NGESO and NGED

Coordinated Operational Methodology for Managing and Accessing Network Distributed Energy Resources (COMMANDER)

Workstream 1 Report – Development of Coordination Schemes

Type of document (version) Confidential

WSP Project no. 70083589

Our Ref. No.NG reference: NIA2\_NGESO012

Date: March 2023

|  |
| --- |
| WSP  WSP House 70 Chancery Lane London WC2A 1AF  Phone: +44 20 7314 5000  Fax: +44 20 7314 5111  WSP.com |

Quality control

|  |  |  |  |
| --- | --- | --- | --- |
| Issue/revision | First issue | Revision 1 | Final issue |
| Prepared by | Marouf Pirouti (WSP)  Matt Yates (WSP)  Harry Fachiridis (WSP)  Danny Pudjianto (ICL)  Goran Strbac (ICL) | Harry Fachiridis  Matt Yates  Beth Hanna  Danny Pudjianto | Beth Hanna |
| Checked by | Beth Hanna | Nuno Pedro |  |
| Authorised by | Nuno Pedro |  | Nuno Pedro |
|  |  |  |  |
| Project number | 70083589 | 70083589 | 70083589 |
| Report number | 1 | 1.2 | 2.0 |

Contents

Executive summary

[Glossary 3](#_Toc130479029)

[1 Problem Statement 6](#_Toc130479030)

[2 Scope of Work and Approach 8](#_Toc130479031)

[2.1 An innovative approach to ESO-DSO Coordination 8](#_Toc130479032)

[2.2 Project scope 8](#_Toc130479033)

[2.3 Workstream 1 approach 9](#_Toc130479034)

[3 ESO-DSO Coordination in Great Britain 11](#_Toc130479035)

[3.1 ENA’s Open Networks project 11](#_Toc130479036)

[3.1.1 Future Worlds impact assessment 13](#_Toc130479037)

[3.1.2 Consultation on Future Worlds impact assessment 14](#_Toc130479038)

[3.2 ENA primacy rules 14](#_Toc130479039)

[3.3 DSO and ESO projects to support coordination across networks 15](#_Toc130479040)

[3.4 Future System Operator 16](#_Toc130479041)

[3.5 Ofgem 17](#_Toc130479042)

[3.5.1 Future of local energy institutions and governance 17](#_Toc130479043)

[3.5.2 Future of Distributed Flexibility 17](#_Toc130479044)

[3.6 Key conclusions 18](#_Toc130479045)

[4 European Union Developments 20](#_Toc130479046)

[4.1 EU projects – overview and findings 20](#_Toc130479047)

[4.2 Key conclusions 22](#_Toc130479048)

[5 Stakeholder Consultation 24](#_Toc130479049)

[5.1 Purpose 24](#_Toc130479050)

[5.2 Consultation process 24](#_Toc130479051)

[5.2.1 Identification of key stakeholders 24](#_Toc130479052)

[5.2.2 Format and scope of engagement 25](#_Toc130479053)

[5.3 Emerging themes from stakeholder consultation 25](#_Toc130479054)

[5.4 Emerging key themes 26](#_Toc130479055)

[6 Development of Coordination Schemes 28](#_Toc130479056)

[6.1 Scheme identification 28](#_Toc130479057)

[6.1.1 Single entity led schemes 28](#_Toc130479058)

[6.1.2 Joint coordination schemes 29](#_Toc130479059)

[6.2 Scheme 1: Enhanced coordination 30](#_Toc130479060)

[6.3 Scheme 2: Distributed flexibility coordinator 30](#_Toc130479061)

[6.4 Roles and Responsibilities 31](#_Toc130479062)

[6.5 Data management and information exchange 32](#_Toc130479063)

[7 Workstream 2: Techno-economic analysis and modelling 34](#_Toc130479064)

[7.1 Enhancing the model 34](#_Toc130479065)

[7.2 Developing the energy system scenarios 35](#_Toc130479066)

[7.3 Running the model 35](#_Toc130479067)

Glossary

|  |  |
| --- | --- |
| **Term** | **Definition** |
| ADE | Association for Decentralised Energy |
| ANM | Active Network Management |
| BEIS | Department for Business, Energy and Industrial Strategy |
| CIM | Common Information Model |
| DER | Distributed Energy Resource |
| DNO | Distribution Network Operator |
| DSO | Distribution System Operator |
| ENA | Energy Networks Association |
| ENTSO-E | European Network of Transmission System Operators for Electricity |
| ESO | Electricity System Operator |
| FSO | Future System Operator |
| ICL | Imperial College London |
| IWES | Integrated Whole Energy System |
| Ofgem | Office of Gas and Electricity Markets |
| ON | Open Networks (ENA initiative) |
| NGED | National Grid Electricity Distribution |
| NGESO | National Grid Electricity System Operator |
| STOR | Short Term Operating Reserve |

|  |
| --- |
| *Executive summary*  The increase in Distributed Energy Resources (DERs) connecting to the distribution networks increases the ability of National Grid Electricity System Operator (ESO) and the Distribution Network Operators (referred to as Distribution System Operators – DSOs – reflecting their future role) to utilise flexibility services to manage and operate their networks. Coordinating DERs to provide flexibility services to both transmission and distribution networks, while minimising conflicts and enhancing synergies will be complex and challenging.  The ESO and National Grid Electricity Distribution (NGED) have engaged WSP and Imperial College London (ICL) to deliver the Commander project that will undertake techno-economic analysis and an impact assessment of several preferred ESO-DSO coordination schemes and then develop an engineering roadmap for the preferred scheme. It is expected that the roadmap changes could be scaled up to be applied across other DNOs as well.  This report presents the outcomes of Workstream 1 in which we carried out a literature review and stakeholder engagement to inform the selection of ESO-DSO coordination schemes to assess in later workstreams. To do this we reviewed the most relevant information about previous coordination projects undertaken in GB and the European Union (EU) and engaged with stakeholders to confirm the characteristics of the preferred schemes.  It is apparent that, although there is a strong preference in GB for coordinated whole system arrangements, there are some differences between stakeholder groups regarding the split of responsibilities between parties. For example, DNOs may prefer to lead coordination of DERs, since they have greater visibility of these assets and pre-existing stakeholder relationships. In addition, activities to date in both GB and the EU have identified similar system and operational challenges with whole system coordination solutions, such as forecasting accuracy, network visibility and the role of regulation.  Workstream 1 undertook theoretical selection and development of two schemes for further analysis during the project. The “single entity led” type of schemes, characterised by the primacy of either DSO or ESO in access to DERs, have been rejected for further analysis due to a number of identified risks, such as institutional and operational conflicts and sub-optimal utilisation of DERs. The two developed schemes are:   * Scheme 1 – Enhanced Coordination, ESO and DSO manage access to DERs via a set of primacy rules and share and/or hold DERs capacity, supported by data management processes agreed with the wider industry; and * Scheme 2 – the newly created role of Distributed Flexibility Coordinator supervises and manages access to DERs, in close collaboration with ESO and DSOs, and ensures settlement and compliance, as well as information transparency and visibility.   Workstream 2 will focus on techno-economic modelling of the two preferred schemes using ICL’s Integrated Whole Energy System (IWES) model, which is a least-cost optimisation model that can simultaneously minimise long-term investment and short-term operating costs across the whole energy system. The IWES model will be used to assess the coordination schemes under different scenarios and sensitivities to understand their performance characteristics and effects on how energy systems should be developed and operated.  Workstream 3 will provide an impact assessment of the two preferred schemes. This will include qualitative measures, based on the most relevant criteria, and quantitative assessments, where possible providing an indication of cost to deploy each scheme. This workstream will create a preferred scheme, based on both this analysis and the whole-systems costs developed in Workstream 2.  Finally, Workstream 4 will develop an engineering-based roadmap for implementing the preferred scheme. This will include a time-sequenced series of tasks required for scheme delivery, high-level assessment of ability to deliver against required tasks and identification of the highest priority elements to implement. |

Contact name

Nuno Fernandes Pedro

nuno.pedro@wsp.com

**Beth Hanna**

[Beth.hanna@wsp.com](mailto:Beth.hanna@wsp.com)

# Problem Statement

A growing number of Distributed Energy Resources[[1]](#footnote-2) (DERs) connected to distribution networks create both opportunities and challenges for the ongoing energy system transformation. The proactive management of DERs to provide market-based ancillary services to both transmission and distribution networks could influence better flexibility services, leading to a more efficient utilisation of existing and new network capacity, reducing capital costs to connect these DERs to the network, and enabling more efficient operation of the whole energy system to support decarbonisation strategies. However, coordinating DERs to provide flexibility services to both transmission and distribution networks will be complex and challenging.

National Grid Electricity System Operator (ESO), which operates the GB electricity transmission network, has historically used transmission connected generation to manage system frequency by balancing demand and generation as well as managing system security and constraint issues. Decommissioning of large transmission connected generation and the growing number of DERs connecting to distribution networks, mean it is becoming increasingly important that ESO also has visibility of and ability to utilise DERs for network balancing services.

