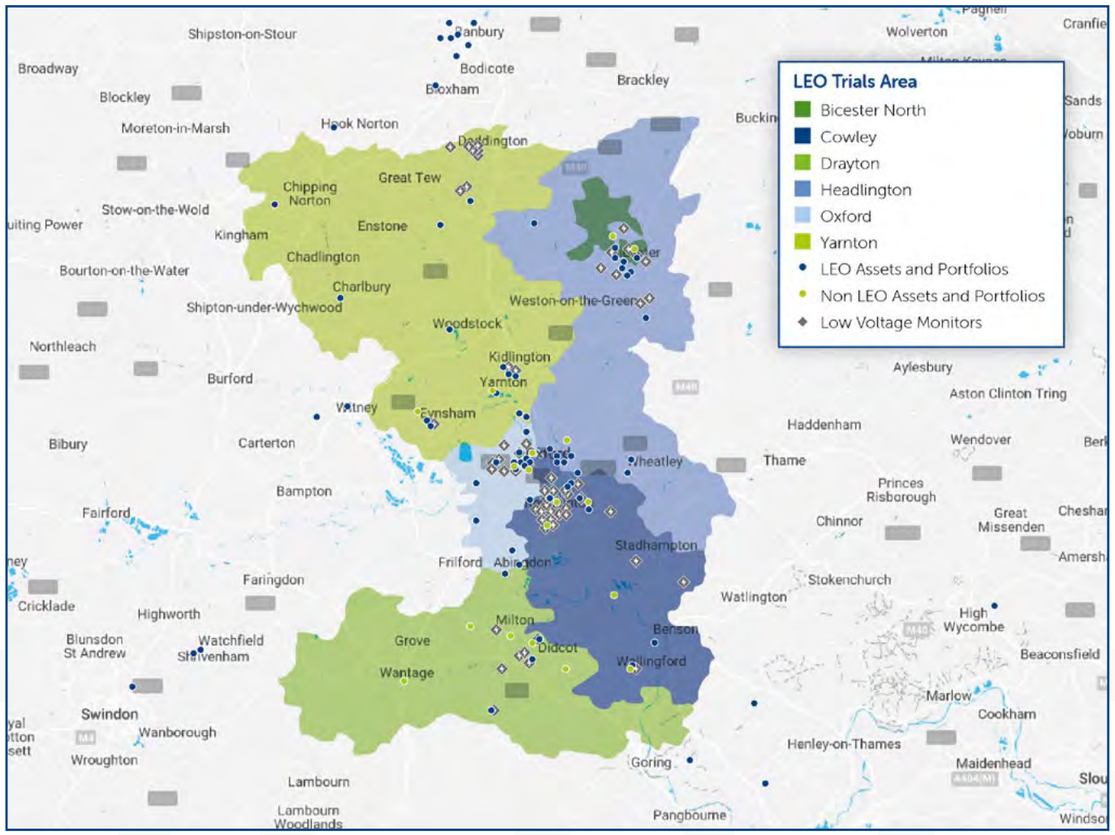


Figure 3: TRANSITION-LEO trial areas, installed monitoring and DERs.

As specified in the NIC submission document[1], **TRANSITION** set out to consider the Market Models, consistent with the published strategy and consultations from the Department of Business, Energy & Industrial Strategy (BEIS)[iv] and Ofgem at the time. Following this, the ENA ON-P identified five future worlds that could exist once the role of the DSO has been established[14], along with associated transition pathways.

Within this context, **TRANSITION**, in collaboration with Projects LEO, considered the use cases and flexibility services likely to exist in such a DSO world[15,16], and identified six services to be trialled which either supported the network (DSO-Procured) or improved the efficient use of existing capacity whilst benefiting market participants (DSO-Enabled).

A description of these services is provided in Table 1, with a full description of each service provided on the TRANSITION website[17].

Table 1: Summary of DSO-Procured and DSO-Enabled Services trailed during **TRANSITION**.

Service	Description of Service
DSO Procured Services	
Sustain Peak Management (SPM)	A market participant delivers flexibility (increase generation or reduce demand) to the DSO to reduce the load on a critical DNO asset (such as a transformer) that is forecast to become overloaded due to increased demand.
Sustain Export Peak Management (SEPM)	A market participant delivers flexibility (increase demand or reduce generation) to the DSO to increase the load on a critical DNO asset (such as a transformer) when it is forecast to become overloaded due to increased generation.
Secure DSO Constraint Management (pre-fault) (SCM) **- new**	A market participant delivers flexibility (increase generation or reduce demand) to the DSO to reduce the load on a critical DNO asset (such as a transformer) that is subject to an emerging issue that could result in an unplanned outage if not addressed.
Dynamic DSO Constraint Management (post-fault) (DCM) **- new**	A market participant delivers flexibility (increase generation or reduce demand) to the DSO after an unplanned outage to help restore electricity to a network area or relieve pressure on the system so it can recover.
DSO Enabled Services	
Exceeding Maximum Export Capacity (MEC)	Two market participants in a network area with limited (or no) spare export capacity trade a portion of their export capacity for an agreed period without affecting the network. The Buyer can increase their export level, but the Seller must reduce their export level.
Exceeding Maximum Import Capacity (MIC) **- new**	Two market participants in a network area with limited (or no) spare import capacity trade a portion of their import capacity for an agreed period without affecting the network. The Buyer can increase their import level, but the Seller must reduce their import level.

The above services were used to test flexibility markets operating on the distribution network during Project Trials, see **Figure 1**, of increasing complexity:

Market Trials
Run over three Trial Periods (TP1, TP2 and TP3) in conjunction with Project LEO to develop the market fundamentals, develop the commercial arrangements and refine the design of the systems and tools[18].

Technical Trials
Advanced the technical requirements, capabilities, processes, data, and tools needed to run a flexibility market in close to near real time and tested these in an integrated manner.

[iv] BEIS existed until February 2023 when it was split to form the Department for Business and Trade (DBT), the Department for Energy Security and Net Zero (DESNZ) and the Department for Science, Innovation and Technology (DSIT).

3 Project Details and Outcomes

3.1 Overview

An overview of the developments made during the Project Trials is provided in Table 2.

Table 2: Summary of Project Trials

Parameters	Market Trials			
	Trial Period 1 (TP1)	Trial Period 2 (TP2)	Trial Period 3 (TP3)	Technical Trial
Time Frame	Nov-21 to Feb-22	May-22 to Sep-22	Nov-22 to Feb-23	Mar-23 to May-23
Duration (weeks)	17	20	17	12
Network areas involved Bulk Supply Points Primary substations	 3	 6 0	 6 4	 1 4
Products (delivery timescales) Season Ahead Week Ahead Day Ahead	 No Yes No	 Yes Yes Yes	 Yes Yes Yes	 N/A Yes Yes
Service Type and number trialled DSO-Procured DSO-Enabled	 1 1	 4 2	 4 2	 4 N/A
Service Delivery days	Mon - Fri	Mon - Fri	Mon - Fri	Mon - Fri
Service Delivery windows DSO-Procured DSO-Enabled	 1500 - 1900 0000 - 2400	 1500 - 1900 0000 - 2400	 0000 - 2400 0000 - 2400	 0000 - 2400 0000 - 2400
Scheduled/Forecasted	Scheduled	Scheduled	Scheduled	Forecasted

In addition to carrying out the Project Trials, **TRANSITION** conducted numerous workshops and ran simulated trials to explore and produce learnings about questions and topics that could not be reasonably tested within physical trials.

The simulated trials were conducted in partnership with ENWL, using models of the networks in the Northwest of England[11].

Whereas the physical trials were held on SSEN's network in Oxfordshire, the simulated trials have been carried out using models of ENWL's network, including regions in Greater Manchester, to assess the impacts of different sources of uncertainty and risk, and how sensitive the optimal or near-optimal decisions about procuring flexibility are to different inputs and market behaviours.

The simulation approach synthetically generated sets of data, as though they were genuine observations and predictions being collected or estimated in real-time.

These were then provided as inputs to tools which approximate the decisions a DSO will have to make about flexibility. In response, the tools issue outputs for different flexibility services, comprising of procurement and/or dispatch decisions.

The assumptions made within the modelling process aimed to maximise the necessary use of flexibility services (e.g., by taking a more conservative view of asset ratings than is typical within network planning and operation) and assert that there is widespread availability of flexibility services, with costs that are efficient.

This is so the simulated trials could provide as much learning and insight as possible about how flexibility services might operate technically. This was an important enabler for understanding the impact of flexibility at scale in business-as-usual (BAU) operation, complementing the physical trials completed in Oxfordshire.

The key outcomes from all works carried out in **TRANSITION** are summarised in the remainder of Section 3, along with the methodology used to achieve these and the key messages and learnings for each.

*Simulated Trials Summary Report | SSEN Transition (ssen-transition.com)

3.2 Market Design Arrangements

Throughout the Project, TRANSITION regularly interacted with Ofgem and the ENA, disseminating information and acting as a learning vehicle by testing the latest thinking and developing new ideas to support the market design for the DSO transition.

As part of this work, TRANSITION:

- Considered the use cases, flexibility services and products (delivery timescales) likely to exist following the transition to DSO[15,16], and tested six services (see **Table 1**) to support the development of DSO flexibility markets.
- In collaboration with TNEI, developed a baselining tool[19] to enable users to explore the historic and nomination methodologies implemented by members of the ENA. Tested these, along with the regression methodology, and provided feedback to improve delivery validation and settlement for DSO-Enabled services[20].
- Developed a set of Basic Market Rules (BMR)[21] to provide the guiding principles on market behaviour, covering a diverse range of topics, including service procurement, delivery obligations, conflict management and service stacking. The rules were tested and revised during several events[22,23,24] and used throughout the Market Trials.
- Developed an End-to-End (E2E) process (see Section 3.6) to enable close to real time procurement of flexibility (e.g., week-ahead/day-ahead) and within day dispatch.
- Held a DSO Functions Workshop[25] to understand stakeholder's views on the three functions of the DSO set out by Ofgem[9].
- Developed a Temporary Capacity Variation process to enable market participants to temporarily increase their import or export capacity and participate in DSO-Enabled services[26].
- Developed two different auction mechanisms for the provision of flexibility: Pay-as-Bid and Pay-as-Clear[27]. The impact that these different approaches had on market liquidity and competition as well as 'bidding behaviour' was tested via virtual auctions.
- Produced a prioritised regulatory roadmap to highlight the 21 code changes necessary to deliver the DSO-Procured and DSO-Enabled services in BaU activities[28].

The above was tested during the Market Trials, during which the Project LEO partners (including councils, aggregators, universities, and platform providers) provided feedback to challenge concepts and inform improvements to the tools and associated processes that supported the market design.

TRANSITION has delivered an evidential base to inform decisions on market design for flexibility services and proven the value of collaboration and coordination, leading to a whole systems approach in ED2.

Key points to note for other DSOs:

- This baselining tool can enable DSOs to explore the methodologies being implemented by ENA ON-P. This can provide a solid basis for future development, but users should consider the inherent errors within these methodologies and their suitability for different DER types.
- Standardised solutions should be developed that enable all flexibility providers to access flexibility markets (either directly or through a third party).
- Primacy rules must be developed to enable market participants to assess the risks associated with participating across different markets.
- The Temporary Capacity Variation process needs to be more efficient to enable its use in BaU. DSOs should consider how DSO-Enabled services can work alongside the Network Access Significant Code Review (Access Strategic Code Review (SCR)) to enable new connections.
- The BMRs provide a basis for developing a set of flexibility market rules that apply to all flexibility markets and capacity services. Further work is required by the ENA ON-P to identify the best way to adopt these within wider industry.

3 Project Details and Outcomes

3.3 Contractual Arrangements

TRANSITION developed and trialled contractual arrangements to support DSO-Procured and DSO-Enabled markets, which were revised and simplified based on feedback from project partners and wider industry.

These are summarised below:

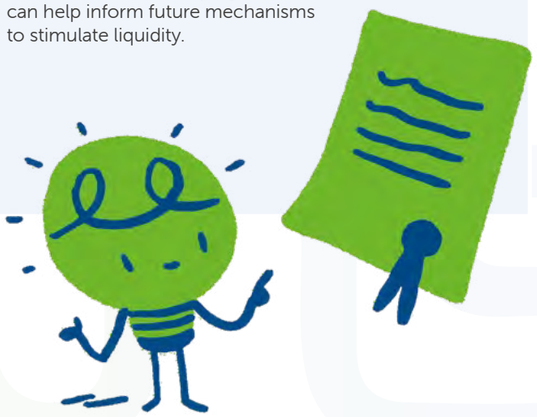
- The **TRANSITION Flexibility Services Agreement (FSA)**[29] was developed from the industry-standard version[30]. It was implemented as a framework agreement to reduce the time to contract flexibility and was streamlined throughout Market Trials.
- A short and simple legally binding **P2P Term-Sheet**[31] enabled the trading of import and export capacity between connected parties.
- A legally binding **NMF Platform Terms and Conditions** enabled trading on the NMF[32].
- A **Temporary Capacity Variation Notice (TCVN)** was developed to obtain approval for connected parties to increase their import or export capacity during Market Trials[33].
- A series of legally binding **Market Stimuli Packages (MSP)**[26] were designed for the Market Trials to stimulate new flexibility providers to come to market. They paid for a minimum level of flexibility to be delivered during a defined period. Although not used during the Market Trials, feedback enabled a simplified version to be used during the Technical Trials.

Learnings from developing and using the above have been widely shared[24,34,35,36] to support the ENA ON-P and all DSOs. Feedback consistently emphasised the need for contractual mechanisms that are concise, easy to understand, and accessible to all market participants. This was particularly the case for those who can unlock grid-edge flexibility, such as small scale flexibility providers and aggregators who experienced specific challenges around resource[34] access and liability[36].

Simplified contractual arrangements are key to enabling wider participation and unlocking flexibility from aggregators and suppliers.

Key points to note for other DSOs:

- The contractual agreements developed by **TRANSITION** can inform and support DSO flexibility markets in BaU.
- Contractual mechanisms should be easy to understand, concise, efficient, and accessible, particularly for new market entrants or those with smaller DERs who cannot afford a formal legal review.
- Further standardisation of the contractual arrangements across DSOs would reduce the transactional cost for market participants and increase liquidity.
- Framework Agreements can enable closer to real time procurement and thereby scale up the procurement of flexibility; however, the FSA needs developed further to enable this.
- Feedback from developing the MSPs can help inform future mechanisms to stimulate liquidity.



3.4 Price Evaluation Methodology

The industry standard Common Evaluation Method (CEM) tool[37] is used to determine a ceiling price for DSO-Procured services when it is used to defer investment in reinforcement for a period of more than one year.

The Market Trials provided an exploration of flexibility prices using the CEM tool which can inform load related expenditure deferral commitments and the use of flexibility[34,35,36].