Distribution Network Operators (referred to as Distribution System Operators – DSOs – reflecting their future role) are also transitioning to more active management of the challenges posed by a growing number of DERs. Currently, ESO and DSOs have separately sought to access and utilise DERs’ flexibility services to manage their networks:

* ESO‘s main route for accessing DER is through direct contracts with flexibility providers for services such as reserve and response, frequency management and managing network both pre- and post-fault constraints.
* DSOs have used “non-firm” connection agreements to manage DERs’ use of their networks and entered into agreements to directly procure flexibility services for managing local distribution constraints and local system restoration, if required

ESO and DSOs both utilising DERs flexibility services for separate purposes can result in conflicts between one or more services, leading to inefficiencies within the electricity system. An operational example of those conflicts would be the interaction between ESO’s need to access DERs for Short Term Operating Reserve (STOR) and DSOs’ Active Network Management (ANM) schemes to manage flow across distribution networks. Hence, managing service conflicts and operational optimisation efficiently and transparently while facilitating the potential for flexibility market platforms is of great importance.

In addition to managing conflicts, there are potential opportunities for synergies between ESO and DSO actions, leading to more efficient and lower cost outcomes than can be achieved through separate, uncoordinated actions. Further, from transmission and distribution investment planning perspectives, the whole system coordination and system optimisation could lead to a more efficient use of network capacity, allowing more DERs to connect, while reducing required capital investment.

Investigating a pathway for a more coordinated and cost-effective approach to utilise DERs flexibility services by both DSOs and ESO could benefit end consumers by unlocking DERs’ flexibility potential. This project aims to identify and examine several ESO and DSO coordination schemes and outline an engineering-based roadmap to implement the preferred scheme. Removal of barriers through efficient coordination mechanisms will generate greater market access and competition for DERs. Facilitating these connections will play a key role in driving the whole energy system’s transformation towards Net Zero.

# Scope of Work and Approach

In order to optimise the use of DERs, flexibility providers should be able to provide services to multiple entities, which means **efficient coordination between ESO and DSOs** is critically important when accessing DERs, both when contracting for services from the same asset and when different assets could be in conflict. Therefore, the objectives of this project are to:

1. develop and test **innovative** **ESO-DSO coordination schemes**[[2]](#footnote-3) for accessing and managing DERs with respect to their qualification, procurement, dispatch and settlement.
2. quantify and assess the **techno-economic feasibility** of the developed coordination schemes for accessing and managing DERs within commercial arrangements, planning and operational timescales, as well as to assess impact of the schemes on future flexibility markets.
3. develop an **engineering-based roadmap and recommendations** for the practical implementation of the preferred ESO/DSO coordination scheme.

## An innovative approach to ESO-DSO Coordination

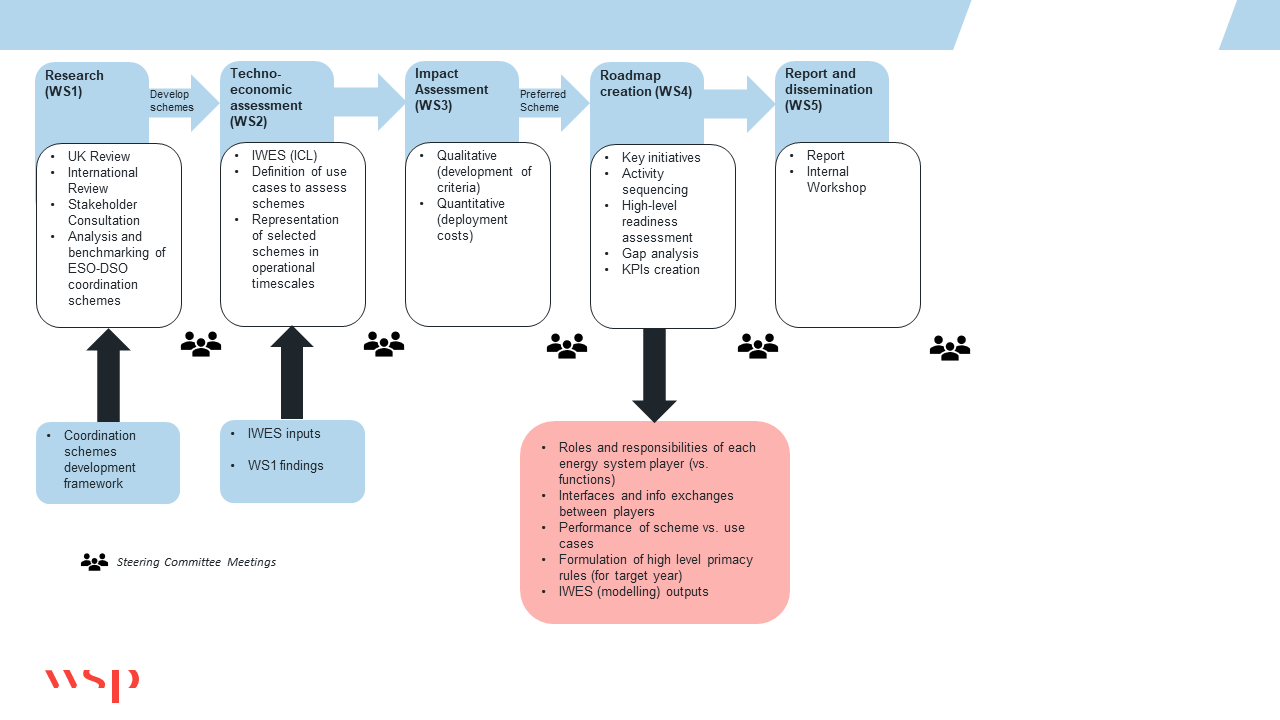
Project Commander has been informed by previous and ongoing industry initiatives that impact the future ESO-DSO coordination space, namely the ENA Open Networks project and the use case-driven primacy rule programme currently being carried out by the network companies. However, Commander also takes a more holistic view of the interaction between whole system and local balancing actions:

* Simulates hypothetical coordination schemes and focuses on a “what if” approach. Unlike industry initiatives aimed at improving ESO-DSO coordination based on current problems, in this project we will focus on envisaging and defining, with the best detail possible, coordination schemes that may enhance ESO-DSO coordination in the energy system in 2035 and 2050.
* Models the future energy system with an objective function focused on cost minimisation under different schemes for operating the transmission and distribution systems. It will also identify use cases that consider whole system management of a range of possible operational conflicts.
* Proposes to deliver a roadmap that supports implementation of technical, commercial and regulatory changes that could be scaled up across GB’s DNO regions and adopted across both ESO the DSOs.

## Project scope

The Commander project is being delivered through five workstreams (WS), as summarised in Figure 2-1**Error! Reference source not found.** and described in more detail in the following section.

Figure 2-1 - Summary of overall approach



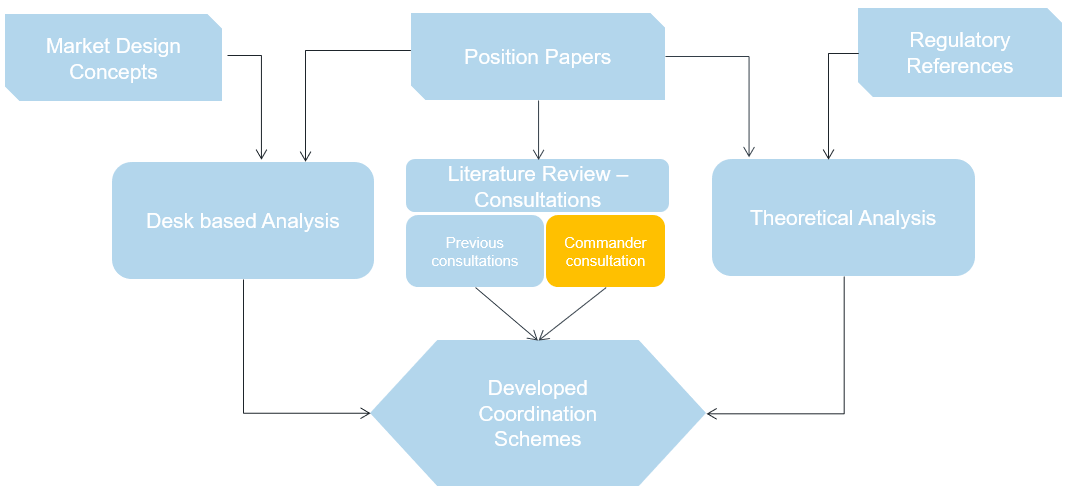
The purpose of each WS is to:

* WS1: Undertake a literature review and stakeholder engagement to identify alternative ESO-DSO coordination schemes for qualification, procurement, dispatch and settlement of DERs.
* WS2: Perform techno-economic modelling of the whole electricity system to quantify and assess the feasibility of the schemes identified in WS1 for accessing and managing DER services in operational time scales.
* WS3: Undertake an impact assessment of the identified coordination schemes using a combination of quantitative assessment of the relative costs and benefits and a qualitative assessment across criteria that will be informed through stakeholder feedback.
* WS4: Develop an engineering-based roadmap and recommendations for the practical implementation of the preferred scheme identified through the activities carried out in WS 1-3. This will cover the technical, commercial and regulatory aspects of key activities that need to happen to enable physical deployment.
* WS5: Over the project duration we will complete all reporting and knowledge dissemination required under the Network Innovation Allowance, including project management outputs and the annual and close out reports.