The following points are worth noting:

- The price ceiling for flexibility was increased across all services to stimulate competition, liquidity, and reliability in the market based on feedback regarding the difference between the price offered and the price required by potential participants. The revised price ceiling was comparable to market-based flexibility pricing but was still insufficient to create a liquid market as the DERs had relatively low levels of flexibility (low resulting payment) and there were low levels of flexibility available (largely connected to the LV network).
- An opportunity cost element was included in the price for Sustain Export Peak Management to reflect the associated lost income (reduced export) or increased cost (demand).
- The CEM tool requires accurate data inputs, such as baseline reinforcement cost estimates, which are difficult to get an accurate estimation for.
- The CEM tool does not consider the deliverability of widespread reinforcement and there are difficulties in capturing the associated wider socio-economic benefits (avoided costs for other market actors, air quality benefits and supporting the delivery of Net Zero) within the tool.

Future work is required to consider how the practical application of a robust methodology (CEM) can be developed to provide an adequate incentive for future flexibility to ensure market liquidity.

A liquid market requires a fair price for flexibility that reflects the associated local and wider socio-economic benefits, as well as the network benefits obtained by other market actors, such as the ESO.

Key points to note for other DSOs:

- The price ceiling is a major barrier to participating in DSO services and could make investing in lower voltage markets unattractive compared to higher voltage levels. However, if the costs are too high for it to be economic for the DSO, mechanisms may need to be addressed to improve liquidity.
- The processes for gathering and implementation data in the CEM tool needs to be improved to reflect the true value of flexibility.
- Further consideration is required to determine if DSO-Procured services can compete financially with other services and whether any cost element is missing, e.g., DSO services can provide additive or complimentary flexibility to support to other parties (e.g., another DSO/the ESO).
- Exclusivity clauses should be considered to ensure market participants can stack different revenue streams; this is imperative to a liquid market in which both Market Participants and the network can benefit.
- The lack of an accurate baseline model exacerbates the low financial reward for some DER types; errors mean the fulfilment of the requested capacity is low and thereby the settlement is reduced.

3 Project Details and Outcomes

3.5 System Architecture and Data

The system architecture, data sets and data exchanges were established as part of the work to develop and integrate the suite of DSO tools (including NMF, PSA, Select and Dispatch (S&D) and forecasting tools).

Developing these integrated solutions required the standardisation of data interaction, naming conventions and programming language (e.g., Python) to enable Application Programme Interfaces (APIs) and scripts to be developed and used wherever possible. A simplified diagram of these data exchanges used in **TRANSITION** is provided in **Figure 4**.

As part of this work, a state-of-the-art operational forecasting tool[38,39] was developed with Sia Partners and included several novel features to improve the accuracy of the forecasts, including:

- A range of automated API data feeds from external sources, including system/network data from NeRDA and real-time settlement data from ElectraLink, an industry first.
- The ability to forecast deep in the network (at an 11kV feeder level).
- The provision of a central forecast for the network up to ten days ahead, based on 40 scenarios with an envelope of the uncertainty for key areas including for wind and solar.
- The ability to reforecast quickly within-day to reflect changes.
- Availability of visualisations to support decision-making by control room operators.

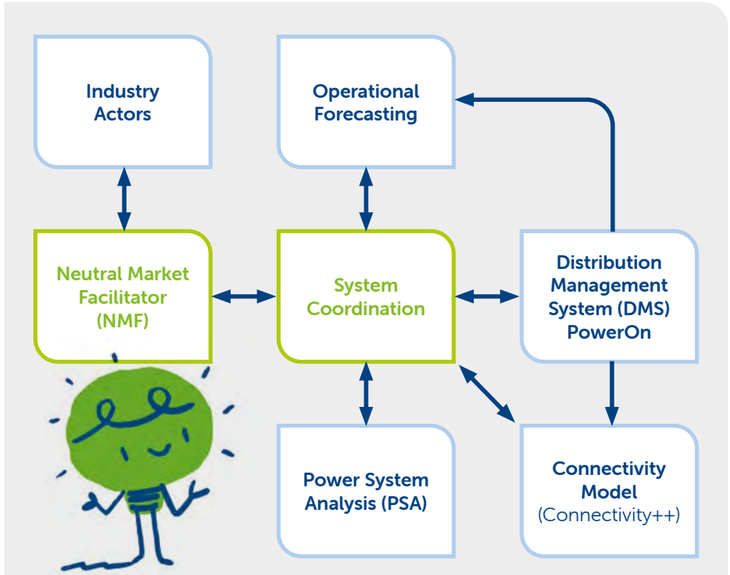


Figure 4: Data interaction between DSO tools and industry actors

This work highlighted the value of standardised and accurate data sets to enable flexibility markets closer to real time when the manual handling of significant volumes of data is not feasible. This has informed the future requirements for system architecture and data operating at scale; the learnings were shared with relevant SSEN BaU teams and disseminated through presentations to Ofgem and the ENA[40].

A diverse range of data sources from supply, through delivery, to use can improve short term planning and decision making.

Key points to note for other DSOs:

- Standardisation of data interaction, naming conventions and programming language (e.g., Python) enables the sharing of data between DSO tools and market participants, reducing development time.
- Forecasting accuracy is improved by access to real time network generation and demand data, such as that provided by NeRDA and ElectraLink.
- The outputs of forecasting tools should be based on multiple scenarios to support decision-making within the 0-10 day time horizon.

3.6 Neutral Market Facilitation

The NMF function within TRANSITION was designed to fulfil the Service/Market Facilitation capability[41] and provide an independent, DSO-facilitated, flexibility marketplace. This enabled TRANSITION to trial market models where the DSO may not have the obligation for neutral facilitation of markets and provide feedback on who could fulfil the role of market facilitator.

To inform the processes for the NMF platform, **TRANSITION** developed a robust E2E process that defines the interactions to be undertaken, when, and by whom to **Register, Procure, Deliver, and Settle** flexibility services.

This work considered the requirements specification written for the NMF[42] and the data exchange and governance published to operate a flexibility marketplace[43].

The E2E process was refined to incorporate feedback captured during a series of stakeholder workshops and reflect new functionality during Market Trials; however, the core principles remained consistent throughout, proving it can help define and communicate the principal interactions required for DSO functions.

A simplified version is provided in **Figure 5**.

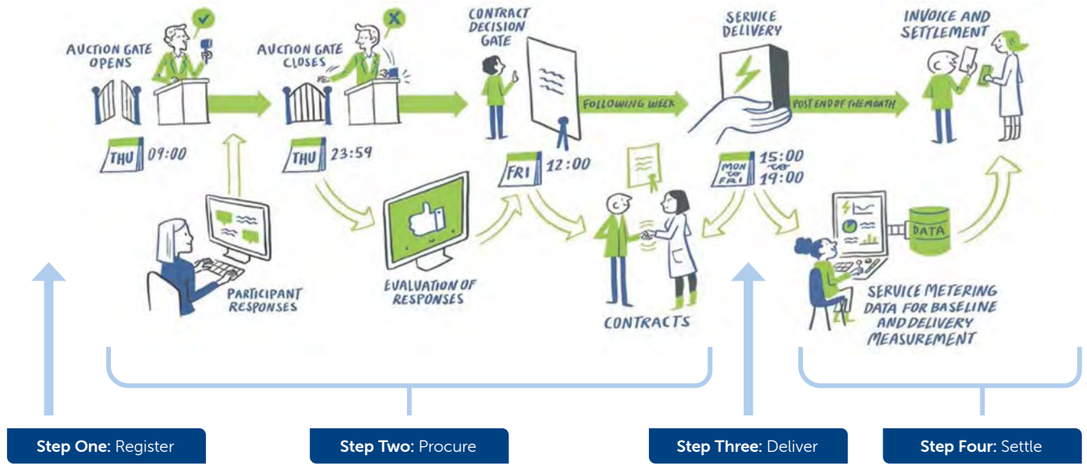


Figure 5: Simplified E2E Process

Once developed, the NMF platform enabled market participants to interact with the marketplace to offer flexibility for DSO-Procured services, trade with counterparties for DSO-Enabled services, upload metering data for baselining and declare DERs unavailable.

It also enabled the DSO to issue requests for flexibility, send out intents to dispatch, notify participants at relevant market gates and calculate the settlement, whilst enabling the extraction of data for analysis and reporting.

The NMF platform successfully operated as the central market whilst interacting with a satellite platform, operated by Piclo (a project LEO partner), to enable an alternative route to market.

This supported the development of the energy services market by providing choice for flexibility providers.

APIs were developed to transfer auction data to and from the NMF to ensure the markets for flexibility services operated as a single integrated marketplace (see **Figure 6**).

Learnings captured from developing and testing the NMF and associated tools are provided in the Market Trials Report[34,35] and can inform industry requirements for future tools.

3 Project Details and Outcomes

3.6 Neutral Market Facilitation

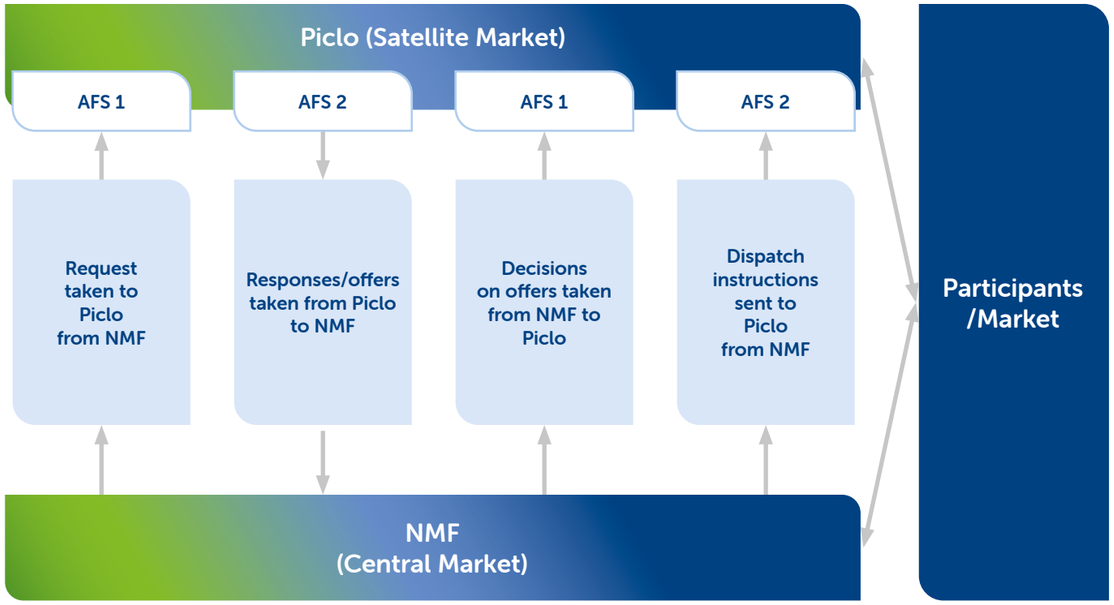


Figure 6: NMF-Piclo Data Transfers

TRANSITION successfully established that the neutral facilitation of a marketplace can enable the delivery of a variety of flexibility and capacity services and products (delivery timescales).

Key points to note for other DSOs:

- **TRANSITION** developed a robust E2E process for DSO-Procured and DSO-Enabled services which provides clarity on the roles and responsibilities and data and information requirements between market participants. This can be used as a good basis for industry wide flexibility processes.
- APIs improved the experience of market participants and can decrease the operational burden and costs associated with participation.
- Data sets and processes should be standardised across DSOs to improve market liquidity by reducing the burden on market participants.
- A central platform market model may provide more access opportunities for participants due to the lower set-up costs, and the simplified training and familiarity interacting with one platform. However, there is a risk that a central platform creates a monopoly provider which would need to be managed by stakeholders.

3.7 System Coordination

The system coordination function within TRANSITION is a separate function from the NMF market capability (see Section 3.6 above).

It provides the core intelligence for flexibility market coordination and decision making, provides an input interface for control room engineers, and manages automated data flows between sub-component DSO systems and the NMF.

The WSC function was initially integrated within the Opus One solution during the Market Trials. The solution operated successfully for the initial market trials, however, the need for an alternative solution was identified to provide greater visibility, operability and alignment with SSEN's ED2 initiative. This solution required different systems and interfaces to forecast network requirements to support a flexibility market operating in near-real time, e.g., every hour. The essential systems being demand and generation forecasts, network topological data and network models.

The project considered integrating PowerFactory and the suite of PSA scripts to the existing Opus One WSC solution. However, this option could not be developed to meet the requirements within the budget and project timescales. The PSA and S&D tools were therefore developed in lieu of the integrated approach and used during the Technical Trials.

This experience confirmed **TRANSITION's** approach of developing solution agnostic requirements and using an agile approach when planning, developing, and deploying such systems. However, the need for a separate S&D tool was identified as an alternate solution to provide greater visibility and operability, align with SSEN's ED2 initiative and integrate with the PSA tool (see **Section 3.9**)[v].

The S&D tool is an economic optimisation tool that enables the automatic selection of contracts for dispatch whilst considering the ability of DERs to resolve the constraint via the PSA tool and has four high level steps:

- **Create DSO Requests** across different time horizons (e.g., week ahead and day ahead) and DSO-Procured services based on the outputs of the PSA.
- **Contract with Flexible Service Offer(s)** by validating and accepting offers received in response to a request using Sensitivity Factors[vi] and the total cost of delivery, see **Figure 7**.
- **Dispatch of Flexible Service(s)** by running dispatch analysis to determine the most economic and viable contract against the requirements.
- **Provide Audit and Data Access** to support analysis and reporting.

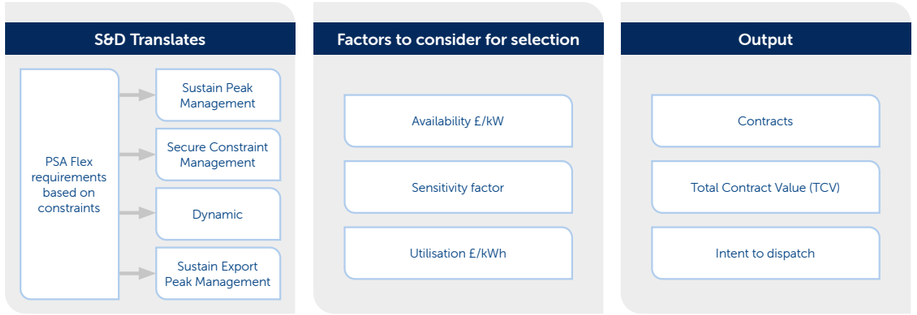


Figure 7: Hight Level Diagram of the S&D tool

The learnings from developing and implementing this tool[44,45,46] can help inform the deployment of flexibility during ED2 and wider industry requirements.

Automatic constraint prediction and economic optimisation tools are required to enable the efficient use of flexibility at scale.

Key points to note for other DSOs:

- The S&D tool enables the economic optimisation of available flexibility, provides transparency of selecting/instructing DERs, and significantly reduces the burden of procurement closer to real time.
- The optimisation solver within the S&D does not consider the maximum utilisation hours identified per DER and could result in under-delivery.

[v] The S&D Tool supports the DSO model and enables a PowerFactory based system Power System Analysis tool. This complies with industry standard and can thereby by adopted by other DSOs.
[vi] Sensitivity Factors may be used to assess the impact a DER has on a network element. The scale of the Sensitivity Factors (from 0 to 1) determines whether the DER has a low (0) or high (1) impact. The sign (-ve/+ve) of the Sensitivity Factors tells us whether the (low/high) impact is helpful (+ve) or harmful (-ve) (in terms of loading), depending on the direction of the network flows (import/export) and the type of DER (demand/generator).