## Workstream 1 approach

This report summaries the activities we have carried out under WS1 and the key conclusions that supported identification of the two ESO/DSO coordination schemes that will be quantitatively assessed in WS2, as described in section 7. Our approach to delivering WS1 is summarised below in Figure 2-2.

Figure 2-2 – Approach for development of coordination schemes



The development and selection of coordination schemes considers inputs from previous projects, literature and stakeholder engagement. For Commander we have undertaken a range of activities, are described in the relevant report sections:

* Section 3 – Review previous and ongoing industry initiatives focused on ESO-DSO coordination, in particular, the Energy Networks Association’s (ENA) Open Networks project developing “Future Worlds” and Ofgem’s consideration of potential DSO models.
* Section 4 – Review of outcomes of international developments relating to coordination between transmission and distribution network operators to identify key issues and learnings that could help inform our choice of preferred coordination schemes.
* Section 5 – Engage key stakeholders (e.g. DNOs and suppliers) through a survey and follow up interviews to understand what they perceive to be the key challenges with the current arrangements and preferences regarding future coordination models.
* Section 6 – Use the knowledge gathered from the research, analysis and stakeholder engagement to develop preferred coordination schemes for assessment in WS2 and WS3.

In Section 7 we describe future analysis to inform our final recommended coordination scheme and the high-level approach for how we will carry out WS2.

# ESO-DSO Coordination in Great Britain

Although ESO-DSO coordination covers a broad range of areas where both ESO and DSOs could coordinate their activities, currently coordination has been mainly around day-to-day operation of the network and addressing network capacity issues due to the large connection of DERs. Examples of this operational coordination include:

* Coordinating interface outages.
* ESO utilising DERs for Short Term Operating Reserve (STOR) and frequency response, i.e. Dynamic Containment (DC), Dynamic Regulation (DR), Dynamic Moderation (DM) and Firm Frequency Response (FFR) in network constrained areas where DSOs have contradictory requirements.
* Using DERs for voltage support through the joint ESO and UK Power Networks Power Potential innovation project.

In this chapter we summarise initiatives that have focused on identifying and assessing approaches to ESO-DSO coordination, both at a whole system level and to address individual issues.

## ENA’s Open Networks project

In 2017, after consulting industry experts on a number of future market models[[3]](#footnote-4), the ENA launched the Open Networks’ Future Worlds project that considered how future industry needs could be met by flexibility markets. The aim was to identify market structures that could facilitate services from DERs for national and regional (i.e. transmission and distribution) needs. Workstream 3 was focused on the DNOs’ transition to a DSO role where they will be responsible for:

* Coordinating the transfer of power between local and regional networks, ensuring secure and efficient real-time operation of distribution networks, and identifying capacity requirements.
* Providing new distribution network connections and managing connection agreements.
* Enhancing system securing and resilience.
* Defining distribution network service requirements and assessing the value of flexibility.
* Ensuring the availability of services to support network operation.
* Setting charges for the use of their networks.

Table A8-1 in Appendix A includes a detailed description of each function as defined in Open Networks Project.

A key output of Workstream 3 was the development of five possible future market frameworks, or “worlds”, which could materialise as part of the DNO transition to DSO and ensure efficient and fair operation of the energy system. For each world a set of functions were also developed, including system coordination, network operation, investment planning, connections and connection rights, system defence and restoration, services/market facilitation, service optimisation, and charging.

Each of the five worlds are summarised below, with detailed descriptions included in Table A8-2 in Appendix A:

1. World A: DSO coordinates – the DSO procures and activates these resources based on a pre-defined power exchange schedule agreed with the ESO.
2. World B: Coordinated procurement and dispatch – the ESO and DSO both procure and collaborate with each other to activate flexibility resources.
3. World C: Price driven flexibility – network access and forward-looking charging reforms reduce the need for the system operators to directly procure flexibility resources.
4. World D: ESO coordinates – the ESO procures and activates resources, while the DSO indirectly procures them through the ESO.
5. World E: Flexibility coordinators – independent flexibility coordinators operate the flexibility market in a neutral and transparent manner, and both the ESO and DSO indirectly procure and activate resources through these coordinators.

To simplify our analysis of advantages and disadvantages of the five worlds and support engagement with stakeholders, we have grouped them based on the three core architectures of ESO-DSO coordination schemes – ESO driven, DSO driven and joint coordination – and summarised main advantages and disadvantages in Table 3-1.

Table 3-1 – High-level summary of strengths and weaknesses of Future Worlds

|  |  |  |
| --- | --- | --- |
| Architecture | Strengths | Weaknesses |
| DSO Driven | * Potential to achieve the highest level of efficiency in orchestration of distribution network controllable assets and DER dispatch. * Opportunity to re-optimise distribution network assets. * Utilises DSOs’ knowledge of their own distribution network’s operation. * No exchange of distribution network operational data with the ESO. * Less computational and modelling requirements (restricted to each DSO). | * Possible conflict of interest for the DSO when managing network assets and validating DERs’ services bids (could be solved with an independent DSO). * Complex computational and modelling challenges with validating DER bids. * Incorporation of distribution-level markets adds complexity. * Lack of experience of the DSO on market processes (e.g. market design, market clearance). * DSOs might not push network assets to their limits that could reduce their lifetime, leading to reduced DER services. |
| ESO Driven | * Having a central entity responsible for whole system decision processes could simplify ESO-DSO coordination. * Faster and more straightforward adoption of new standards. * ESO can expand existing platforms and make the most of distribution assets without the same conflict of interest. * ESO is already experienced with managing procurement and dispatch. | * Risk of less efficient facilitation of services by DSO. * Less effective orchestration in cases where ESO cannot control DSO assets. * Computational and modelling challenges in validating and dispatching both transmission and distribution networks. * Increased difficulty in coordinating the system with increased DERs penetration. * Significant volume of real-time operational data to be transferred from DSO to ESO. * ESO is unfamiliar with interpreting distribution network requirements. |
| Joint coordination | * DSO can manage its controllable assets more efficiently than ESO-managed model and ESO can manage whole system issues more effectively. * Results in the most efficient solutions from a whole system perspective. * Elimination of the need for the DSO to transfer operational data to the ESO. | * Coordination between ESO and DSO becomes complex as decision processes are not centralised in one entity. * Increased regulation required to manage potential conflicts of interest in decision making (either of the DNOs or the independent coordinator). * Computational and modelling challenges due to the significant scale of the distribution network managed by individual DSOs. |

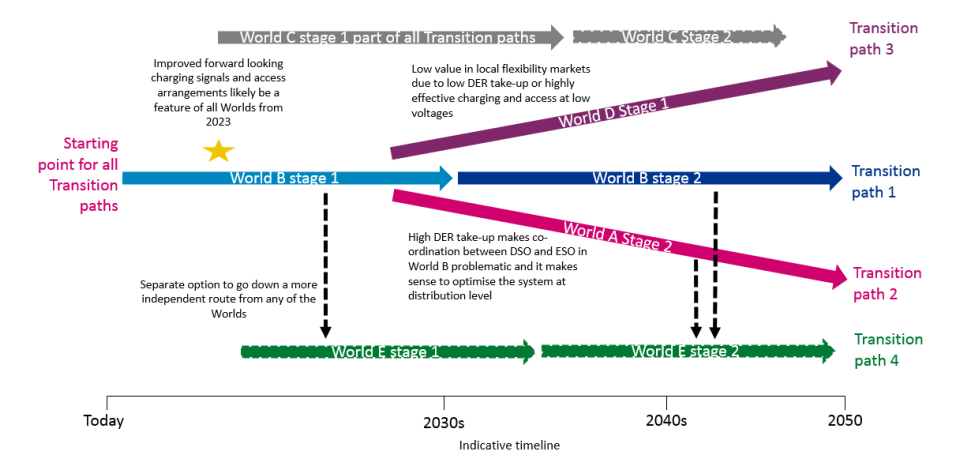
### Future Worlds impact assessment

In 2019, the Open Networks project commissioned an independent impact assessment of the relative costs and benefits of the five worlds[[4]](#footnote-5) to highlight their strengths and weaknesses and impact on network operators and users. This was supported by stakeholder engagement, to generate feedback on both the worlds proposed and the methodology of the impact assessment.

For the impact assessment it was assumed that World C would not represent a stand-alone world but instead act as a component of all other future worlds. Additionally, each of the other four worlds was split into two stages of development; stage 1 where coverage is limited, and stage 2 where the full scope of each world is realised.

The impact assessment built on previous views that the four worlds were all plausible with each offering potential benefits over the others by presenting four potential transition paths, spanning from the present day until 2050. These were created to demonstrate decision points, which might lead to transition from one world to another, as outlined in Figure 3-1. The transition pathways were designed around the assumption that the starting point is World B (stage 1), which was assumed to most closely align with current arrangements.

Figure 3-1 - Potential DSO transition pathways and triggers



### Consultation on Future Worlds impact assessment

As previously indicated, the impact assessment was accompanied by stakeholder engagement. Key points that emerged from the individual responses included:

* Some respondents did not consider World A to be a viable option and it was recommended for removal or defocus in future work.
* There was general support for the approach of removing World C as a standalone option, and instead incorporating elements in all other worlds.
* The majority of respondents agreed to some level that the transition paths should start in stage 1 of World B (indicating that this most closely represents the current situation), although some stakeholders contended that present day status is closer to World D (stage 1), and that this should be reflected in the transition pathways presented.
* Timescales suggested in the pathways were considered too long by some, with others questioning the need to consider regional differences in timescales for transition (for example, due to different uptakes in technologies across licensed areas).

## ENA primacy rules[[5]](#footnote-6)

In 2021, the ENA Open Networks group commenced work on “Primacy Rules”, which seek to manage service conflicts between ESO and DSOs. The group identified use cases for situations where there could potentially be conflicts between ESO and DSO services required from DER and developed primacy principles that use cases needed to facilitate:

* Deliver the least Whole Electricity System cost to consumers
* Facilitate Fair, Accessible and Efficient markets
* Be clear, transparent, consistent, inclusive and deliverable.

The Primacy Rules working group then assessed the use cases against positive and negative criteria to identify those use cases that would be taken forward for assessment, with the initial three uses case looking at the following services using different assets in the same area:

1. STOR and generation led ANM
2. DNO services and the transmission constraint management service
3. BM and generation led ANM.

The assessment seeks to identify the economic impact of the primacy rules to mitigate each conflict on relevant parties in order to understand what option delivers the mode efficient outcome for end consumers. The outcomes of this Open Networks project is relevant for Commander and can provide useful insights, but it is focused on resolving individual use cases in detail, rather than applying a holistic approach to actively coordinating system needs.

## DSO and ESO projects to support coordination across networks

In addition to the Future Worlds and primacy work that network operators have all contributed to, some network operators are undertaking individual projects to explore ways to support cross-network coordination. Key relevant projects by DSO include:

* **Scottish & Southern Electricity Networks (SSEN):** Transition[[6]](#footnote-7) is SSEN’s project that commenced in 2021 and is focused on undertaking live trials. Most recently, SSEN has partnered with the Local Energy Oxfordshire (Project LEO), with an objective to explore the most effective system architecture, tools, platforms, and market mechanisms required to enable the transition from DNO to DSO. This has resulted in development of the Neutral Market Facilitator (NMF) platform, used in flexibility trials across Oxfordshire.
* **UK Power Networks (UKPN)[[7]](#footnote-8):** The Power Potential project was a live system trial that demonstrated a world-first regional reactive power market through a partnership between ESO and UKPN. In addition to the reactive power market, the project illustrated the principle of a whole system operator enabling DER on the distribution network to deliver dynamic voltage control for transmission constraints.
* **SP Energy Networks (SPEN)[[8]](#footnote-9):** FUSION has been trialling local demand-side flexibility through a structured and competitive market, based on the Universal Smart Energy Framework. This included an open tender for flexibility procurement conducted in East Fife, with interactions managed using a cloud-based platform. This project also assessed potential primacy rules, intended to manage conflicts between DSO and ESO, for the specific use case of STOR vs ANM[[9]](#footnote-10).
* **NGED[[10]](#footnote-11):** Electricity Flexibility and Forecasting Systems was created to provide more accurate forecasting of network constraints. Additionally, focus was given to determining optimal arrangements for coordination and conflict resolution, with a suggested methodology based on comparison of marginal cost for both parties. This project did not include creation of a trading platform, to avoid duplication of other projects.
* **NGED[[11]](#footnote-12):** A project was completed to address coordination between ANM schemes and the balancing market, with the aim to reduce consumer costs and risks to security of supply. World B from the ENA’s Future Worlds was used to assess the impact. Some shortlisted solutions included reconfiguration of ANM schemes to hold headroom, preventing counteraction of balancing services, improved information exchange between DNOs and generators, and changes to balancing services procurement which allow the ESO to factor in risks of curtailment. Benefits of improving coordination were estimated to range between £40m and £110m per year.
* **ESO, NGED & UKPN[[12]](#footnote-13)**: Regional Development Programmes (RDP) developed the MW dispatch service, aimed at DER of greater than 1MW whose power output may be curtailed following ESO instruction to manage transmission constraints and defer reinforcement. Compensation is then agreed with the DER based on the level of curtailment. This is designed to allow the DER to fulfil obligations to a DDO and then subsequently partake in the ESO service. The DER is required to provide operational visibility and commercial controllability as a condition of their connection agreement, facilitated through the DSO’s ANM systems. This service is intended to provide a lower capital investment cost than other services (e.g. Balancing Mechanism), making it more viable for smaller DERs to participate. Further findings from the workstream were that data exchange mechanisms for local transmission data should be put in place[[13]](#footnote-14) and ESO are deploying control room processes that actively consider Primacy Rules as part of decision making, trialled under the MW dispatch programme[[14]](#footnote-15).

## Future System Operator[[15]](#footnote-16)

In July 2021, the Department for Business, Energy and Industrial Strategy (BEIS)[[16]](#footnote-17) and Ofgem launched the Future System Operator (FSO) consultation with the aim of creating an impartial body with responsibilities across the electricity and gas systems. The FSO is intended to drive progress towards Net Zero while maintaining energy security and minimising costs for consumers and would take a whole energy system approach when operating, planning, and developing the network.

In their decision, BEIS and Ofgem set out expectations regarding the FSO including that it will be a public corporation, with operational independence from government, which will be licensed and regulated by Ofgem and funded through price control agreements. The new company will be founded on existing capabilities and functions of ESO and National Grid Gas, with a phased implementation.

There was strong agreement from the consultation that the FSO should coordinate with DSOs to ensure optimal system-wide planning, with some respondents suggesting that data sharing will play a key role in this coordination. There was a mixed response to the FSO taking on DSO roles, with some citing lack of regional expertise and existing stakeholder relationships.

## Ofgem

### Future of local energy institutions and governance

In April 2022, Ofgem issued a Call for Input CFI) on the future of local energy institutions and governance, focusing on effectiveness of these arrangements at a sub-national level[[17]](#footnote-18),[[18]](#footnote-19). Ofgem received responses from 73 stakeholders with general confirmation that the current institutional arrangements need to be reviewed, but notable differences across energy system functions and wide-ranging views on where attention should be focused.

On 1 March 2023, Ofgem published a consultation[[19]](#footnote-20) setting out their proposed reforms. The key components are:

* Energy system planning: introduce Regional System Planners (RSPs) to ensure there is accountability for regional energy system planning
* Market facilitation of flexible resources: assign a market facilitation function to a single entity with sufficient expertise and capability to deliver more accessible, transparent and coordinated flexibility markets.
* Real time operations: keep real time operations within the DNOs, ensuring clear accountability for network reliability and safety.

Ofgem also indicated they consider the FSO taking on the RSP and market facilitation roles to be their lead option, via additional licence obligations. This is because they consider both roles to have strong synergies with the FSO’s national functions and would support greater local and national consistency and coordination. However, Ofgem is seeking input from stakeholders on their proposals, including whether another entity could undertake the RSP and market facilitation roles.

### Future of Distributed Flexibility

In March 2023, Ofgem conducted a CFI on the Future of Distributed Flexibility, with focus on the role of digital energy infrastructure to facilitate increased flexibility market liquidity[[20]](#footnote-21). This CFI presents four potential archetypes which represent varying degrees of intervention and technical functionality. These are summarised as:

1. **Business as usual (BAU)**: Developing from the status quo with no strategic intervention, this represents multiple individual markets with varying arrangements and levels of evolution. This assumes a lack of any consistent coordination; while some markets may coordinate bilaterally, this will not be uniform, resulting in unevenness.
2. **Thin**: A directory is used to assist market participants in understanding the market landscape. However, there is no common point of access to join markets, or established coordination mechanism, unless bilateral action is taken. Market conflicts would not be revealed until real time operational disfunction occurs (outside of bilateral agreements and sharing).
3. **Medium**: This involves creation of a singular and scalable digital location where markets are visible and coordinated under a known governance framework. Outside of this, markets are able to retain their own designs, platforms and systems. This exchange would play a role in flagging conflicts at competition or dispatch stage for participants to remedy offline, based on transparent market positions and actions.
4. **Thick**: Central platform for end-to-end delivery of flexibility. It is expected that all processes being managed centrally would allow for full market optimisation (with all markets cleared simultaneously, with consideration of whole-system management). The central platform gives notification of conflicts and seeks to resolve these though optimisation.

From analysis of these, the BAU and Thin options would be considered sub-optimal for delivery of flexibility, given the position taken of either no or minimal coordination. The other archetypes are more desirable, easing market access and assisting with the drive towards Net Zero.

A qualitative assessment of the archetypes is included in the CFI. The Thick option scores more favourably in “Market coordination of operations and access” and “Trust and governance” categories in comparison to the Medium option. However, the assessment identifies that the Thick option will be challenging to achieve, particularly regarding time and cost of delivery, requirements on external dependencies (data visibility initiatives) and adaptability.

## Key conclusions

Although it did not reach a final preferred option, the Open Networks Future Worlds work has converged on World B, at least as a starting point for further whole system development, as its successful delivery is the most likely solution to create efficient use of resources and lower consumer costs. Stakeholders have also generally been supportive of World B, although with differing opinions about how the system might develop to resemble the other worlds more closely in the future. However, there was strong opposition towards World A.

Stakeholders who support World E consider that independence is an important factor in how flexibility services are accessed and paid for and, therefore there should be an independent flexibility coordinator.