3 Project Details and Outcomes

3.8 Network Model

Network models can provide an accurate representation of an electricity distribution network based on various data sets regarding the physical connections for generation, demand, and storage. The models are used to study the resulting network load flows under different scenarios and inform the development of an electricity distribution network. This can be used to identify constraints and the flexibility required to mitigate them.

TRANSITION created a vertically integrated digital model of the electricity distribution network across three voltage levels, 132/33/11kV (see **Figure 8**), in the Project Trial area. This model was developed from pre-existing models, including SSEN's BaU system planning data and network connectivity data from geographical information system Electric Office. This was done in collaboration with SSEN project Connectivity+[vii]. Further details of the data requirements to support these network models togetherwith the main business processes can be found in the PSA Model Development Report[47].

During the Technical Trials, the network model was used by the PSA tool (see **Section 3.9**) to identify future constraints on a continuous basis (i.e. every half-hour) and determine the level of flexibility required to resolve the constraint at each node, for example at an individual Bulk Supply Point (BSP) or a primary substation in Oxfordshire.

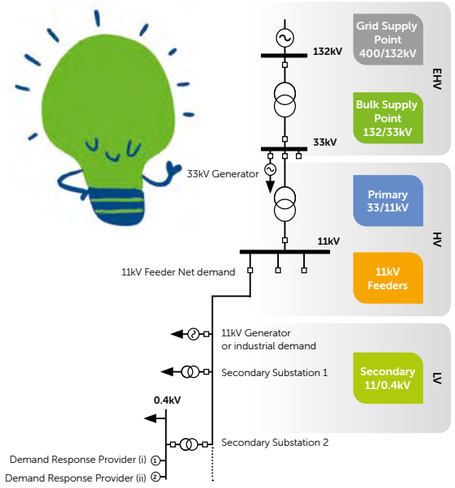


Figure 8: Integrated Network Model

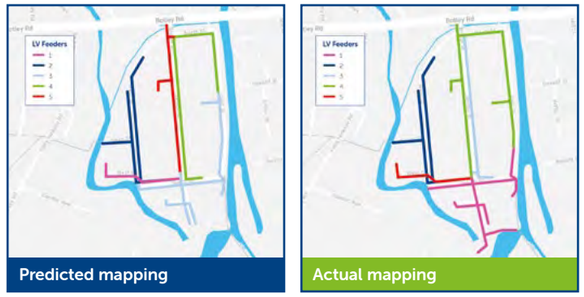


Figure 9: Impact of from field investigations to improve the accuracy of the LV network model.

In addition to this, the project developed a model of the LV (0.4kV) network on Osney Island[35]. This was developed in conjunction with Project LEO using the industry standard software DIgSILENT PowerFactory (PowerFactory).

This model was not used to run flexibility markets (auctions were limited to BSP and primary levels) because of the significant differences in the modelling approaches for Extra High Voltage (EHV)/High Voltage (HV) and LV networks (such as the need to consider factors like phase imbalance on HV networks).

Further, incorporating the LV network with other voltage levels increases the size and complexity of the model and the computational effort required. However, the LV monitoring and field investigation (see **Figure 9**) helped SSEN to understand the effort that would be involved in such a process and how it would scale to other parts of the LV network.

This prompted the development of alternative data-driven methods, for example using smart meter data to identify the phase connectivity of the customers, which ultimately enabled the community to connect solar panels that would otherwise not have been able to connect.

Robust digital models of the LV network at the street level form the basis for accurate forecasts that can enable greater uptake of Low Carbon Technologies

Points to note for other DSOs:

- Integrated network models are essential to estimate flexibility requirements and evaluate benefit of flexibility provided.
- The model development process and maintenance needs to be efficient and use automation where possible.
- Using accurate connectivity data as input into the models is key to ensure accuracy of the results.

[vii] NeRDA provides near real-time data on the assets in the network. However, the PSA only needs the current circuit breaker status (open, closed, indeterminate).

3.9 PSA Tool

TRANSITION established the data requirements for an integrated network model to run PSA for BSPs and primary substations (see Section 3.8).

This then led to the development and deployment of a PSA tool that:

- Used network models, real-time network topology data (via NeRDA[viii]) and forecasts of demand/generation to identify future constraints on a half hourly basis.
- Calculated the level of flexibility required to resolve the constraints identified.
- Validated the effect on power flows of instructing DERs to deliver DSO-Procured services using Sensitivity Factors to determine the effect of dispatching DERs at a particular location to resolve the constraint based on actual network connectivity[48].

The PSA tool was developed in Python and used PowerFactory for Network Model management and load flow calculations in an automated, multi-processing environment.

This significantly reduced manual effort and enabled better visualisation of results. The resulting solution is scalable, aligned with ED2 initiatives and integrates with the S&D tool (see Section 3.9).

The learnings from developing and implementing this tool can be found in the PSA Report[49] which can help inform the wider industry requirements.

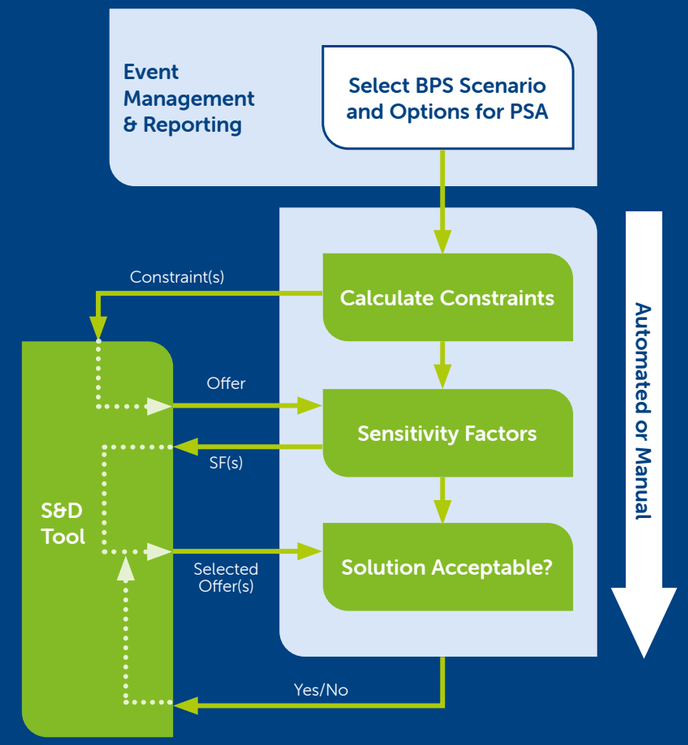


Figure 10: High Level Diagram of the PSA tool

The automation of PSA modelling at all voltage levels can facilitate the identification and communication of flexibility requirements within DSOs and to potential flexibility providers.

Points to note for other DSOs:

- Automation of data processing in PSA modelling will reduce the burden on DSOs and increase the usefulness of visualisation tools, which can support decision making.
- There should be a standardised methodology on how Sensitivity Factors are calculated and used across DSOs and an industry education plan to inform affected parties.
- A form of look-up table using Sensitivity Factors for various network configurations and unplanned outages would significantly improve the speed of approval of trades for DSO-Enabled services, encouraging market growth.

[viii] NeRDA provides near real-time data on the assets in the network. However, the PSA only needs the current circuit breaker status (open, closed, indeterminate).

4

Performed compared to the original project aims, objectives and deliverables

TRANSITION was designed to help progress the transition to a DSO and successfully addressed several issues.

It informed the design requirements for the NMF and WSC platform, developed the roles and responsibilities within the marketplace, developed the market rules required for the trials, and implemented and tested the concept and systems by means of trials in Oxfordshire. **TRANSITION** created ten project learning objectives and seven deliverables to achieve the above and, as shown in this section, **TRANSITION** has met and exceeded each.

4.1 Project Objectives

#1 Identify the data requirements and data exchanges for DSO functions, informed by Open Networks. Map this against current technology (service provider) capabilities and develop requirements for future technologies.

The detailed project proposal[1] identified nine functional groupings and twelve competencies to represent the activities of an effective DSO based on the ENA ON-P's Workstream 3: Product 2 | Functional and System Requirements (2017). These functional groupings and competencies were used to develop the architecture and approach used in the Project Trials[18].

The trial architecture and updated ON-P Functional and System Requirements[50] (2018) were subsequently used as the basis for the procurable system requirements for the NMF[42] and WSC[51] platform. In addition to these documents, **TRANSITION** published NMF Data Exchange and Governance[43] and a High-Level Solution Design Summary[52].

A high-level market review of forecasting system providers was also conducted[53]. The NMF and WSC platform requirements formed the basis of competitive procurements, and a series of vendor engagement workshops[54,55], and webinars took place along with a dissemination webinar[56].

Through this procurement exercise, **TRANSITION** was able to map the current state of the market for systems to fulfil the DSO functional and system requirements established by the ENA ON-P Programme Workstream 3 for the components critical to **TRANSITION**. The mapping of the procured solutions to the logical functions tested during the Project Trials is shown in **Figure 11**.

Figure 11: Mapping of procured solutions to the Trial Architecture

Through a series of collaborative workshops with Project LEO and other system stakeholders, the market rules[22] and use cases[15] were developed. This enabled the data exchanges and governance to be refined and the trial processes to be developed.

These were reviewed following each Trial Period but required very little adaptation based on learning from the trials. The approach taken by **TRANSITION** to develop the requirements, data exchanges, industry processes and market rules should therefore be considered for adoption as an industry standard approach.

The learning from the trials on Tools and Platforms[57], Data[40] and Market Development[58] were disseminated through a series of 'Show and Tell' webinars. Additionally, learning on the forecasting competence was disseminated through a series of reports[39,38].

TRANSITION maintained a horizon scan on emerging thinking in relevant areas to the programme and the scope and approach to **TRANSITION** remained valid through several proposals[3,50,41,59,60,61].

#2 Using the outputs from Open Networks, test and validate the market model options being proposed. Understand the requirements to create a sustainable market that can facilitate competition based on whole system needs.

TRANSITION tested and validated the three market models specified in the original NIC submission document (summarised in **Table 3**). The methods used were revised to align with changing ON-P to maximise understanding of market facilitation and feedback to the ENA.

Table 3: Methods used to test and validate the market model options being proposed

Market Model	Method
Local Market Multiple local markets based around a specific geographical area which was expected to be a DNO licensed area.	Tested using the NMF in isolation and with a satellite platform, both using different combinations of network nodes and different routes to market during the Market Trials.
Central Market A single GB-wide marketplace managed by a single NMF[ix].	Tested through a workshop with ESO (conflict management) and the Market Trials using combinations of network nodes (simulated central market). Also obtained feedback from one market participant who qualified for the new Demand Flexibility Service during TP3 (market conflict).
Commercial Market Multiple discrete but differentiated markets that may not be bounded by geography or network topology.	Tested indirectly and through workshops that explored the issues of conflict management and primacy.

In testing these models, **TRANSITION** has helped to understand the requirements to create a sustainable market that can facilitate competition based on whole system needs. These learnings have been shared with stakeholders on an ongoing basis (including ENA), and summarised during dissemination sessions held at the end of each Project Trial period[40,57,58]. Highlights included:

- Barriers to entry can be reduced if flexibility services and associated processes across the different markets (ESO, DSO and P2P) are simplified, demystified and standardised.
- Implementing a "central market", which automatically interacts with satellite markets, can provide more accessible routes to market, reducing the barriers to entry. A central platform market model may provide more access opportunities for participants due to the lower set-up costs, and the simplified training and familiarity interacting with one platform. However, there is a risk that a central platform creates a monopoly provider which would need to be managed by stakeholders.
- To ensure the provision of flexibility over the long term, it is critical that market participants are free to stack different revenue streams across the different markets for flexibility services and that primacy rules are transparent to ensure the safe operation of the network.
- Flexibility provided on the distribution network delivers wider societal and whole system benefits which is not reflected in the price paid for DSO-Procured and DSO-Enabled services. Rectifying this would ensure flexibility is fairly rewarded and encourage market growth.
- DSO-Enabled services can provide increased utilisation of existing flexibility, although work is required to enable these in BaU.

Our experience of testing these market models and the learnings from this has shaped SSEN's response to industry consultations (e.g. Ofgem's Future of Distributed Flexibility[10] and Local Energy Planning Governance Arrangements[9]).

[ix] This could be analogous to the role to be fulfilled by the Future System Operator.

4 Performance Comparison

4.1 Project Objectives

#3 **Build on learnings from previous and ongoing projects, as well as collaboration opportunities such as T.E.F. and LEO. This will help develop understanding of a range of areas where a collaborative approach will be beneficial, including monitoring and modelling requirements to provide network data, connectivity, and constraint data in sufficient detail to let the market operate in different network types.**

TRANSITION benefitted from significant reach as a project, far greater than originally envisaged. This was primarily through engagement with other projects which raised the visibility of flexibility as a solution and highlighted the value of collaboration in innovation (see Table 4).

Table 4: Example Projects with whom **TRANSITION** interacted

Project	Benefit of Collaboration
LEO	The alignment of objectives meant the projects worked closely over four years, maximising the opportunities available to each project, the value from trials, and significantly enhancing the overall learnings. This was all achieved at no additional cost to customers.
ENA ON-P	Regular interaction to ensure **TRANSITION** continued to act as a learning vehicle for the ENA ON-P and to provide feedback on experience. Took part in a formal collaboration to develop the baselining tool, which avoided duplication of effort and reduce costs.
T.E.F.	Interaction with FUSION (SPEN) and EFFS (WPD) significantly increased the effectiveness of each project, avoided unnecessary duplication of effort, and maximised learnings for the industry through knowledge sharing across DSO activities and joint work (several reports to ON-P and joint presentation on baselining[20]).
NeRDA	Understand how to develop automatic/API connections between the forecasting system and internal SSEN network data, including the use of a NeRDA portal to view LV monitoring data.
ICLSG	Interacted with Ausgrid, Enel and ESB to share experiences from a variety of community and resilience projects.
Other DSO-related projects	Interacted with the following projects either through ENA ON-P or directly to learn from their work; Power Potential, Regional Development Plans, Distribution FES, TERRE, Optimise Prime, Power Forward Challenge (MERLIN), and BEIS Flexibility competition (e.g., TraDER, Piclo and ISLE).
Other innovation projects	Learned from the work completed by other projects, including; Connectivity+, TVV and TVV2, Low Carbon London, RaaS, LEAN.

#4 **Establish system processing and visualisation requirements, including data protection and information security. This will ensure that cyber security risks are effectively identified and managed.**

A wide range of stakeholders were involved with establishing the processing and visualisation requirements of the DSO tools; in particular the Information Technology (IT) security requirements associated with the NMF, WSC and the testing strategy. This extensive engagement provided learnings based on experience with similar projects, e.g., understanding the sharing of personal identifiers. A summary of the outputs from this work is provided in Table 5 below.