Under all options, conflict management will be key in a system where more actors are granted agency, with supporting mechanisms such as data sharing and interoperable platforms playing a key role in delivery of system-wide flexibility coordination. We have reviewed a number of innovative projects that ESO and DSOs have undertaken exploring aspects of ESO-DSO coordination, including communication systems, power markets and live trials. All of these have successfully demonstrated the benefits of joint coordination, but, as each has been focused on specific issues, there is currently still limited evidence of how these solutions could be combined and scaled up to form an integrated whole system solution.

More recently, Ofgem has been exploring the future roles and responsibilities of different parties in relation to distributed flexibility and market integration. Ofgem’s current position indicates they consider there to be a need for an independent party to manage the flexibility market, including regional development, which is compatible with the independent flexibility coordinator role. This role could potentially be carried out by the FSO, although Ofgem is currently consulting on the potential for it to be filled by other third parties instead.

In addition, Ofgem’s Future of Distributed Flexibility CFI identified a number of different archetypes for market integration. The Medium and Thick archetypes deliver robust solutions, which are an exchange where markets are coordinated and conflicts are flagged and resolved ahead of dispatch, or a centralised platform which allows for co-optimisation of markets, based on system requirements and final costs.

The direction of travel in GB is very strongly towards a jointly coordinated approach, with roles for both an independent coordinator and the network companies, supported by a centralised market platform (although the level of centralisation could vary). We have used the outcomes of this literature review, to help inform our development of preferred coordination schemes, as described in section 6.

# European Union Developments

This section provides an overview of projects being carried out in the European Union (EU), focused on TSO-DSO coordination schemes, with identification of any key challenges or lessons that could inform development of the schemes being assessed in this project.

## EU projects – overview and findings

EU initiatives, such as the Green Deal and REPowerEU, that aim to end the EU’s reliance on foreign fossil fuels require a digital and sustainable transformation of the energy system. To achieve this, Horizon Europe, the EU’s key funding program, has enabled the research and development of various TSO-DSO coordination schemes such as SmartNet and CoordiNet. In addition, the ENTSO-E and EU DSOs are actively collaborating to harmonise cooperation between transmission and distribution network operators to enable the transition to Net Zero by 2050.

We have reviewed the following key EU research projects, which suggest the effective implementation of TSO-DSO interaction using flexibility resources can mitigate network issues. The key conclusions from each project are summarised in Table 4-1.

Table 4-1 – Summary of EU project findings

|  |  |
| --- | --- |
| Project | Findings |
| SmartNet[[21]](#footnote-22) [[22]](#footnote-23) | * Project compares four different coordination schemes with use cases of three EU countries * Whole system approach and all its components need considering for the development of coordination schemes and real-time market architectures. * Forecasting errors in flexibility procurement can hurt the coordination process. Risk mitigations include bringing gate closure as close to real-time as possible, increasing market clearing frequency and improving forecasting capabilities. * Decentralised schemes are less efficient overall, requiring additional coordination measures. A “common marketplace” is the preferred solution. * Regulatory guidelines were developed based on these results. * Stakeholder feedback indicates a preference for the “Common TSO-DSO AS market model”, highlighting advantages such as common optimisation[[23]](#footnote-24). Additionally, most respondents agree that the DSO should remain separated from balancing responsibilities. |
| CoordiNet[[24]](#footnote-25) [[25]](#footnote-26) | * Adequate network visibility & automation of operator interfaces are essential for coordination schemes. A central data hub was incorporated, which proved valuable in assisting with sharing and handling of data. * Cascading market closing times is an effective strategy. Also, day-ahead markets should be complemented with intra-day markets. * There are four classification layers considered in the developed TSO-DSO coordination models: whole system needs, buyer, number of markets and flexibility resource access. * Flexibility providers can easily underestimate the time and preparation needed to provide flexibility. * Compatibility of the business use case with regulations is essential. |
| EU-SysFlex[[26]](#footnote-27) | * Data exchange should be aggregated to reduce complexity. * System operators should inform connected grids about available flexibility potential. * Flexibility selection and activation should be carried out by the system operator where the flexibility is connected. * German demonstrator using a decentralised optimisation approach, with principle of “local before regional”, was proven to be highly resilient, efficient and secure. * Aggregation platforms with standardized interfaces and communication are important for scalability and replicability. * Forecasting and optimization of distributed energy resources should be developed for successful market operation. * The process for flexibility selection and activation should be automated for efficient and effective DSO/TSO coordination. * Ancillary market rules should be developed to allow smaller units and new types of assets. * Increased system observability in distribution grids should be achieved. * More accurate forecasting of market prices and algorithmic features for market bidding strategies and handling forecast uncertainty can improve overall performance of the VPP. |
| NorFlex[[27]](#footnote-28),[[28]](#footnote-29) | * Preferred market architecture for flexibility is the one where both DSOs and TSO can procure flexibility from distributed sources. Procurement by local flexibility markets, rather than direct participation of distributed resources, is preferable as a transition measure (i.e., cascade market architecture) * Significant challenge in the development of the flexibility market was overcome by the deployment of additional sensors across the entire network to enhance observability and improve congestion forecasting capabilities. * Business models for FSPs require a lot of development in intelligence of portfolio optimisation and lag advanced tools of DNOs who can already settle bids using automated algorithmic traders. * Business case for flexibility provision negatively impacted by high costs of advanced technological solutions, and would require financial support. * Standardisation regarding data formats and communication protocols is a significant barrier for the development of flexibility markets incurring complexity and additional costs. Data exchanges between DSOs and TSOs need to be harmonised to a CIM in the long term. * Flexibility for solving congestions in the distribution system was priced higher than flexibility provision for system balancing. Increased competition for services connected to distribution network will improve the situation. |
| GOPACS[[29]](#footnote-30),[[30]](#footnote-31) | * GOPACS is one of the first TSO-DSO coordination platforms implemented for solving network congestion, resourcing flexibility from existing market platforms. * Platform design retains system balancing at its core, due to initial development to serve TSO requirements. * Standardisation of flexibility products and procurement processes for long term contracts is crucial. * Coordination between different markets for procurement of flexibility from distribution connected assets is important. * Coordination in GOPACs between DSOs and TSO is not wholly automated, based on current limitations of DSO digital capability. GOPACs uses hierarchy rules to disqualify orders which could cause congestion in other areas/networks * Frequency response was identified as the most important network service from DERs, while inertia response may be required in the far future. |
| NODES[[31]](#footnote-32),[[32]](#footnote-33) | * NODES is a flexibility market platform deployed in various pilot projects, including IntraFlex (WPD) * Automation of pre-qualification procedures and trading functions is key to successful local flexibility markets, as are DSOs' operational security processes. * The lack of regulatory incentives for exploiting flexibility and inadequate technical sophistication of DSOs are the two most significant barriers to the development of local flexibility markets. Incorporation of flexibility incentives in long-term network planning should be implemented. * APIs are the preferred option for automating data processes, and data harmonisation should involve FSPs as an integral part of the process, rather than being enforced from top-down. * Contracts of different temporal scales are beneficial for flexibility assets. * Evolution of NODES pilot projects towards a business-as-usual state and the revision of national regulatory frameworks for DSOs towards a more TOTEX approach are anticipated to feature in future work. * Independent operators of local flexibility markets offer impartiality, whereas if operated by network operators, the buying side may achieve a dominant position which could impact market liquidity. |
| DA/RE[[33]](#footnote-34) | * IT platform which facilitates coordination between TSOs, DSOs, generation and storage in Baden Wuertemburg (TransnetBW control area), focused on congestion management scheme. * Issues instructions based on central optimisation algorithm which analyses redispatch requirements, cost data submitted by generators and availabilities. This is achieved while accounting for network restrictions of all participants. * DSOs are required to implement required data exchanges, which were not in place prior. |

## Key conclusions

The EU TSO-DSO coordination projects highlight several preferences and technical requirements for future implementation. In terms of preferences for market structures and overall coordination mechanisms, the following conclusions can be reached from the projects surveyed:

* Stakeholder feedback from both SmartNet and NorFlex indicates a preference for TSO-DSO joint coordination, with selected models sharing assumptions with the ENA Open Networks’ Future World B. A perceived advantage of these coordination mechanisms is the ability to incorporate common optimisaton across all networks. This preference aligns with the GB perspective and will be taken into consideration for scheme selection in this project.
* It was identified that a potential transition measure towards a joint coordination model is a cascade market architecture, whereby procurement is achieved through local flexibility markets rather than allowing direct participation of distribution connected sources.
* Centralised schemes were identified as being more cost-effective than decentralised options, which introduce extra coordination steps, reducing overall efficiency. The lower cost option is to create a “common marketplace” solution, which share similarities with the Medium and Thick archetypes in Ofgem’s CFI.
* In terms of market structure, it is recommended to complement existing day-ahead markets with other products, such as intra-day markets, to achieve the most efficient use of flexibility resources through use of closer to real time procurement and dispatch.
* Market platforms identified could be based on optimisation, using all available information about constraints, costs and availability, or could use hierarchy rules (similar to primacy rules) to make determinations about orders which could have adverse impacts on other grids.

The literature review also identified several technical requirements, which must be met to successfully deliver flexibility coordination. These include:

* Forecasting errors introduced within the procurement stage can negatively affect the coordination process. Recommended mitigations for this include bringing gate closure as close as possible to real-time and improving forecasting techniques and algorithms. Risk assessment around the ability to robustly forecast should also be incorporated into the process, based on technology type.
* Adequate network visibility, enhanced by data capture and sharing, is vital for effective coordination. This is a key challenge with achieving greater ESO-DSO coordination in GB, where visibility of DER at lower voltages is currently limited.
* Automation of operator interfaces, including during flexibility selection and activation processes, will allow for more effective real-time management of networks. To support this, the preferred solution is to implement robust APIs.
* Platforms used to facilitate flexibility should have standardised interfaces and communication, which will allow for scalable and replicable solutions, aligned with the CIM concept. Data harmonisation should involve input from FSPs to capture requirements from outside of network operators.

These more technical requirements will not be considered within the techno-economic modelling of WS2. However, the impact assessment conducted in WS3 will identify the key requirements across all of these areas for successful delivery of the two selected schemes.

# Stakeholder Consultation

## Purpose

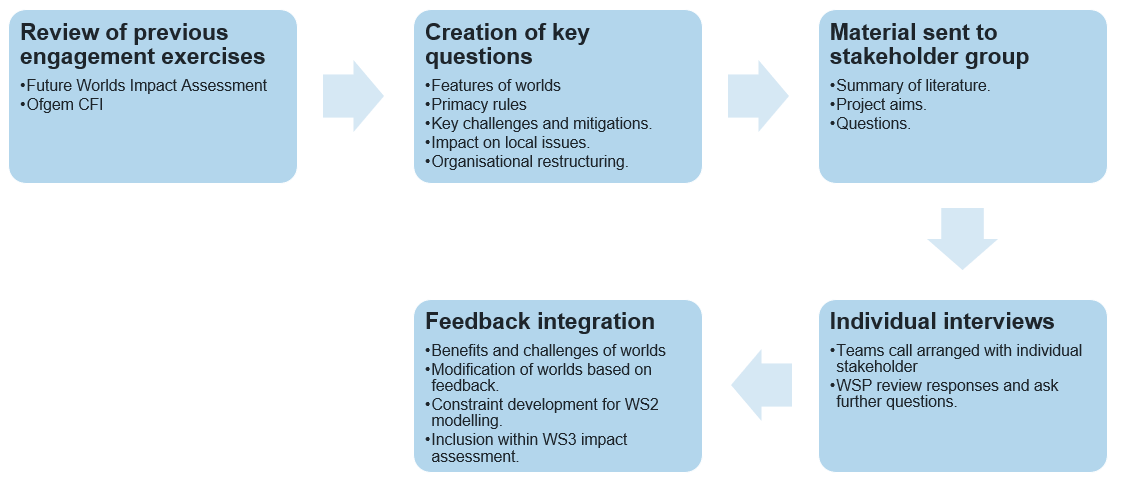
In addition to the literature review, we undertook stakeholder consultation to target key uncertainties in the evolution of ESO-DSO coordination, and provide further definition of the expected roles, responsibilities, accountabilities, and requirements for coordination schemes. Stakeholder responses will help shape the schemes which are explored further within the project, feeding into the modelling and impact assessments being conducted in WP2 and WP3.

The stakeholder consultation process also introduced the Commander project to the wider group of DNOs and aligned it with ongoing work being carried out under the Open Networks project, ensuring it provides additional value and avoids unnecessary duplication of work.

## Consultation process

An outline of the overall consultation process is shown in Figure 5-1 and described in further detail below.

**Figure 5-1 – Summary of stakeholder engagement process**



### Identification of key stakeholders

It was decided to focus this initial engagement on stakeholders who would be most affected by changes required to deliver greater volumes of flexibility in support of a Net Zero energy system on key points which were raised by the Open Networks project since its inception. We engaged with a list of stakeholders agreed with ESO and NGED, including the five other DNOs, Ofgem and the Association for Decentralised Energy. In addition, Energy UK has proposed engagement opportunities with their members, including providing our survey to several domestic energy suppliers and aggregators.

### Format and scope of engagement

It was decided that, given the complexity of the subject matter and likely divergence of views between stakeholders, the best way to gather responses was through a survey. This would give respondents time to consider the questions, consult with relevant colleagues and provide open answers. We also proposed to have follow up interviews to explore further specific points raised on the survey responses.

The survey questions were identified during the literature review described in Chapter 3, which included the Open Networks project and Ofgem’s April 2022 CFI. The full list of questions asked is included in Appendix C.

## Emerging themes from stakeholder consultation

At the time of writing this draft report, responses have been received from two DNOs and one domestic supplier. We recognise that responses received so far will not fully represent the stakeholder groups concerned and should be treated as indicative feedback rather than comprehensively representing different groups’ views.

Significant feedback (i.e. that could change aspects of the schemes being assessed) received after the report is finalised will be presented at the Steering Group meetings. Stakeholder views on key topics received to date are summarised in Table 5-1:

Table 5-1 – Summary of stakeholder views

|  |  |  |
| --- | --- | --- |
| Topic area | DNOs | Domestic supplier |
| Key challenges | * Visibility of data * Information sharing currently limited by data protection and commercial sensitives * Translating market signals across different regions * Lack of market participation/fluidity, caused by investment barriers such as relatively low market value and policy uncertainty * FSPs concentrating on higher value markets (capacity) * Constraint queues preventing asset build * Some internal capabilities are missing and must be developed * Current barriers (e.g. payment resolution) make it simpler to resolve issues within one organisation | * Lack of cohesive framework from which investment decisions can be made * Concern that primacy will not cover fringe events, where a single decision maker may be more appropriate * ESO visibility over resources as smaller DERs become more commonplace. |
| Joint coordination | * Ofgem are planning on basis of World B * This should be easier to standardise * Shared accountability leads to more amicable coordination * Provides greater opportunities to stack revenues and participate in more marketplaces * Knowledge sharing should draw from expertise in multiple organisations * If accountability is lacking for participants, this could lead to change from World B. * Combined service fee may be required so that coordination does not negate ability to revenue stack * Risk that differing DSO response levels could create skewed market geographically | * Capturing full system interactions is integral to optimal balancing approach. * Transmission and distribution connected assets competing should drive balancing costs to optimal level. * One party should have oversight of full system (and take a lead role) |
| Primacy | * This currently provides a focus for networks to achieve cooperation * Difficulty providing counterfactual calculations. * Difficult to determine primacy for each use case. * Primacy holder may switch (e.g. ANM vs STOR could have DSO primacy in short-term and joint primacy in long-term) | * Primacy may not cover all cases leading to uncertainty. * A lead party is required with full overview of all voltage levels. |
| Structural change | * DNO has good synergies (local engagement) to develop flex conversations * DNO/DSO separation is already beginning with separation of market trading functions * Regulators should enforce accountabilities rather than requiring structural change. * DSO should publish as much information as possible so decision making is transparent. * Accountabilities may be less clear under new structures (with higher costs) | * There are conflicts of interest for DSOs to remain part of DNO company. * Preference to combine DSO functions with ESO to form a national system operator which covers all voltages |

## Emerging key themes

* Domestic suppliers favour structural change to mitigate conflicts of interest, while DNOs’ view is that the best functions for delivering local flexibility already exist within the network operators and that Ofgem should manage and regulate accountabilities. Factors relating to institutional rearrangement will be considered in greater detail in WS3 within the impact assessment of each scheme.
* The domestic supplier did not consider the primacy rules to be sufficient to address all conflicts, while the DNOs are supportive of the work they are doing, albeit recognising challenges with case-by-case rulings. Schemes developed in this project will have some basis in primacy work to reflect the ongoing workstream, while also attempting to address potential gaps and risks.
* Both suppliers and DNOs recognise that solutions where both ESO and DSOs collaborate and manage flexibility should deliver the best value for the end customer. However, this coordination approach requires a transparent and robust conflict resolution method if benefits are to be realised. Any techno-economic modelling of coordination controlled by one party performed during this project will result in more expensive system costs. As a result, the schemes developed will align to this viewpoint, while looking to assess challenges of implementation within the impact assessment of WS3.
* Both groups also recognise the challenges posed by a lack of visibility over resources within the current and future energy systems, which needs to be addressed under any coordination scheme. It was also identified that capability building will be required across organisations to facilitate enhanced coordination. These are high priority areas, which will be considered in the WS3 impact assessment of this project.

# Development of Coordination Schemes

The aim of the proposed ESO-DSO coordination schemes is to minimise the overall energy system costs to customers by maximising the whole-system value of flexibility services provided by DER to support efficient system operation and investment in low-carbon technologies and energy security. The schemes are designed to mitigate the operational conflicts between ESO and DSO objectives when utilising DER services. Operational conflicts reduce or nullify the effectiveness of the DER services leading to higher costs and triggering new operational problems. Better ESO-DSO coordination will also improve the efficient use of common resources, minimising service costs and maximising the value of the flexibility assets, which should incentivise further investment across GB.