Table 5: Summary of IT security and visualisation requirements outputs

Data Protection and Information Security	Visualisation Requirements
Challenges surrounding sensitive and personal data in relation to General Data Protection Regulation and the impact on the operation of the DSO flexibility market are understood, e.g. limited or aggregated locational DER data can impact the accuracy of the PSA model.	A visualisation tool was developed to display a detailed LV network in a user-friendly and geographical way. This was used to display analysis for Osney Island.
ElectraLink aggregated data for the forecasting tool was limited, targeted, controlled and used in a manner solely for the specific intended purpose[38].	The operational forecasting dashboard was designed to be simple and user-friendly with status alerts to support adoption of operational forecasting for decision-making processes in the context of flexibility markets[39].
The data collected from new LV network monitors helped to develop SSEN's understanding for system processing and data protection, experience that was further fed back to the wider LEO project partners.	Feedback was collected on the user experience of the market platforms, with market participants highlighting the importance of user-friendly and graphical interfaces[35].
The publication of a requirements specification for the NMF[42], WSC platform[51] and High-Level Solution Design[52] considered data protection, information security and system processing during development.	

#5 **Develop and test DSO Use Cases that will be tested within the project on different network configurations as well as the market/trading rules and timeframes to allow a neutral market to develop. This will remove barriers to new technology and markets allowing the increased use of market-based solutions as alternatives to reinforcement.**

TRANSITION, in collaboration with Projects FUSION and LEO, considered the use cases and flexibility services likely to exist in such a DSO world[15,16], and identified six services to be trialled (see Table 1).

This enabled **TRANSITION** to develop:

- the E2E process which defined the interactions to be undertaken, when, and by whom across season-ahead, week-ahead, and day-ahead procurement horizons.
- the different systems and tools that enabled close to real time procurement of flexibility, e.g., week-ahead/ day-ahead) and within day dispatch.
- the NMF platform which allowed **TRANSITION** to test the DSO functions and competencies needed to facilitate and/or operate different market models (see Table 3).
- the interaction between the NMF and a satellite platform to test an alternative route to market, simulate flexibility services markets, and provide consumer choice.
- three market simulation workshops that engaged specific stakeholders to test elements of the use cases (BMR[22], conflict management[23], and DSO functions[25]).

4 Performance Comparison

4.1 Project Objectives

#6 Evaluate stakeholder experience of DSO trials. Comprehensive stakeholder consultation will include discussion with licensees, aggregators, statutory authorities, consumer groups, community energy groups and engagement with the supply chain.

Comprehensive stakeholder engagement was vital to the success of **TRANSITION**. It ensured the project remained valid and at the forefront of trialling aspects of the DSO in a facilitated marketplace:

- The primary means of engagement during the Market Trials was the collaboration with Project LEO which provided an opportunity for **TRANSITION** to work together with and get feedback[34,35,36] from councils, social enterprise, aggregators, universities, and platform providers.
- The collaboration with Project LEO also allowed **TRANSITION** to benefit from a greater understanding of the concerns and issues of market participants when developing and testing the market. Feedback was collected regularly and this was used to challenge concepts and inform improvements to the tools and associated processes used throughout the trails.
- Engagement with Ofgem occurred through: the T.E.F. stage gate process which successfully justified the progression of all three projects; workshops to develop and test the BMRs; and webinars to disseminate the key learnings.
- **TRANSITION** engaged with network licensees through monthly T.E.F. meetings to discuss progress and topics of common interest; regular ENA ON-P meetings to provide and receive feedback on progress and findings; and industry engagement events (e.g., Energy Networks Innovation Conference) to provide updates on specific topics.
- The **TRANSITION** website, press releases and social media (see Appendices B and C) were used to engage with the wider stakeholder community, particularly potential trial participants and vendors.

#7 Understand and communicate the requirements of an NMF/WSC Platform and the commercial mechanisms that will be required for market participation to trial ways in which energy markets can evolve.

TRANSITION engaged with the ENA ON-P and Ofgem regarding the concept of neutral market facilitation and system co-ordination. The commercial mechanisms developed and tested during the trials were also communicated with market participants and wider industry:

- Requirement specifications were published for the NMF[42] and WSC Platform[51], along with a data exchange and governance approach for the NMF[43]. Potential providers of the NMF and WSC attended presentations[56] during the tendering process.
- Feedback from NMF users and SSEN informed the development of future platforms.
- The Low-Level Design of the PSA and S&D tool[62] and a comprehensive and detailed summary of the load forecasting solution[38] were shared with stakeholders.
- A series of educational workshops[63] were provided to all market participants on various topics (e.g., how flexibility markets worked, the E2E process, etc.) to ensure all aspects of the market were understood and terminology was clear.
- A baselining working group was established to consider the two baselining methodologies used in **TRANSITION** and how these could be further developed (see **Section 3.2**). This group, in collaboration with T.E.F., presented a summary of its outputs to a wide market audience[20].
- **TRANSITION** developed and trialled contractual arrangements to support markets for DSO-Procured and DSO-Enabled flexibility services. These arrangements were revised and simplified using feedback from project partners and the wider industry (see **Section 3.3**).

Future consideration should be given to standardisation across all flexibility markets to reduce barriers to entry (services, commercial arrangements, stacking of services, and terminology) and incentivise participation.

#8 Present the commercial interactions required for a DNO to transition to a DSO, develop and demonstrate NMF Platform tested on different network configurations that will accelerate the transition from DNO to DSO. This will demonstrate the true value or flexibility from a whole system perspective. Maximising access to existing markets alongside new markets and being able to stack revenue across them.

Developing the commercial interactions and testing these as part of the Market Trials allowed **TRANSITION** to test what is required to transition to a DSO during ED2, whilst developing a "proof of concept" NMF Platform that is scalable and applicable anywhere in the UK. Table 6 provides an overview of the various activities undertaken to meet this objective and the outcomes.

Table 6: Commercial interactions required for a DNO to transition to a DSO

Activity	Outcome
Defined an E2E process for DSO-Procured and DSO-Enabled services that is provider and technology agnostic and extends to the definition of several supporting processes at a lower level[64].	Informed how markets for flexibility services can operate and be coordinated. The learning from the trials was used to inform development of the NMF.
Developed the NMF to provide the marketplace for DSO-Procured services and DSO-Enabled services. This included the implementation of APIs to transfer auction data and information between the NMF and a satellite platform[58].	Informed the implementation of a DSO-facilitated flexibility marketplace and how it can operate with satellite markets, and, by extension, with aggregator platforms.
Conducted Market Trials over four trial periods to test the effectiveness of the NMF as a marketplace for different market models across a variety of network delivery points (BSP and Primary), configurations (meshed and normally open), and types of networks (urban and rural) [34,35,36].	Demonstrated the ability of the NMF to deliver DSO-Procured and DSO-Enabled services under different market models and network conditions.
DERs enabled to provide services to **TRANSITION** was used to deliver the ESO Demand Side Flexibility service during TP3, although not through the NMF. This demonstrated that, once enabled for one market, flexibility can be used across multiple markets[24].	The creation of a single marketplace across ESO, DSO and P2P reduced barriers to entry, increase liquidity, and reduced customer costs.
Trialled stacking DSO Services across multiple time-horizons to determine the enablers and barriers to support this[36].	A more realistic value for providing flexibility is required to attract greater participation (see **section 3.4**) and the rules regarding stacking of different services need to be considered more holistically.
Two methods of overcoming poor liquidity were trialled: (i) engagement with potential providers within the **TRANSITION** trial area who could support long-term operation, and (ii) short-term commercial mechanisms to increase market liquidity and reliability)[26].	Understanding the motivations of customers can be advantageous when recruiting flexibility providers. There is also a need for simplicity in the delivery of market stimulation offers.
ENWL carried out a series of simulated trials using models of their networks in the Northwest of England, including regions in Greater Manchester[11].	Explored questions and topics which could not be reasonably or easily tested within physical trials, such as the impacts of different sources of uncertainty and risk, and the sensitivity of optimal or near-optimal decisions about procuring flexibility to different inputs and market behaviour.

4 Performance Comparison

4.1 Project Objectives

#9 **Understand the network modelling and forecasting requirements needed by the WSC platform to calculate the flexibility needs for different timeframes. This will also inform the dispatch of flexibility assets to relieve constraints in specific parts of the network for different timeframes (e.g., week-ahead, season-ahead).**

The WSC function was initially integrated within the OpusOne solution during the Market Trials, which contained both a version of the network model applicable for the trial area extracted from SSEN systems and integrated into Opus One solution, and an Opus One forecasting too. The solution operated successfully for the initial trials., however, the need for an alternative solution was identified to provide greater visibility and operability and align with SSEN's ED2 initiative. This solution required different systems and interfaces to forecast network requirements to support a flexibility market operating in near-real time, e.g., every hour. The essential systems being demand and generation forecasts, network topological data and network models.

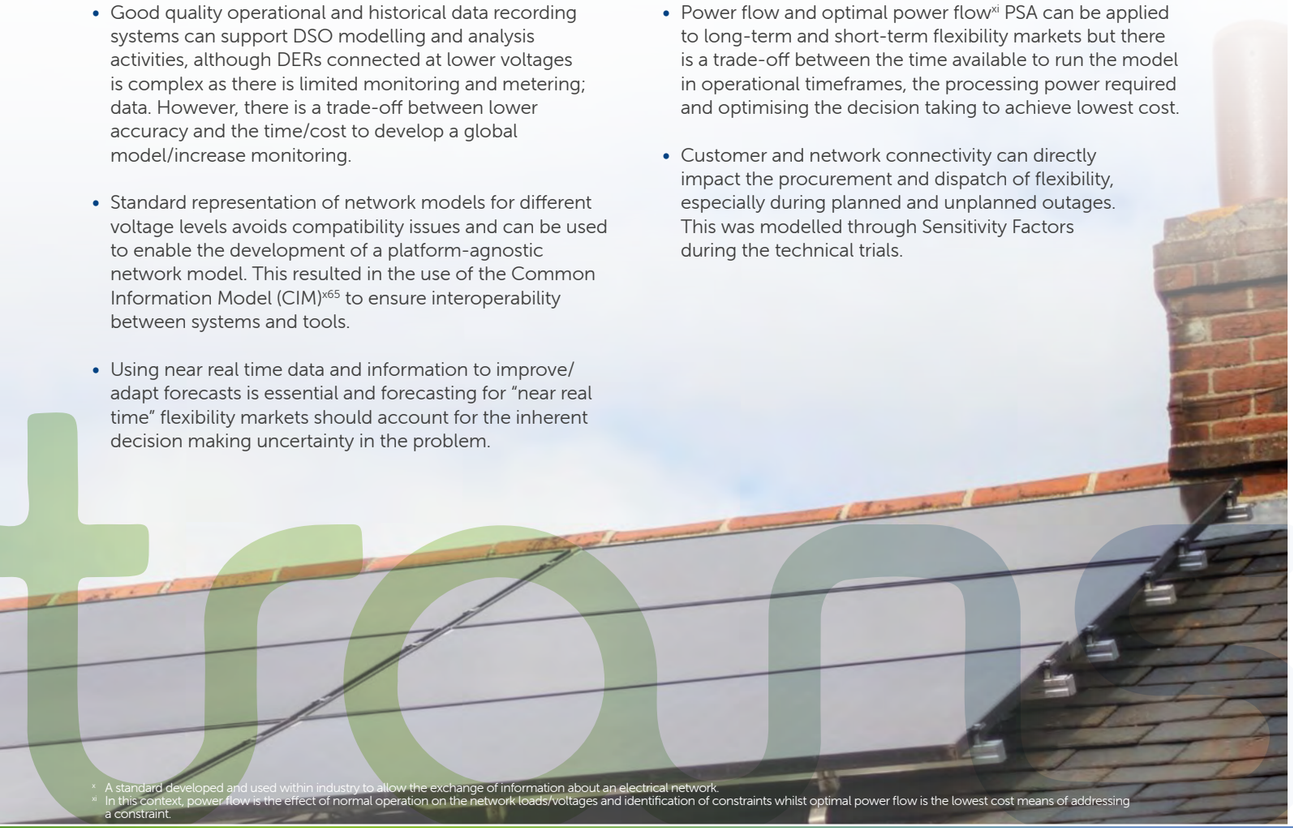
The project considered integrating PowerFactory and the suite of PSA scripts to the existing Opus One WSC solution. However, this option could not be developed to meet the requirements within the budget and project timescales.

The PSA (**Sections 3.9**) and S&D (**Section 3.7**) tools were therefore developed in lieu of the integrated approach and used during the Technical Trials. This experience confirmed TRANSITION's approach of developing solution agnostic requirements and using an agile approach when planning, developing, and deploying such systems.

The network model (see **Section 3.8**) integrates the various data sets required to provide an accurate representation of the physical network, including real-time topology updates (via NeRDA) to ensure the latest view of the network is used when procuring/dispatching flexibility. The PSA tool (see **Section 3.9**) performs analysis on the integrated network model to determine the network flexibility requirements based on nodal demand and generation forecasts provided by the forecasting engine (see **Section 3.5**).

The development and testing of these integrated systems advanced our understanding of how:

- Good quality operational and historical data recording systems can support DSO modelling and analysis activities, although DERs connected at lower voltages is complex as there is limited monitoring and metering; data. However, there is a trade-off between lower accuracy and the time/cost to develop a global model/increase monitoring.
- Standard representation of network models for different voltage levels avoids compatibility issues and can be used to enable the development of a platform-agnostic network model. This resulted in the use of the Common Information Model (CIM)[x65] to ensure interoperability between systems and tools.
- Using near real time data and information to improve/adapt forecasts is essential and forecasting for "near real time" flexibility markets should account for the inherent decision making uncertainty in the problem.
- Power flow and optimal power flow[xi] PSA can be applied to long-term and short-term flexibility markets but there is a trade-off between the time available to run the model in operational timeframes, the processing power required and optimising the decision taking to achieve lowest cost.
- Customer and network connectivity can directly impact the procurement and dispatch of flexibility, especially during planned and unplanned outages. This was modelled through Sensitivity Factors during the technical trials.

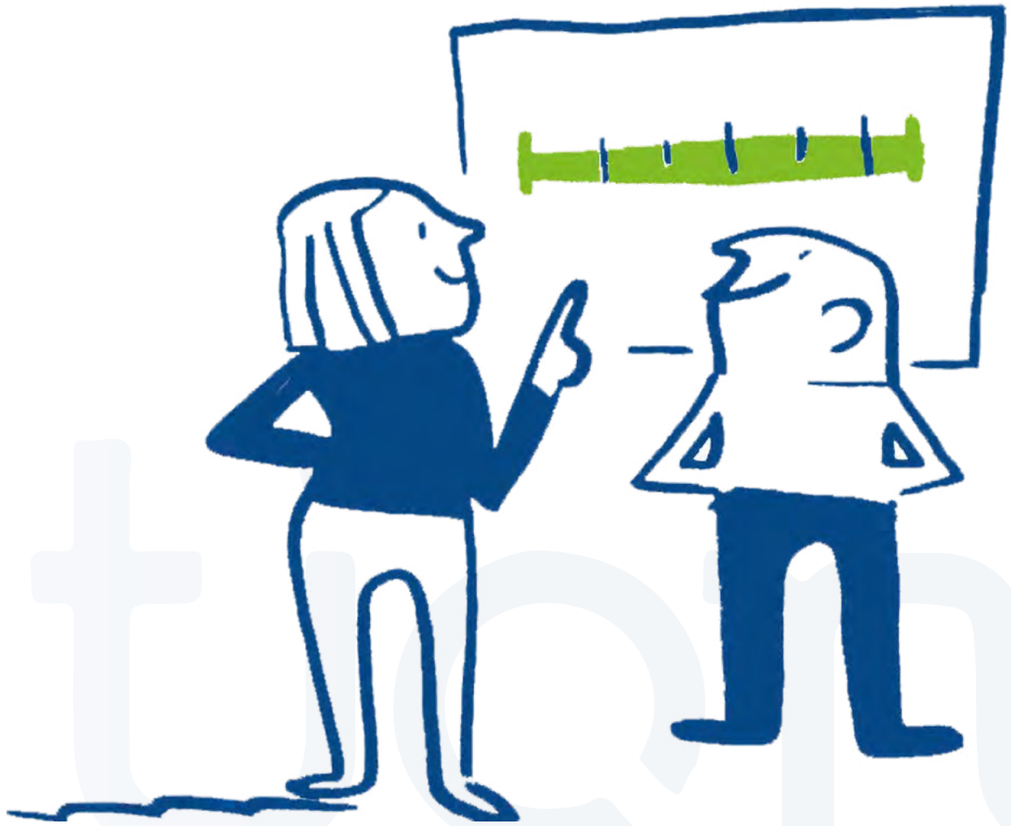


[x] A standard developed and used within industry to allow the exchange of information about an electrical network.
[xi] In this context, power flow is the effect of normal operation on the network loads/voltages and identification of constraints whilst optimal power flow is the lowest cost means of addressing a constraint.