## Scheme identification

We have used criteria for selecting and developing the coordination schemes to be assessed in WS2 and WS3, namely:

* The cost-effectiveness of the system, as measured in terms of the overall costs for accessing, procuring and activating flexibility resources, as well as any potential benefits to consumers or other stakeholders.
* The level of integration and coordination between the transmission and distribution grids, as this can impact the overall effectiveness of the system in meeting the needs of both transmission and distribution networks.
* Complexity of the market design and operational coordination between parties, as this will affect the feasibility of the proposed scheme and its ability to be implemented.
* The level of transparency of the system’s decision-making process, which is important to ensure participants trust the robustness of the market and how it supports their commercial interests.

### Single entity led schemes

We considered the ENA Open Networks project on developing different worlds and other literature, including the outcome of projects carried out by individual DNOs and developments in the EU. Based on our literature review and stakeholder consultation, we have concluded that “single entity led” coordination raises significant challenges for future-proof ESO-DSO coordination, because:

* **Sub-optimal utilisation of DERs:** these coordination arrangements result in the ESO or the DSO having priority access to the full capacity of a DER or reserving a specific level of capacity, with only the remainder accessible by the other party. This leads to ineffective flexibility markets for DERs, with flexibility providers unable to stack different flexibility services provided by the asset.
* **Higher costs:** the inability of ESO or DSOs to access a wider range of DERs triggers the need for more costly alternatives. For DERs, being unable to provide flexibility services to both ESO and DSO increases market entry barriers.
* **Institutional and operational conflicts:** primacy given to one entity creates a risk of real or perceived conflicts of interest, potentially reducing trust in the market and limiting overall competitiveness of flexibility markets.

### Joint coordination schemes

The remaining relevant schemes are those that assume decisions about which entity has access to DER services happen dynamically as conflicts arise, rather than a DER’s output being pre-assigned to the ESO or DSO. To achieve this, the scheme will need to be underpinned by:

* Visibility of ESO and DSO requirements across all timescales, from long-term planning stages to real time.
* Price-driven flexibility and market-oriented mechanisms that reflect physical world requirements.
* Enhanced communication between ESO, DSO and relevant stakeholders across all timescales.
* Easier access to market for DERs and effective price signals.

In addition, regardless of the details of the specific joint coordination scheme chosen, it will need to include three key aspects that will support development of a robust market with a large number of participants (including smaller flexibility providers):

* **Commercial:** commercial frameworks will be used transparently to minimise end-consumer costs. At a national level, transmission-connected and aggregated distribution-connected flexibility will compete to provide services needed by both ESO and DSOs. At a local level, regional markets would be set up to allow competition between distributed sources to support the active distribution network management to minimise distribution system costs.
* **Connection arrangements:** all customers wishing to connect to distribution networks will discuss their development with their local DSO or independent DNO. Where network constraints exist (or are forecast to exist), the customer will be offered an ANM connection agreement to enable them to connect before reinforcement has taken place. This connection agreement will define the level and timeframe during which the customer has a “non-firm” connection. Where the presence of ANM causes potential issues across the transmission and distribution interface, the DSO will coordinate with the ESO to conduct a transmission impact assessment. The transmission connection procedure remains unchanged.
* **Planning:** transmission and distribution network planning will consider the benefits of using flexibility services to provide lower-cost alternative solutions to network reinforcement. Sufficient network capacity should be built to transport energy and enable flexibility services to be deployed and utilised to meet system needs.

Previous work undertaken by the ESO, DNOs and EU equivalents has also identified potential for differences in how joint coordination schemes could operate, including the extent that Primacy rules predetermined access and whether coordination is outsourced to an independent third party. We have also considered Ofgem’s work on the future of flexibility services, including the functional and commercial arrangements. Based on our assessment, we propose the following two schemes:

* **Scheme 1: Enhanced Coordination**
* **Scheme 2: Distributed Flexibility Coordinator.**

The remainder of Section 6 elaborates on the key design features of the two schemes and compares differences in roles and responsibilities of the main stakeholders and data and information exchanges.

## Scheme 1: Enhanced coordination

This scheme supports greater operational coordination than would be the case under a single entity led scheme, but would retain some similarities, such as the use of primacy rules to determine access to DER services, rather than this being done dynamically. Key design principles underpinning Scheme 1 are:

* ESO will maintain direct visibility of and control access to large or aggregated distributed flexibility resources while DSOs can access all distributed flexibility resources.
* ESO and DSOs will apply an agreed set of primary rules to mitigate operational conflicts while maximising the synergy across procurement and dispatch activities. The applicable rules will be determined by the type of conflict and, where more than one rule is required to resolve it, the rules will be applied sequentially. Details of the rules that will be applied in the quantitative studies will be explored further in the subsequent workstreams.
* The scope of coordination is limited to the planning and operation of electricity distribution networks, not including other energy vectors, such as gas or heat networks.
* The share of DER capacity is based on fixed thresholds and/or primacy rules, not on an optimal basis.

## Scheme 2: Distributed flexibility coordinator

Under this scheme, both the ESO and DSO have full access to DSR flexibility services, with decisions about access to services determined on an operational basis by a Distributed Flexibility Coordinator (DFC). Key design principles underpinning Scheme 2 are:

* DFC acts a neutral market facilitator for all distributed flexibility sources, ESO and DSOs. ESO and DSOs can access full potential of distributed flexibility capacities.
* DFC is responsible for collecting service requirements from ESO and DSOs and volumes and costs associated with distributed flexibility services, optimising those across all timescales and identifying procurement solutions for ESO and DSOs.
* There is a common flexibility procurement platform as part of an integrated system with visibility and managed access for all relevant stakeholders.
* DFC enables the visibility of flexibility volumes not only in electricity networks, but also gas, and heating/cooling systems enabling sector-coupling flexibility benefitting the electricity system.

We recognise that there is significant complexity that would need to be addressed to achieve coordination in operational timescales, including addressing multiple current barriers that are not driven by the independence of the coordinating body. Some examples of this include managing competing timescales when a party becomes aware they need a service and when delivery is required, access to sufficiently granular data and systems to store and process it, and the trade-off between security of supply and local constraints with priority potentially differing, depending on alternative options that are available at each location.

As part of the WS3 impact assessment, we will seek to separate out the additional benefits of a DFC, rather than the ESO/DSO managing coordination between themselves on an ongoing basis.

## Roles and Responsibilities

Table 6-1 defines a set of roles and responsibilities for the key stakeholders involved in each stage of the process to access DER services.

Table 6-1 – Definition of roles and responsibilities

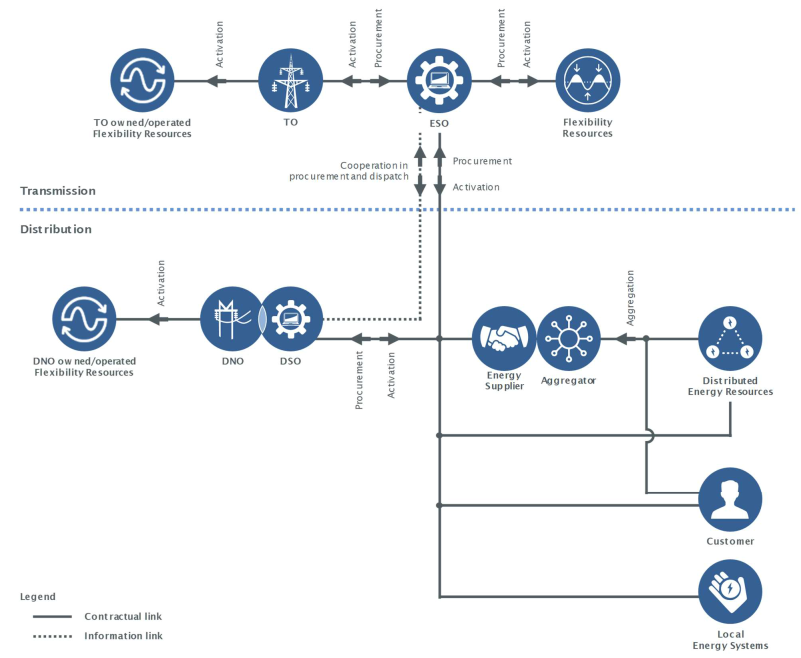
|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Stage** | **Currently** | **Scheme 1 – Enhanced Coordination** | **Scheme 2 – Distributed Flexibility Coordinator** | **Assessment workstream** |
| **Qualification** | ESO and DSOs have their own separate qualification processes | ESO and DSOs will have a coordinated qualification process to remove repetitive processes for DSOs and ESO services. | The qualification process will be fully standardised and integrated into one process administered by the DFC. | WS3: IA |
| **Procurement** | Flexibility services contracted up to 6 months in advance, confirmed in operational timescales, i.e. Day Ahead | ESO and DSOs will procure flexibility services in a coordinated manner using forecasts of their long- and short-term flexibility needs. This could potentially be through a continuous flexibility market. | DFC will coordinate the procurement of flexibility services through a centralised continuous market accessible to all DERs, according to the needs of ESO and DSOs (e.g. short-term constraint management, deferral of reinforcement). | WS2: IWES |
| **Dispatch** | ESO and DSOs dispatch flexible resources independently | ESO and DSOs may still use their own dispatch platforms to instruct DERs for certain flexibility services. However, services will be coordinated in advance through a data exchange medium such as an API and determined by Primacy rules. | ESO and DSOs indirectly activate DERs through the DFC, via a centralised platform that optimises availability of flexibility volumes and pricing according to ESO and DSO requirements. | WS2: IWES |
| **Settlement** | Settlement and baselining are done separately by ESO and DSOs | ESO and DSOs may still settle their required services with DERs. The settlement and baselining process will be standardised and will follow the same approach for both ESO and DSOs. | Settlement and baselining will be fully carried out by DFC in full coordination with ESO and DSOs. | WS3: IA |
| **Compliance** | ESO and DSOs have their own compliance process | The compliance process post flexibility services utilisation will be standardised and follow a similar approach for both ESO and DSOs. | The compliance process will be overseen by the DFC who will administer all flexibility related data. | WS3: IA |

## Data management and information exchange

Scheme 1 requires the creation of robust data sharing processes between the ESO and DNOs, underpinning the creation of primacy rules and the required visibility to enable coordinated planning and operations. For Scheme 1 the information exchanges primarily reflect the ENA Open Networks’ World B, as shown in Figure 6-1.