#10 **Understand the additional functionality that can be provided by the NMF and WSC platforms with the use of integrations to outside partners and systems. This will inform how we work with third parties for the purpose of integration both in best practice for internal design of the NMF and WSC, and in building a streamlined methodology of collaboration with future integrations.**

Several data sets and data exchanges were established as part of the work to integrate the DSO tools with outside partners and systems. This has provided an understanding of:

- The APIs required to enable the integration of the NMF with satellite market platforms to enable market participants to interface with either platform during Market Trials (see **Section 3.6**), thus providing an alternative route to market and delivering customer choice.
- The APIs required to automate data flows between a market platform and a DERs control system (as per the Piclo platform).
- The APIs required as part of the forecasting solution to retrieve network load data (via NeRDA) and half-hourly settlement data (via ElectraLink) and send the forecast to the WSC platform (Opus One) or PSA (PowerFactory) system.
- The APIs required as part of the forecasting solution to retrieve network load data (via NeRDA) and half-hourly settlement data (via ElectraLink) and send the forecast to the WSC (Opus One) or PSA (Powerfactory) system.
- The APIs required to update the network model with real-time PI/SCADA topology data (via NeRDA).
- The standardisation of data format, interaction, naming conventions and programming language (e.g., Python) enabled APIs and scripts to be developed and used wherever possible, particularly in relation to CIM requirements for PSA data integration and interoperability.



4 Performance Comparison

4.2 Project Deliverables

TRANSITION identified seven Ofgem Project Deliverables which were strongly linked to the objectives and spanned the lifecycle of the project. In addition, Common Project Deliverables were identified in the Project Direction, dated 28th September 2018. The project has successfully completed all Project Deliverables as shown in Table 7.

The project commissioned a report from an independent third party to verify whether the Project Deliverables have been achieved. Arup were commissioned, via a competitive tender, to discharge the requirements of paragraph 8.82 of the Electricity Network Innovation Competition Governance Document. The audit report was submitted with the Close Down report, and confirmed:

> "The outcome shows all seven specific deliverables were met at a level that meets or exceeds expectations. Two parts of the common deliverable have also been achieved, with the close down report in progress and therefore excluded from the scope of this audit. The project also achieves substantial additional value from coordination with LEO, the other TEF projects and the broader Open Networks community. This has facilitated the adoption of learning significantly through informing SSEN's decisions on DSO and sharing outputs that have become industry standards and best practice through Open Networks."

Table 7: Review of Project Deliverables

Ref.	Project Deliverable	Status	Evidence
	Ofgem Project Deliverables		
1	Work Package (WP) 6 Trial Specification - produce and apply the site selection methodology and select the Trial networks.	Completed	"**TRANSITION** Site Selection Methodology" submitted on 29th March 2019, and published on **TRANSITION** website.
2	WP2 Requirements design development - data exchange requirements and updated data governance processes specified.	Completed	"Best Practice Report - Market Facilitation for DSO" And "Neutral Market Facilitator Data Exchange and Governance" submitted on 31st May 2019, both published on the **TRANSITION** website.
3	Stakeholder feedback event (Stage Gate).	Completed	"Joint T.E.F. Stage Gate 2020 - Main Document v1.0" submitted on 28th February 2020, and published on the **TRANSITION** website.
4	WP7 Deployment - develop appropriate commercial arrangements and contract templates for flexibility services. Network adaptation for trial deployment.	Completed	"Network adaptation for trial Deployment" and "Oxfordshire Programme Commercial Arrangements" submitted on 30th July 2020, both published on the **TRANSITION** website.
5	WP7 Deployment - platform Full Acceptance Testing completed.	Completed	"Platform Acceptance Testing" submitted on 25th June 2021, and published on the **TRANSITION** website.
6	WP8 Trials stage 1 - completion of one stage of trials.	Completed	"**TRANSITION** and Project LEO Market Trials Report - Period 1" submitted on 29th April 2022, and published on the **TRANSITION** website.
7	WP8 Trials stage 2 - completion of second stage of trials.	Completed	"**TRANSITION** and Project LEO Market Trials Report - Period 2" submitted on 30th November 2022, and published on the **TRANSITION** website.
	Common Project Deliverable		
N/A	Comply with knowledge transfer requirements of the Governance Document.	Completed	Four **TRANSITION** Project Progress Reports published:4th October 2019, 2nd October 2020, 24th September 2021 and 23rd September 2022. Completed Close Down Report which complies with the requirements of the Governance Document - this submission. Evidence of attendance and participation in the Annual Conference as described in the Governance Document.

5 Required modifications to the planned approach during the Project

Discussions and work regarding the DSO transition have continued at pace since TRANSITION commenced in October 2018 which resulted in the following minor changes to the planned approach.

System Co-ordination and PSA Solutions

During TP1 it became apparent that most DSOs including SSEN/ESO were adopting PowerFactory as an industry standard application for PSA and the project considered integrating PowerFactory and the suite of PSA scripts to the existing Opus solution.

This option could not be developed to meet the requirements of the Technical Trials within the budget and project timescales. The PSA (**Section 3.9**) and S&D (**Section 3.7**) tools were therefore developed and used during the Technical Trials.

This experience confirmed **TRANSITION's** approach of developing solution agnostic requirements and using an agile approach when planning, developing, and deploying such systems.

Market Models

ESO-DSO co-ordination through the delivery of STOR could not be tested during the Market Trials.

This interaction was therefore explored through three alternative routes:

- a workshop with the ESO to explore conflict management issues and refine the BMR. The revised BMR became the basis for the development of primacy rules work by ENA ON-P.
- using combinations of substations to simulate a central market.
- obtained feedback from a market participant who qualified for the new Demand Flexibility Service during TP3 to represent market conflict.

6

Significant Variance in Expected Costs

Cost Category	Total Budget[1]	Total Forecasted Spend	Comment
Labour	£4,095,070.33	£4,795,493.93	Higher than planned[4]
Equipment	£1,117,393.84	£275,157.49	Lower than planned[4]
Contractors	£3,318,310.76	£3,907,194.87	Higher than planned[4]
IT	£3,136,925.86	£2,822,140.31	Lower than planned[4]
IPR Costs	£0.00	£0.00	On plan
Travel & Expenses	£561,827.59	£120,303.04	Lower than planned[4]
Payments to users	£385,562.33	£3,553.73	Lower than planned[4]
Contingency	£0.00	£0.00	On plan
Decommissioning	£72,550.75	£0.00	Lower than planned[4]
Other	£0.00	£0.00	On plan
Total	**£12, 642,641.46[3]**	**£11,923,843.37[2]**	

Notes: The table above details the total forecasted spend against the Project budget for each category.

1. As per Ofgem NIC Governance v3 and inline with the Project Direction dated 28th September 2018 the Project Budget detailed above is nominal and has not been adjusted to consider inflation and/or interest.
2. Up to 31st August 2023 the project spent £11,561,141.97 which has been processed through the Project Bank Account. In addition, the project has outstanding commitments of £362,701.40 which has yet to be processed through the Project Bank Account. The total Project forecasted spend is therefore £11,923,843.37 (as detailed in the table above).
3. The project submitted a revised financial forecast as part of the Stage Gate documentation in February 2020. The revised project budget reduced from £12,791,541.46 to £12,642,641.46. Refer to the 2020 Project Progress Report or the Stage Gate submission for a detailed explanation
4. Projected variances in excess of ten percent against each category are explained below: "Labour" and "Contractors" are higher than initially projected due to the resources required to produce the output and deliverables required for the project. "Equipment" and "IT" are less than expected due lower costs for IT infrastructure and servers, and installation of protection, monitoring, automation equipment. "Travel & Expenses" is lower than expected primarily due to previous years Covid restrictions. "Payment to Users" is lower than expected due to market liquidity and the size of assets available for the trials. "Decommissioning" is lower than expected as all decommissioning costs associated with the cloud based IT solutions have been included in the "IT" category.

7

Updated Business Case

In the original NIC submission document, TRANSITION presented a robust business case, supported by a comprehensive Cost Benefit Analysis (CBA), which highlighted several benefits that could be gained from the project, such as cost savings through the deferral or avoidance of traditional reinforcement using flexibility.

Since the project was awarded funding, advancements within the industry has meant the business case has only improved, as discussed below.

Costs Reduced and Value Added

Collaboration with both T.E.F and LEO has led to increased efficiencies, refer to Stage Gate submission, and enhanced the knowledge gained, increasing the likelihood of a successful rollout into BaU. As such, the ratio of benefits to costs and customer value for money have been strengthened, for example:

- T.E.F delivered several benefits through joint works with the ENA ON-P and other industry projects, including the Anglo-Canadian Power Forward Challenge, BEIS FleX, Prospering from the Energy Revolution (part of the Industrial Strategy Challenge Fund), and ReFlex.
- **TRANSITION** developed the baselining tool in collaboration with the ENA ON-PO and TNEI to avoid duplication of effort and reduce costs. This tool was tested with LEO during the Market Trails and learnings were shared via T.E.F.
- The innovative DSO-Enabled services defined and trialled in collaboration with Project LEO have directly informed the ENA ON-P and laid the groundwork for future innovation projects, such as Project ExtenDER.

Realisation of Accelerated Benefits and Market Liquidity

Since the project was awarded funding, GB-wide targets for clean energy and CO_2 reductions have increased in their prevalence and ambitions:

- A significant driver for flexibility is the increase in renewable energy with recent commitments to develop 50GW of wind and 70GW of solar by 2030 and 2035 respectively[66]. The incentives to support these commitments will likely accelerate the delivery of the benefits of flexibility and at a higher level than originally anticipated.
- The electrification of heat and transport will be a major component of residential decarbonisation; Government is investing £6.6 billion for improving energy efficiency and low-carbon heating[67] and committing to end the sale of new petrol and diesel cars by 2030[68]. These changes will increase the number of DERs available at the grid-edge, which in turn will increase the amount of flexibility available to the DSO and to other markets.
- The 2023 FES forecasts that demand side flexibility will be increasingly important in an electrified, renewable world, increasing to potentially over 40GW by 2050[69]. Further, there has been continued investment in creating flexibility platforms, which has been supported by the BEIS Flexibility competition.

Relevance Reaffirmed

It has become increasingly clear that DSO functionality is a critical part of the future energy value chain and must be developed at pace to achieve Net Zero:

- All DNOs are now delivering against their investment plans for ED2 and committed to taking a flexibility first approach, with an aim to defer traditional network reinforcement through flexibility services and flexible connections. The learnings and feedback provided will support the rollout of DSO and the delivery of ED2 ambitions.
- Ofgem has issued two consultations on the Future of Distributed Flexibility[10] and Local Energy Institutions and Governance[9]. The increasing discourse in this area highlights the significance of **TRANSITION** and its outputs (see **Section 3**), which provide an evidential base that can inform industry and regulatory decision making.
- The introduction of the Access and Forward-Looking Charges Significant Code Review changes the connection boundary for stakeholders connecting to the network and reduces the cost of connections. The likely increase in the number of new connections will drive the need for new flexibility products (delivery timescales) and services that will be informed by **TRANSITION**.

SSEN's ED2 Ambitions

SSEN's DSO capabilities have been accelerated based on the experience and learnings from **TRANSITION**. This will support SSEN's ED2 ambitions[70] to:

- Grow flexible connections to 3.7GW of capacity across 35 zones, avoiding £417.6m of reinforcement cost and offsetting 1.8mtCO_2 by enabling low-carbon technologies to connect.
- Procure at least 5GW flexibility service deferring up to £46.3m of reinforcement, and create new markets with maximum participation from innovators and community groups.
- Deliver wider benefits including improved market liquidity for the ESO, and by supporting third-party initiatives that deliver a broad range of wider economic and societal benefits for our communities.

8

Lessons Learnt for the Future

TRANSITION was delivered during a period of great change, with challenges arising both within the industry and globally. A summary the main challenges encountered by the project are provided below, along with the mitigations put in place, to inform future innovation projects.

Energy Crisis

The significant rise in fuel prices caused by the post-pandemic economic recovery escalated into a global energy crisis due to the invasion of Ukraine. This affected the level of market participation in the trials, as the costs of participation became excessive.

To mitigate against this, the price ceiling was reviewed and increased across all services during TP2, and a simple MSP was introduced to increase liquidity during the Technical Trials. Future innovation projects should consider suitable financial (e.g., MSPs) and/or technical (e.g., APIs) mechanisms to encourage participation[35,36].

Future innovation projects should consider suitable financial (e.g., MSPs) and/or technical (e.g., APIs) mechanisms to encourage participation[35,36]. Further, industry should consider the challenges in including the wider socio-economic benefits of flexibility during CBA, and how these can be overcome to increase competition, liquidity, and reliability in the market.

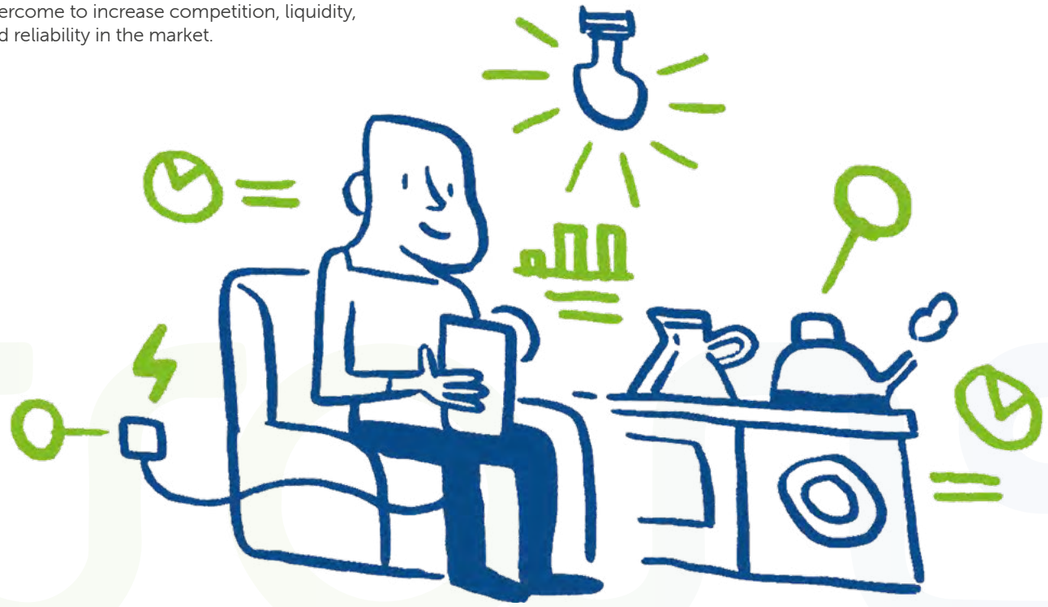
Defining the solutions for both the NMF and WSC Platform

Scoping the requirements and developing the solutions for the NMF and WSC was a significant challenge as this had not been done in this sector before.

The requirements were based on market knowledge from within SSEN, the latest position from the ENA ON-P, and similar platforms in other areas and jurisdictions.

This was an evolving process, and the project had to prioritise resources to ensure these systems could meet the objectives of the associated trial periods (see **Figure 1**).

Future innovation projects should ensure adequate time and resources are allowed, and that an agile approach is taken when testing and deploying such solutions.



Liquidity

The lack of liquidity and competition in the market has been a constant issue throughout the project. Stakeholder engagement allowed **TRANSITION** to identify the barriers experienced by market participants and, where possible, mitigate them to increase liquidity. These barriers included:

- **Contractual documentation** - barriers to participation included; contract length, language and complexity. Future innovation projects should keep such documents simple, concise, and accessible, and develop these with stakeholders to ensure they are fit for purpose.
- **DSO-Enabled Services** - there was limited opportunity to test these services due to the lack of counterparties willing to transact capacity services and uncertainty of how to identify potential counterparties.Future innovation projects should provide visibility of potential counterparties to stimulate the market and simplify processes to enable trades.
- **Auction mechanisms** - APIs developed during the trials improved the experience of market participants and can decrease the operational costs associated with participation. These should be considered by future innovation projects where possible.
- **Recruitment for trials** - liquidity improved significantly following the onboarding of aggregators. Future projects should develop a recruitment strategy to engage with a broad range of providers, including aggregators. This is especially important when developing a SLES, as aggregators are experienced and have knowledge of these markets.
- **Knowledge and skillset** - **TRANSITION** used innovative and simple approaches[xii] to communicate and engage with market participants who had different levels of knowledge and skill. Future innovation projects should use a similar approach, ensuring language is tailored and information is relevant to each stakeholder group.
- **Cost of participation** - The costs to enable and participate in the Project Trials were significant relative to the reward. Future innovation projects should consider suitable mechanisms (financial, technical and reputational) to help participation in future innovation projects.

COVID-19

This pandemic slowed or delayed work until later in the project; the main activities affected were the installation of monitoring equipment at LV substations and the readiness of DERs to participate in TP1.

Engagement activities, including events and workshops, were moved online, or cancelled. This meant that the initial engagement with NMF and WSC platform venders took longer than planned, and recruitment of market participants was deprioritised as teams adapted to working from home.

Within this landscape, **TRANSITION** adapted by increasing the use of virtual platforms to continue the dissemination of learnings and general awareness of the project. This general acceptance and adoption of online webinars, conferences and other virtual engagement methods opened new opportunities and the potential to reach wider audiences whilst reducing the carbon emissions generated by the project.

Although no longer essential, future innovation project should consider the benefits of adopting similar methods when carrying out engagement, although the value of face-to-face engagement in building relationships should not be forgotten.

[xii] A range of simple animations which explain each of the flexibility services being testing in the Project Trials is available at: Understanding flexibility services - Project LEO (project-leo.co.uk). These were shared with Open Networks and have received positive feedback, praising the 'back to basics' approach shown in the animations

9

Project Replication

Developing the systems and processes to implement and test DSO flexibility markets has required a wide range of tools, expertise, and skillsets.

For each outcome identified in **Section 3**, this section provides a list of the components and knowledge required to replicate these. Delivering these outcomes has allowed SSEN to upskill and develop capabilities and advance the design requirements for DSO markets. The resulting learnings have been disseminated to the wider industry, ENA and policy makers, and DSO's/ESO ahead of ED2.

9.1 Physical Components and Knowledge

Market Design (Section 3.2)	
Component	**Background Data, Tools and Knowledge**
Baselining Tool	• ENA baselining tool[19] and baselining methodologies[71] to validate delivery and enable settlements, including T.E.F recommendations for future use[19,20]. • Data checking tools for historic data submissions.
BMR	• Basic Market Rules[21] to provide guiding principles on market behavior.
Products and Services	• Details of use cases, products (including day ahead) and services[15,16] to enhance BaU activities. • International experience of the use of flexibility[72]. • Details of services in a facilitated market[73].
Processes and Mechanisms	• A flow diagram that defines the steps, interactions, and timings to Register, Contract, Deliver, and Settle DSO-Procured and DSO-Enabled services; this was used to develop the requirements for the NMF platform (see below). • A Temporary Capacity Variation process to enable market participants to temporarily increase their import or export capacity and participate in DSO-Enabled services. • Two different auction mechanisms for the provision of flexibility: Pay-as-Bid and Pay-as-Clear[27]. • Forms, including invitation to tender[74] and asset qualification forms[75], for the delivery of DSO-Procured and DSO-Enabled services.

Contractual Arrangements (Section 3.3)	
Component	**Background Data, Tools and Knowledge**
Contractual Documents	• Revised FSA[29] to improve acceptability for market participants with small DERs; this includes several schedules which provides details on the commercial forms/ processes used (including settlement, registration, unavailability declarations, etc.). • A legally binding P2P Termsheet[31] for DSO-Enabled services. • A Temporary Capacity Variation process and form[26] to support requests and agreement for P2P trades. • Ts&Cs[32] to enable market participants to trade DSO-Procured and DSO-Enabled services on the NMF platform.
Market Stimulation Packages (MSPs)	• Stimuli packages for the Market Trials and Technical Trials[26] to reduce costs and encourage new flexibility providers to come to market. • A MSP calculator which enabled market participants to determine what they might earn from using their DERs to supply flexibility through these packages[76].

Price Evaluation Methodology (Section 3.4)	
Component	**Background Data, Tools and Knowledge**
CEM Model	• The ENA's CEM[77] tool to determine the price ceiling for flexibility; this was required due to low liquidity at auctions.

System Architecture and Data (Section 3.5)	
Component	**Background Data, Tools and Knowledge**
System Architecture	• The naming conventions, language (Python), standards (CIM) and data sets to pass information across different systems[78,79]. • Automated APIs to: - obtain system/network data feeds from NeRDA to the Sia forecasting tool[38] - obtain real-time settlement data from ElectraLink to the Sia forecasting tool[38] - send data between central and satellite markets[57] to improve the experience of market participants[34,35,36].
Forecasting Tool	• A Forecasting solution[38,39], which included novel features to: - Determine a scenario-based forecast envelope up to 10-days ahead for demand and different types of distributed generation. - Automate API data feeds from NeRDA and ElectraLink. - Forecast deep into network (11kV). - Reforecast within a short timescale. - Provide control room visualisation and improve operational value.

Neutral Market Facilitation (Section 3.6)	
Component	**Background Data, Tools and Knowledge**
NMF Platform[xiii]/ Satellite Platform	• The NMF function, defined separately from the WSC function (see below), to enable market participants to interface with the marketplace whilst improving visibility and reducing complexity; a requirements specification[42], high level solution design[52], and a report on data exchange and governance[43] were produced.

System Co-ordination (Section 3.7)	
Component	**Background Data, Tools and Knowledge**
S&D Tool/WSC Tool	• The system coordination function to provide the core intelligence for flexibility market coordination and decision making; a requirements specification[51], and high level solution design[52] were produced. • A S&D tool to generate requests, enable the automatic selection of contracts (whilst considering the most economic and viable contract against the requirements) and issue dispatch instructions; a Low Level Design for the S&D tool has been produced.

Network Model (Section 3.8)	
Component	**Background Data, Tools and Knowledge**
Integrated Network Model	• An integrated network model was developed in PowerFactory in conjunction with OGS tool CIMphony to enable a ensure interoperability between systems and tools; the data requirements for this model have been provided[47]. • The LV network model which identified the benefits of LV monitoring in supporting/improving the view of network connectivity[40].

Power System Analysis (Section 3.9)	
Component	**Background Data, Tools and Knowledge**
PSA Tool	• The PSA Tool developed using Python and PowerFactory, to calculate the anticipated power flows under different near-term topology changes and forecast scenarios; a Low-Level Design for the interaction of the PSA tool has been produced[62]. • The concept of sensitivity factors to determine the effect of dispatching DERs at a particular location to resolve a constraint based on actual network connectivity[48] were developed.

[xiii] The NMF platform operated as a Central Market and mimicked a single GB-wide marketplace managed by a single NMF.

10

Planned Implementation

SSEN are currently evaluating the capabilities required to implement DSO systems and a flexibility marketplace facilitated by the DSO across their license area during ED2. SSEN's DSO Action Plan[80] outlines the building blocks required to deliver on the DSO core functions and procure 5GW of flexibility during ED2.

This strategy was heavily influenced by **TRANSITION** (in collaboration with LEO) and expanded the understanding of the energy ecosystem. As detailed in **Section 3**, **TRANSITION** has developed the tools, systems, data sets, and linked technical/commercial processes required to support DSO flexibility markets. These outcomes, and the learnings gained from developing and implementing them, will be imperative to enabling SSEN's transition to the DSO. There will however be a balance of adopting these in BaU directly, and/or using them to inform future requirements. For each outcome detailed in Section 3, the below provides commentary on how SSEN plans to modify its business model, and any future work required.

Table 8: Planned Implementation Activities and Actions

Market Design (Section 3.2)		
Component	**Planned Implementation**	**Actions Required**
Baselining Tool	To be adopted in BaU.	**ENA ON-P** - consider developing simpler and more accurate baselining methods to encompass all DERs and whether baselining is a requirement for all DSO services.
BMR	Learnings from developing the BMRs are providing a basis for developing a set of flexibility market rules during ED2.	**ENA ON-P** - identify the best way to adopt the BMRs within wider industry codes and standards and develop transparent primacy rules to ensure the safe and fair operation of the network.
Products and Services	Use flexibility services to delay the reinforcement that would otherwise be necessary to meet demand.	**ENAON-P** - standardised products and services across DSOs to encourage participation of new flexibility. **Ofgem** - consider who will fulfil the market facilitator role for DSO services, how market participants should access the market and the suitability of a central and satellite market model.
Processes and Mechanisms	Learnings from developing an E2E process can streamline and inform marketplace engagement to support the delivery of flexibility commitments in ED2.	**SSEN** - refine the E2E process to suit BaU requirements to deliver ED2 commitments. **ENA ON-P** - consider adopting the E2E process to further standardise flexibility procurement across DNOs.

Contractual Arrangements (Section 3.3)		
Component	**Planned Implementation**	**Actions Required**
FSA	Use FSA as a framework agreement to procure flexibility in BaU.	**SSEN** - via ENA ON-P, promote FSA as a framework agreement with increased standardisation of Appendices.
TCV	The TCV process and documentation to be considered by projects looking to enable capacity trading.	**SSEN** - review the TCV approval process for future projects considering DSO-Enabled services and determine if the approval timescale could be reduced.
P2P Termsheet	The P2P Termsheet to be considered by projects looking to enable capacity trading.	**SSEN** - to consider the P2P Termsheet as an agreement for DSO-Enabled Services internally and promote to the ENA ON-P for wider consideration.
NMF Ts&Cs	Learnings can be used to develop the contractual arrangements for a procurement platform in ED2.	**Ofgem** - consider who will fulfil the market facilitator role for DSO services and how market participants should access the market.
MSPs	Feedback will inform future mechanisms to stimulate liquidity.	**ENA ON-P** - consider how feedback from developing the MSPs can help inform future mechanisms to stimulate liquidity, especially for market participants with portfolios of small DERs.

Price Evaluation Methodology (Section 3.4)		
Component	**Planned Implementation**	**Actions Required**
CEM Model	Use the CEM model to inform the wider value of flexibility in BaU.	**ENA ON-P** - review the CEM model to determine its limitations (e.g., does not account for the deliverability of widespread reinforcement). Consider the best way to include the broader socio-economic benefits realised from the use of flexibility and the value realised by third parties who do not pay for DSO-Procured services.

System Architecture and Data (Section 3.5)		
Component	**Planned Implementation**	**Actions Required**
System Architecture	Developing the system architecture, data sets and data exchanges informed internal SSEN ED2 planning requirements and tools.	**ENA ON-P** - Standardise data interaction, naming conventions and programming language (e.g., Python) to enable the sharing of data between DSO tools and market participants and encourage liquidity.
Forecasting Tool	Learnings from developing and testing the Sia forecasting tool informed the requirements/specifications for a new DNO forecasting tool.	**SSEN** - use learnings to inform the requirements/ specifications for a new DNO forecasting tool and share widely through ENA ON-P.

NMF (Section 3.6)		
Component	**Planned Implementation**	**Actions Required**
NMF Platform/ Satellite Platform	Learnings from developing and testing these platforms will inform the way market participants provide flexibility for DSO products and services and can inform industry requirements for future tools.	**SSEN** -consider how to address asset complexity/scalability and market readiness prior to implementation. **Ofgem** - consider who will fulfil the market facilitator role for DSO services, how market participants should access the market and the suitability of a central and satellite market model.

10 Planned Implementation

System Co-ordination (Section 3.7)		
Component	**Planned Implementation**	**Actions Required**
S&D Tool/WSC Tool	Learnings from the development and testing of this tool will inform an analogous BaU tool to be implemented as part of SSEN's ED2 plans for flexibility management.	**SSEN** -consider how to address asset complexity/ scalability and market readiness prior to implementation.

Network Model (Section 3.8)		
Component	**Planned Implementation**	**Actions Required**
Integrated Network Model	SSEN will continue to develop integrated network models that span multiple voltage levels during ED2 to improve modelling outputs in "near real time".	**SSEN** - consider the roll out of this approach, how to reflect ongoing maintenance needs and how increased automation can improve efficiency and enable scalability for increased network penetration. **ENA ON-P** - champion the use of the CIM standard and tools that make use of it (e.g., PowerFactory, Electric Office, etc.) to ensure accuracy and interoperability.

Power System Analysis tool (Section 3.9)		
Component	**Planned Implementation**	**Actions Required**
PSA Tool	Learnings from the development and testing of this tool will inform an analogous BaU tool to be implemented as part of SSEN's ED2 plans for flexibility management.	**SSEN** - consider how (i) to address asset complexity/ scalability (ii) to reflect ongoing maintenance needs and (iii) increased automation can improve efficiency and enable scalability for increased network penetration.

11

Learning Dissemination

TRANSITION is part of a wider partnership of planned innovation with LEO, T.E.F and the ON-P:

- The unique collaboration between Project LEO and **TRANSITION** delivered benefits through shared experience and project learnings. **TRANSITION** benefited from a greater understanding of the concerns and issues of market participants, whilst LEO benefited from a better understanding of DSO issues and flexibility markets. Interaction between **TRANSITION** and LEO was critical to the success of both projects during the Market Trials, with the projects carrying out joint dissemination and publishing joint reports.
- T.E.F. enabled three DNOs to work together to avoid unnecessary duplication of effort, share learnings and produce collaborative outputs[16,20,81] which maximised learnings for industry. As part of this collaboration, SSEN undertook a verbal consultation to receive feedback on the information required by other DNOs (WPD and SPEN) to replicate the outcomes of **TRANSITION** on their network. This feedback was used to draft **Section 9** of this report, and has been summarised in **Appendix A**.
- **TRANSITION** led regular engagement and interactions with all ENA ON-P workstreams to provide and receive feedback on project achievements and learnings. This ensured the ENA ON-P benefited from developing and trialling existing arrangements (e.g., the FSA and DSO-Procured service definitions) and new arrangements (e.g., SIA's forecasting tool, the baselining tool[19] and DSO-Enabled Services definitions), whilst the project remained aligned with the ENA ON-P.

The **TRANSITION** Project website has been live since early 2019, disseminating learnings, best practice information and regular updates on progress through reports, webinar slides (see **Appendix B**) and news releases[82]. In addition, the project used social media to communicate key milestones and deliverables, and published articles in relevant trade and local Oxfordshire press (see **Appendix C**).

11 Learning Dissemination

The project frequently engaged with industry on emerging findings, policy, and regulation, whilst disseminating learnings and receiving feedback on the project. This helped shape the outputs of the project.

- A series of **show and tell workshops** held at the end of the project to disseminate learnings to ENA members and Ofgem. These sessions focused on the requirements to run a DSO flexibility market; tools and platforms[57], data[40] and market developments[58]. Questions and feedback for each session were summarised in a short note[83].
- Participation in blue zone talks and events at the **Conference of Parties (COP) 26** summit to engage and raise international awareness of Project **TRANSITION**. In addition, SSEN hosted two events at their offices in Glasgow which focused on supporting an inclusive and just transition to Net Zero, and the opportunities and challenges faced by innovation projects.
- Annual attendance at the **Energy Innovation Summit**[xiv], during which project representatives engaged with stakeholders from across industry to raise the profile of the project, answer questions and disseminate learnings.
- **International webinars with Ausgrid and Enel, and engagement with the International Community for Local Smart Grids (ICLSG)** to collaborate and disseminate learnings.

TRANSITION held workshops which enabled stakeholders to provide feedback on various aspects of the project, including the:

- **BMRs** (see **Section 3.2**) were tested and revised using feedback from a range of industry stakeholders (including all six DNOs, Ofgem, DESNZ, and the ESO) during several events[22,23,24]. They were used to support the delivery of flexibility services during **TRANSITION**, inform the ENA ON-P and help the development of market rules for the delivery of flexibility services in BaU.
- **DSO Functions Workshop** enabled discussions to understand stakeholders' views on the three DSO functions set out by Ofgem. The event welcomed around 20 attendees from a variety of organisations, including National Grid Electricity Distribution, SSEN, ENWL, DESNZ, flexibility providers and research organisations (University of Oxford, Environmental Change Institute); a summary of the discussions are provided in a workshop report[25].

Figure 12: Oxfordshire Projects Programme Director Melanie Bryce (pictured second from right) representing the **TRANSITION** and LEO projects at COP26

[xiv] Previously known as the Energy Networks Innovation Conference (ENIC)

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Key Project Learning Documents

TRANSITION has generated a host of learnings that have been shared via numerous documents, webinars, and progress reports. These are available on the TRANSITION project website[84], with additional outputs produced via our collaboration with LEO available on the LEO project website[85]. A summary of the key learnings documents for the project are provided in Appendix B, along with their location.

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Data Access Details

Information gathered as part of this project can be provided to interested parties upon request. The form of the information will be in accordance with the SSEN NIC and NIA Data Sharing Procedure, reference PR-NET-ENG-020, Revision 2.00, published on the SSEN website which can be read at https://ssen-innovation.co.uk/wp-content/uploads/2022/04/Network-Innovation-Competition-NIC-and-Network-Innovation-Allowance-NIA-Data-Sharing-Procedure-PR-NET-ENG-020.pdf

Please email future.networks@sse.com for more information.

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Material Change Information

In reference to the Electricity NIC Governance Document version 3.0, the project can confirm that no material change has occurred since the project direction was issued in 2018.

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Appendix and references

Project Close Down Report

September 2023

Appendix A: Key Learning Documents

Report Title	Summary	Publication Date
TRANSITION Site Selection Methodology	This report focuses on a deliverable for TRANSITION Work Package 6 (WP6): Methodology for Trial Specification. Specifically, this report evaluates the counties/areas of local authority within SSEN's networks in Scotland and Central Southern England against a set of 13 criteria to rank each location on attractiveness for development of Project Trials.	March 2019
TRANSITION Forecasting Provider Analysis	This report focuses on TRANSITION's analysis in support of their decision to follow the Western Power Distribution Project EFFS for forecasting output and only develop where necessitated by the trial design.	May 2019
Neutral Market Facilitator- Requirements Specifications	This document defines the requirements for a trial of a NMF system. This involved developing a set of business processes and rules to be supported by the systems, consistent with the work published under the ENA ON-P and is importantly owner agnostic.	May 2019 (Updated November 2019)
Neutral Market Facilitator Data Exchange and Governance	This document describes aspects of governance of the data stored in the NMF and the exchange of data with other systems or people in other organisations via messages into and out of the NMF. This document is prepared for Ofgem deliverable #2 in May 2019 for the TRANSITION project.	May 2019
Best Practice Report - Market Facilitation for DSO	The purpose of this review of international experience of future electricity market facilitation is to help inform the approach to market facilitation in the British electricity market. It seeks to understand the structure of the markets reviewed, their electricity mix, the remaining lives of their existing generating capacity, the plans for its retirement and the policies that promote a move to a low carbon electricity system.	May 2019
Services in a Facilitated Market	This report identifies what flexibility services may be deployed in a future facilitated market. It considers the need for flexibility, proposes a standardised methodology for defining flexibility to create comparability with other markets, the risks of delivery to ensure the market uses flexibility in the most efficient manner, considers the range of services that could exist in a future facilitated market and identifies five services for trialling under TRANSITION.	August 2019
Analysis of Relevant International Experience of DSO Flexibility Markets	The purpose of this report was to look at DSO projects across the world and to identify the relevant international experience of flexibility markets. The findings of the report were used to identify relevant projects, best practice and best value for money for validating SSEN's TRANSITION and LEO projects.	August 2019
Whole System Coordination Requirement Specification	This document defines the requirements for a WSC system.	September 2019 (Updated November 2019)

Appendix A: Key Learning Documents

Report Title	Summary	Publication Date
TRANSITION Project Progress Report	This document focuses on progress of TRANSITION between September 2018 and September 2019. During this reporting period, the Project has focused on: • Defining the requirements for the NMF/WSC platform. • Developing the Flexibility Services to trial. • Define the basic Market Rules which will be utilised during the Trial Phase. • Developing Site Selection methodology. • Selecting a vendor for the Substation monitoring equipment. • Interfacing extensively with the T.E.F. collaboration and Project LEO.	October 2019
High Level Solution Design Summary	The purpose of this document is to provide an executive summary of the High-Level Solution Design document, which provides a high-level view of the components and interactions needed for the TRANSITION project (excluding physical infrastructure of the electricity networks and energy flexibility resources) to achieve its objectives and how the components will be used in the Project Trials.	November 2019
LCNI 2019 TRANSITION and LEO	Copy of TRANSITION and LEO's slides from the LCNI 2019 event	November 2019
NMF and WSC Platform Dissemination Briefing	Copy of TRANSITION and LEO's slides from their Briefing Webinar on the NMF and WSC platform.	November 2019
NMF Vendor Webinar	Copy of TRANSITION slides from their vendor webinar on the Neutral Market Facilitator held on November 2019.	November 2019
WSC Vendor Webinar	Copy of TRANSITION slides from their vendor webinar on the Whole System Coordinator held on November 2019.	November 2019
Oxfordshire Programme Trial Strategy	The purpose of this report is to outline TRANSITION's Oxfordshire programme trial strategy in relation to WP2 phase 1.	February 2020
Market Rules Development Phase 1	This report considers the development of a set of Basic Market Rules that will govern the delivery of TRANSITION's flexibility services.	Febraury 2020
T.E.F Stage Gate Report 2020	This report explores the Stage gates required for each of the three flagship demonstrator projects funded through the 2017 Network Innovation Competition (NIC) to collaborate with industry relevance and value to customers.	February 2020
Regulatory Roadmap and Impact Assessment	The purpose of this document is set out ElectraLink's DSO code governance guidance which will feed into SSEN's TRANSITION and LEO projects.	May 2020
Oxfordshire Programme Commercial Arrangements	This report introduces the commercial analysis required on TRANSITION to both test new initiatives and facilitate technical and IT learning. Namely the report addresses issues surrounding valuation of flexibility resources and how TRANSITION is challenging conventions to help stimulate the market for DER.	July 2020

Appendix A: Key Learning Documents

Report Title	Summary	Publication Date
TRANSITION Network Adaption for Trial Development	The purpose of this report is to provide an update of how TRANSITION is preparing for the trial deployment phase of the project. SSEN owns and manages the electrical distribution network for a large part of Oxfordshire where Project Trials will be conducted.	July 2020
TRANSITION Project Progress Report - 2020	This document focuses on the progress of TRANSITION between the reporting period of October 2019 to September 2020. During this reporting period, October 2019 to September 2020, the Project has focused on: • Successfully completing the procurement of NMF and WSC platform • Finalising High Level Design and requirements • Developing the Commercial arrangements and Flexibility Services to trial • Developing the basic Market Rules which will be utilised during the Trial Phase • Trial site identification with our LEO partners. • Commenced the installation monitoring • Interfacing extensively with the Project LEO, T.E.F. collaboration, ENA ON-P, and other stakeholders.	October 2020
Use Cases and Services to be trialled Phase 1	This report introduces the concept of Use Cases and how they can be applied to TRANSITION. A Use Case is a description of how a Market Actor who uses a process (or system) will accomplish a goal, much like a recipe with a goal of preparing an item which describes a series of written steps how to prepare that item.	November 2020
TRANSITION Flexibility Market Trials Workshop	In this presentation, SSEN's Charlie Edwards introduced the flexibility market trials to external Stakeholders.	December 2020
TRANSITION Service Conflict Resolution - War Games Report	This report summarises the development and delivery of the Service Conflict Resolution workshops held in, key discussions, feedback, and outcomes; the workshop materials are included in an Appendix.	March 2021
Service Description Report - Sept 2020	This report is a collaborative piece of work between Project FUSION and TRANSITION as part of the Joint Work Agreement. The report builds on the recently published FSA by the ENA ON-P in addition to the reports and ongoing work which form the Joint Work Agreement. It iterates the template for service description to define the requirements for all services being considered during the projects FUSION and Project Trials.	April 2021
Platform Acceptance Testing	This report, produced in collaboration between SSEN and Opus One, has detailed the structure approach required to specify and conduct the Platform Acceptance Testing, of both the Neutral Market Facilitator and Whole System Co-ordinator.	June 2021
TRANSITION Project Progress Report 2020/2021	This report focuses on progress in the project between the period of September 2020 to February 2022. The project is split into two distinct phases; Phase 1: Requirements phase, and Phase 2: Deployment and Trial phase. During this reporting period the project has been in Phase 2. The first half of this reporting period focused on finalising the detailed design for the NMF and WSC platform, as well as the development of commercial arrangement for trial deployment. The second half of this reporting period focused on preparation for trial period 1 which runs from November 2021 to February 2022.	September 2021

Appendix A: Key Learning Documents

Report Title	Summary	Publication Date
Value Chain for Flexibility Provider	This paper focusses on the value of flexibility services that exist in flexibility markets today. It considers the interaction of different flexibility services and highlights where revenues can be stacked across different time periods. This information can be used as a foundation to determine a value chain for existing services and as a reference point to consider the value of providing flexibility services.	November 2021
TRANSITION /LEO Trial Plans v1.1	This document sets out the approach for the post-MVS+ trial periods of Project LEO. It is intended to act as a reference guide for the delivery of the agreed learning objectives through the trial phases of Project LEO.	November 2021
Load Forecasting Dissemination Report November 2021	This report, produced in collaboration between SSEN and Sia Partners presents how Sia Partners' Operational Load Forecasting solution has been implemented for the TRANSITION project, and summarises the main outputs and key lessons learnt from this innovation project work to date.	November 2021
Select & Dispatch High Level Overview	The S&D Technical Trials presentation was written during the early discovery stages of the project while engaging with stakeholders to gather its requirement.	April 2022
TRANSITION and Project LEO Market Trials Report - Period 1 (Ofgem)	This report focuses on the first trial period for TRANSITION's flexibility market services and fulfils TRANSITION Ofgem Project Direction, Reference 6 (Trials Stage 1: Completion of one stage of Trials). It gives a flavour of the challenges overcome in setting up a local market for flexibility and produces key learnings and recommendations for each area.	April 2022
Local Energy System Modelling: Osney Island Smart and Fair Neighbourhood Case Study	This report highlights the CAPEX utilisation required for the Osney Bridge Street Substation as part of Project LEO	May 2022
DSO Enabled Peer to Peer Services - Interim Trials Learning	This report summarises the interim findings from the work completed to date by projects TRANSITION and LEO on DSO-Enabled peer-to-peer capacity trading services. The two projects are conducting Joint Trials which include TP1 which ran from November 2021 to February 2022.	August 2022
Historic Baselining Methods - Performance Assessment	This report, produced in collaboration between SSEN and TNEI, examines the performance of the historic baseline methodologies currently being implemented in the TRANSITION trial periods and those available on the ENA ON-P Flexibility Baselining Tool.	August 2022
TRANSITION Project Progress Report	This report focuses on the progress in TRANSITION during the reporting period of November 2021 until September 2022. The first part of this reporting period focused on finalising the detailed design for IT systems including the NMF and WSC platform as well as the development of commercial arrangement for trial deployment. The second part of the reporting period focused on planning and delivery for TP1 from November 2021 to February 2022 and TP2 from May 2022 to September 2022.	September 2022

Appendix A: Key Learning Documents

Report Title	Summary	Publication Date
TRANSITION and Project LEO Market Trials Report - Period 2 (Ofgem)	This report focuses on TP2, building on the learnings from TP1 and informing the future scope of TP3 (the final trial period of the project). TP1 focused on mobilising the technology, markets and recruiting market participants. Through TP2, the focus has been increasing market participants' involvement (both traditional and non-traditional DERs and organisations) and gaining feedback on the variety of products (delivery timescales) and services available, including: • Greater diversity of DSO-Procured services – four DSO-Procured services compared to two during TP1. • Increased geographical coverage of the Trials – six Bulk Supply Points compared to three in TP1. • Diversity of participating DER types – six DER types compared to two in TP1. • Range of procurement horizons for services – three auction horizons (season-ahead, week ahead and day-ahead).	November 2022
Delivering for Peer to Peer	This short note explores the interpretative view of the DSO and Customer to identify issues and suggest recommendations for further investigation to enable DSO-Enabled services in a future market	March 2023
DSO Functions Workshop Report	As part of this project SSEN delivered a workshop to engage stakeholders on the DSO required functions. This reports details what those functions are, how they were described and demonstrated to the audience. SSEN sought feedback on how it could best carry out these functions and from this were able to draw recommendations on priorities that the DSO could implement to improve its service. This report also captures and summaries that feedback.	March 2023
Commercial Findings Workshops Report	This paper summarises the key outputs of two workshops held by Baringa and SSEN in early 2023. The workshops were designed to compile commercial learnings from the LEO and Market Trials.	March 2023
Baselining Experiences and Recommendations: Learning from TRANSITION and FUSION Trials:	A copy of presentation slides from our joint webinar with FUSION project exploring our experiences of baselining throughout our trials. This webinar was held on the 25th of April 2023.	April 2023
TRANSITION and Project LEO Market Trials Report - Period 3 (Ofgem)	This report focuses on TP3, building on the learnings from TP1 and TP2 and informing and informing the future of BaU services. TP3 focus has been increasing market participants' involvement (both traditional and non-traditional DERs and organisations) and gaining feedback on the variety of products (delivery timescales) and services available, including: • An increased number of auctions across all service types – significantly more auctions were run for the DCM and SCM services. • An increased number of procurement horizons – season ahead and week ahead auctions were introduced for the SCM service; and week ahead and day ahead auctions were introduced for the Trading Import and Export Capacity (Exceeding MIC and Exceeding MEC). • Auctions were run at Primary Substations – market participants could participate in an auction at for the SCM, SEPM and SPM services. • market participants could stack services – market participants could stack SCM with SPM services as per the FSA.	April 2023

Appendix A: Key Learning Documents

Report Title	Summary	Publication Date
Real-time Forecast Optimisation Report	The purpose of this document is to provide a comprehensive and detailed summary of Sia Partners' phase 2 evolution of the original Load Forecasting solution implemented in the TRANSITION Programme. It will also provide focus on several studies aiming to inform on the broader contextual value of forecasts, a future upscaling strategy and potential application of TRANSITION's results (which naturally focused on a small locational footprint), to a much wider regional basis potentially including entire DNO license area in future.	April 2023
Project LEO Baselining Working Group Summary Report	This report aims to summarise the discussion and learning relating to baselining that arose throughout the real-world trials carried out as part of Project LEO and TRANSITION.	May 2023
TRANSITION Show and Tell Workshop: Data	Slides from TRANSITION's Show and Tell Workshop on Data. These slides are part of a series from the project that aimed to disseminate key learning from our four years of innovation.	June 2023
TRANSITION Show and Tell Workshop: Market Development	Slides from TRANSITION's Show and Tell Workshop on Market Development.	June 2023
TRANSITION Show and Tell Workshop: Tools and Platforms	Slides from TRANSITION's Show and Tell Workshops on Tools and Platforms.	June 2023
Sensitivity Factors Report	This report explores the development of the sensitivity factors as part of the PSA and S&D build during technical trials.	July 2023
Technical Trails Data Analysis	The Technical Trials Analysis pack is to share the learning and supporting data TRANSITION gathered throughout the technical trials.	July 2023
Show and Tell Workshops: Q&A Responses	As part of our Show and Tell workshops; we made a commitment to responding to each clarifying question in writing with additional information from the team. This document collates those responses into a Q&A form.	July 2023
Simulated Trials Summary Report	This report summarised work done by TNEI Services Ltd (TNEI) to undertake a series of simulated flexibility trials for the TRANSITION innovation project.	July 2023
Technical Trials Full Context Diagram	The TRANSITION Technical Trials context diagram enabled us to share a common view of the project at all our stakeholder meetings and therefore supported the many stakeholder discussions that we had. This drawing allowed us to define the elements and scope without being prescriptive on what the solution might look like. This diagram was used to help us to quickly onboard new colleagues or third parties. It is an important visual tool that supplements our technical solution design documents.	July 2023
Select and Dispatch End to End Process Diagram	The End-to-End process diagram for the Technical Trials shows all the high-level functions of the complete process that supports the DSO during a flexibility market transaction.	July 2023

Appendix A: Key Learning Documents

Report Title	Summary	Publication Date
Market Trials End to End Process	The End-to-End process diagram for the Market Trials shows all the high-level functions of the complete process that supports the DSO during a flexibility market transaction. Each swimlane represents either a business area or a system.	**July 2023**
Market Trials Context Diagram	The **TRANSITION** Market Trials context diagram enabled us to share a common view of the project at all our stakeholder meetings and therefore supported the many discussions that were had over the years of the project. It shows the context of related elements and allowed us to easily see where any new touchpoints and interfaces might be required.	**July 2023**
Power System Analysis Final Report	This document is the final report on the Power System Analysis (PSA) software that was implemented and used for the **TRANSITION** Technical Trials.	**July 2023**
High Level Design Documentation: PSA Tool	The purpose of this functional design document is three fold: • Provide business users and IT support teams with a solution overview • Provide the build team with adequate information for low level design preparation	**July 2023**

Appendix B: News Releases and Social Media Dissemination

Throughout the project, **TRANSITION** published project news releases, primarily to industry media outlets. These focused on recruitment for the trials but also raised awareness of the project and its learnings:

- **SSEN's innovation projects successfully trial unique Neutral Market Facilitator platform**
- **New flexibility measurement tool launched to help Britain's DNOs trade with more visibility and consistency**
- **Project LEO recruiting pioneers for flexibility markets in Oxfordshire**
- **Project LEO reaches another landmark through live flexibility trade with ev.energy**
- **SSEN awards Opus One contract to develop market flexibility and coordination solutions**
- **Oxfordshire's preparations for a Net Zero future supported with innovative new technology (LV monitors installation)**
- **SSEN calls on Oxfordshire generators and asset owners to join innovative project replicating future energy system**
- **SSEN calls for Oxfordshire businesses with just 50kW of flexibility to join market trials | New Power**

In addition to this **TRANSITION** have used social media to communicate key milestones and deliverables to audiences with content focusing on:

- Communicating opportunities to take part in the Flexibility Market Trials
- Sharing links to **TRANSITION** reports and events
- Sharing news about the project
- Reaching out to potential participants in the Flexibility Market Trials
- Educating various audiences on the importance of energy flexibility as one of the ways to address increasing demand and the UK's zero carbon targets
- Disseminating various **TRANSITION** reports and event
- Sharing important milestones that **TRANSITION** achieved

Appendix C: Events List

Activity/Event	Date	Type	Objective
The First Year of Project LEO	June 2020	Webinar	Raise the profile and awareness of the projects and disseminate learnings.
How are Local Networks Enabling the Energy Transition?	June 2020	Webinar	Raise the profile and awareness of the projects and disseminate learnings.
Smart Local Energy Systems: social, technical, and operational aspects	July 2020	Webinar	Raise the profile and awareness of the projects and disseminate learnings.
Presentation on Market Trials at the Virtual ENIC	December 2020	Conference (Virtual)	Raise the profile and awareness of the projects and disseminate learnings.
PFER Board - Progress Update	February 2021	Presentation	To understand the project and the role it is playing in developing energy networks and systems for the future that benefit everyone.
To launch and raise awareness of the ICLSG at COP26	February 2021	Webinar	To understand the importance of smart grids, to want to know more and be part of the group.
Feed into Energy Networks Association development of ideas around capacity trading	March 2021	Workshop	Dissemination on capacity trading (what it is and how it could be used) and opportunity to gauge interest/get feedback from stakeholder to inform ENA ON-P.
Energy innovation webinar for the Oxford-Cambridge Arc	March 2021	Webinar	Raise the profile and awareness of the projects and disseminate learnings.
Future Networks Conference	March 2021	Conference	Raise the profile and awareness of the projects and disseminate learnings.
Presentation given to the members of the Association of Decentralised Energy (ADE)	April 2021	Webinar	Raising the profile and awareness of the projects and disseminate learnings.
Carbon Trust - Raise awareness and profile as well as sharing learning	April 2021	Virtual Meetings	Raise awareness of project LEO and **TRANSITION** and the Project Trials, encourage participation. Influence local Net Zero scenario development. Engage a nationally interested stakeholder.
Smart Energy Conference - Driving Smart as Standard across the economy	April 2021	Conference (online)	Raising the profile and awareness of the project, directing people to the market trials pages with the aim of increasing market trial participation.
Presentation at Utility Week Live	May 2021	Conference	Raise the profile and awareness of the projects and disseminate learnings.
Carbon Trust - Net Zero Energy Transition Week and the launch of the Flexibility in GB report	May 2021	Webinar	Raising the profile and awareness of the projects and disseminate learnings.
Future of Distributed Energy Resources 2021 Conference	May 2021	Conference	Raising the profile and awareness of the projects.
A week long programme of internal SSEN staff webinars covering LEO and **TRANSITION**	June 2021	Webinar	Internal dissemination about LEO to muster support and discuss how LEO and **TRANSITION** can feed into SSEN's planning for ED2.

Appendix C: Events List

Activity/Event	Date	Type	Objective
ENA ON-P Engagement	June 2021	Teams Meeting	To support ENA ON-P in work they are doing to demystify flexibility and to be seen as a leader in this field.
UKRI Engagement	July 2021	In-person Meeting (and online)	Raising the profile and awareness of the projects.
ZCOP Steering Group	July 2021	Teams Meeting	To put a specific action against the Zero Carbon Oxford Partnership via its steering group to consider signing up to the Project Trials and to promote the trials to others.
Panel presentation at Ofgem Green, Fair Future: Delivering the Flexible Energy System of the Future.	July 2021	Conference (Virtual)	Raising the profile and awareness of the projects and disseminate learnings.
Pre-COP26 ENEL event in Milan	September 2021	Conference	To raise international awareness of Projects LEO and **TRANSITION**.
To respond to BEIS questionnaire on flexibility innovation	October 2021	Consultation	To feed into policy development for SLES.
COP26: Attended 5 days of in the blue zone	November 2021	Conference (in-person)	Raise awareness of Project LEO and **TRANSITION** and the role of community energy in the transition to a smart local energy system, attending talks, engaging with attendees produce a range of blog posts and social media.
Presentation at Enel Innovation Tour Webinar	November 2021	Webinar	To raise international awareness of Projects LEO and **TRANSITION**.
ESO/LEO collaboration call to find opportunities to support each other's aims and to share best practice and learning	November 2021	Teams Meeting	Align messaging and share best practice and learning.
Lecture to University of Oxford MSc in Energy Systems	February 2022	Lecture	Teaching about the importance of local energy from DSO perspective and how it supports the transition.
Presentation PFER Six in Sixty Webinar Series - Putting the smart into Smart Local Energy Systems	March 2022	Webinar	To share and disseminate learnings and activities relating to "Smart" in the Smart Local Energy System.
Presentation at IEC CIM Week 2022 on the "Application of CIM for Power System Analysis Model Inter-Operability in DSO Flexibility Markets	March 2022	Conference	Provide an overview of the use cases of CIM for PSA model Inter-Operability in DSO Flexibility Markets, and the key learnings and challenges of using CIM as the source of data for building network models.
UKRI EPSRC Mission Focussed Research Workshop	March 2022	Workshop	To share learnings and experience with the UKRI and network with other projects.
Presentation at ENA Baselining Webinar.	April 2022	Webinar	Launch baselining tools which has been jointly developed by WP5 and ENA ON-P.
TNEI baselining webinar	May 2022	Webinar	To raise awareness of the work on the baselining tools.

Appendix C: Events List

Activity/Event	Date	Type	Objective
Presentation to Users Technology Collaboration Programme Academy (Copper Alliance)	May 2022	Webinar (with Q&A)	Inform European policy makers about Projects LEO and **TRANSITION**, its aims, flexibility markets and the CMPAN concept.
Panellist and presentation at Utility Week Conference (Heat and Future Networks)	May 2022	Conference	
SSE Non-Exec Director Visit - Extend awareness of LEO in SSEN	May 2022	Internal Meeting	Internal dissemination about projects LEO and **TRANSITION** to muster support and continuation work.
Presentation at Imperial College - The Flexibility Landscape	June 2022	Presentation	Raise awareness of the DSO tools and systems developed as part of LEO/ **TRANSITION** and the flexibility market trials carried out.
Presentation at EnergyX2022	June 2022	Conference	Raising the profile and awareness of the projects and disseminate learnings.
Presence at House of Commons Event: Celebrating the Digitalisation of Energy	June 2022	Conference	To raise awareness with policy makers and industry.
Presentation at the "III International Seminar on Distribution's and Commercialization Transformation of Electric Energy and its Regulation"	July 2022	Presentation	Overview of LEO and **TRANSITION** and how these projects have enabled SSEN to trial the systems and tools, as well as the commercial models and processes needed for the transition to DSO.
UKRI PFER insights workshop policy & regulation	July 2022	Workshop	Share project insights with PFER group.
Local Energy Institutions and Governance Workshop: Energy System Planning	August 2022	Workshop	
Ofgem Call for evidence Workshop - Future of local energy institutions and governance	August 2022	Consultation	Response on behalf of projects to guide Ofgem's strategy.
Ox2Zero	September 2022	Panel Discussion	Know more about findings from Projects LEO and **TRANSITION** and the intervention points that are needed to support the energy transition for Net Zero.
SSEN stall of the Energy Innovation Summit in Glasgow.	September 2022	Conference	To Promote LEO and **TRANSITION** as part of energy innovation to energy companies, tech innovators, funders and others interested in Energy Flexibility.
CIBSE EPG Power Hour Engagement with buildings design and management industry as potential flexibility provider education	September 2022	Webinar	Inform buildings industry about flexibility markets opportunities and drivers as part of Net Zero electrification.
Webinar with GEoDE.EU International engagement with other DNOs on flexibility markets and similar experiences in Europe	September 2022	Webinar	International engagement with other DNOs on flexibility markets and similar experiences in Europe.

Appendix C: Events List

Activity/Event	Date	Type	Objective
Knowledge share on electricity networks LV constraints and modelling technical activities	September 2022	Virtual Meeting	Share best practice and discuss emerging themes for Net Zero and impact on LV network constraints - discussing the BEIS LV Strategy work that EA Tech delivered for them, and transposing this to SSEN's experience.
Trial Period 2 Update	December 2022	Virtual Meeting	Provide update to network licensees and Ofgem, progress made during TP2 and learnings.
International conference participation: paper contribution and chairing an invited session hosting a diverse group of experts.	December 2022	Conference	Share new results on probabilistic certification of data-based decision making in smart grids with the international scientific community.
Compared and contrast baselining approaches	January 2023	Webinar	Dissemination on different baselining methodologies used as part of the TEF NIC collaboration (FUSION and **TRANSITION**).
Sharing learnings with BWCE	March 2023	Teams Meeting	Signposted key learnings and report to aid replicability within BWCE catchment.
ICLSG Knowkedge Sharing	August 2023	Virtual meeting	**TRANSITION** shared the technical capabilities required to procure flexibility closer to real time, with an international audience

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