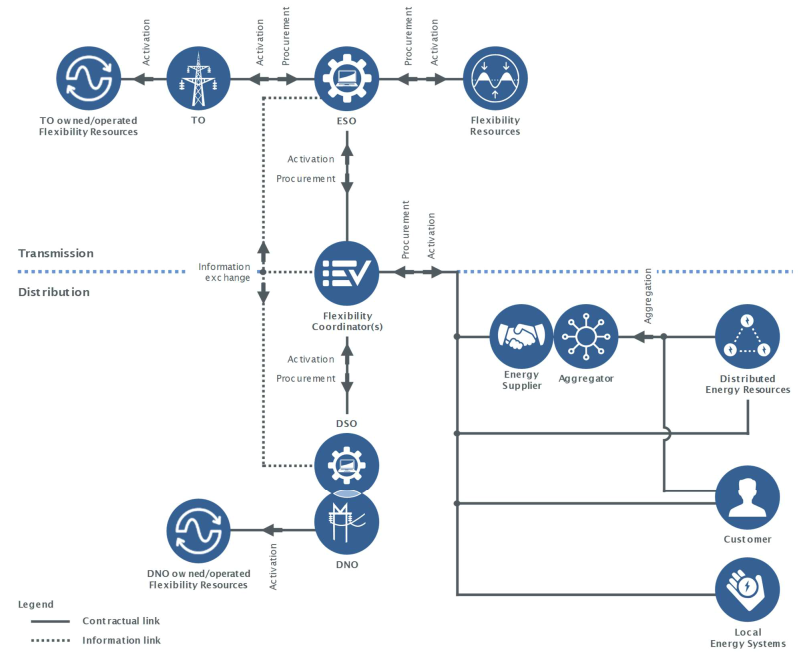
We understand that the ENA Open Networks programme recognises that rules will need to evolve and improve over time to include enhanced exchanges of data to understand system issues across both transmission and distribution, identify market behaviours and coordinate the dispatch of market participants. It is also recognised that there is a need to improve forecasting ability and that efficient data exchange processes will benefit the overall decision-making process within the ESO-DSO coordination[[34]](#footnote-35).

Figure 6-1: High level information exchanges under Scheme 1[[35]](#footnote-36)



Scheme 2 requires a focus on visibility and transparency of all data underpinning the access to DERs and will entail the creation of new platform(s), supervised by the DFC, to manage all the data related with forecasting, procurement, dispatch and settlement of volumes between networks and DERs. The information exchanges underpinning Scheme 2 most closely resemble World E, as identified below in Figure 6-2.

Figure 6-2: High level information exchanges under Scheme 2



In section 7, we provide a high-level description of the techno-economic analysis that will be carried out in WS2 to identify the optimised least cost of each scheme. The outcomes from WS2 will form one of the inputs to WS3, which will undertake an impact assessment for each scheme.

# Workstream 2: Techno-economic analysis and modelling

WS2 is focused on assessing the two joint coordination schemes identified through the literature review, stakeholder engagement and internal assessment described in the previous chapters. This will be achieved by using the Integrated Whole Energy System (IWES) model to enable techno-economic holistic evaluation and analyse the implications of those proposed coordination schemes in the future GB energy system.

IWES is a least-cost optimisation model that can simultaneously minimise long-term investment and short-term operating costs across the whole energy system (electricity, heating, hydrogen) from the supply side, energy network to the end-customers while meeting the required carbon targets and system security constraints. It does this by optimising:

* The deployment of flexibility technologies such as energy storage (thermal, electricity, hydrogen), demand response technologies (e.g. smart electric vehicle charging system with and without vehicle-to-grid capability, industrial and commercial sector demand response), interconnection, electrolysers, and generation flexibility to ensure adequate generation capacity across all operating snapshots and especially during the peak demand with low renewable outputs.
* The distributed flexibility in coordination with the transmission-connected flexibility to minimise the overall energy system costs by providing various services such as energy arbitrage, ancillary services (frequency response, operating reserves, flow management) to optimise energy system investment and operation decisions.

## Enhancing the model

The first step to be carried out under WS2 will be to enhance IWES to represent the two ESO-DSO coordination schemes proposed in WP1 – Enhanced Coordination (Scheme 1) and Distributed Flexibility Coordinator (Scheme 2). Several factors inherent to each coordination scheme will need to be captured in IWES, including:

* The range, cost, and volume of distributed flexibility technologies available – for example, under Scheme 1, the scope of coordination is limited to the electricity system, while in Scheme 2, the presence of an independent distributed flexibility coordinator enables broader coordination between electricity, heat, and gas systems, recognising the benefits of sector coupling flexibility.
* Constraints associated with using these technologies deriving from the identified primacy rules or commercial frameworks.
* Constraints associated with the sharing level of balancing responsibility from ESO and DSO and the rules associated with the flows at the ESO and DSO interface.

Key assumptions associated with modelling the factors above will be listed, and sensitivity studies will be carried out to analyse the impact of different assumptions on the results. In order to assess the relative benefits of different schemes, we will use a counterfactual scenario that assumes there is no whole system coordination leading to no distributed flexibility deployed in the system.

## Developing the energy system scenarios

The second step is to define the energy system scenarios used to evaluate the schemes. We plan to use two snapshot years – 2030 or 2035 and 2050. The former is selected to identify the value of the schemes in the short/medium term, especially from an operational point of view, while the latter is used to analyse the impact of the schemes in shaping both investment and operation of the net-zero energy system. We propose to use the net-zero 2050 Leading the Way energy demand scenario as an input to the IWES model. Once the scenarios are agreed upon, IWES’ input data will be updated accordingly.

## Running the model

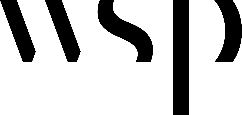
The third step is to simulate the three cases (i.e. the counterfactual and two coordination schemes) through IWES and analyse the impact of the two schemes on GB energy system costs, capacity and operation requirements. The results will be compared and analysed to understand their performance characteristics and effects on how energy systems should be developed and operated. The results of the main studies will be discussed, and a set of sensitivity studies will need to be developed to identify the robustness of the solutions against different assumptions and determine the key drivers of different solutions.

The results will be discussed in the workshop with key stakeholders, and appropriate actions will be taken considering the feedback received during the workshop. The outcome of the analysis will be summarised in a report that NGED and ESO will review before being finalised by the 19th of May 2023.

The work plan with key milestones is as follows:

|  |  |
| --- | --- |
| **Milestones** | **Due date** |
| Enhance the current whole electricity system model to represent the developed ESO/DSO coordination schemes at operational timescales (both pre and post event). | 10/03/2023 |
| Define whole electricity system use cases against which to assess the coordination schemes. These will consider particular geographic locations of the networks, specific types of flexibility services, different technology types of flexibility services, etc. | 24/03/2023 |
| Modelling and analyses of Scheme 1 | 01/04/2023 |
| Modelling and analyses of Scheme 2 | 15/04/2023 |
| Workshop to discuss report results (incl. preparation) | 12/05/2023 |
| Deliverable 2.1 Review Report | 19/05/2023 |
| NGED and ESO review process | 19/05/2023 |

|  |
| --- |
| Future Worlds |



# Appendix A: Future Worlds

This appendix provides greater detail about the Future Worlds created in the Open Networks project, as well as the functions defined by the ENA as introduced in section 3.1.We establish a relation between the three main dimensions considered in this project approach with the ENA Open Networks detailed DSO functions.

Table A8-1 – High-level summary of DSO functions

|  |  |  |
| --- | --- | --- |
| Dimensions (in Commander approach) | Function (ENA Open Networks) | Description |
| Commercial | Service/Market Facilitation | A range of activities including defining distribution network service requirements, supporting market arrangements for these services, assessing value of flexibility, defining new services, co-ordinating potential service conflicts and providing information support to market participants for efficient whole system outcomes. |
| Connections & Connection Rights | Provision and management of distribution network connections, including design, connection agreements, access rights, and management of increasing demand through methods such as queue management and commercial constraint payments. |
| Charging | Settlement of charges for the connection and use of distribution networks with a whole system view and close interaction between network owners and operators to design and operate efficient and equitable network charging arrangements |
| Operations | System  Co-ordination | The coordination of local and regional energy and power transfers with other networks and systems for overall system planning, operation, and optimisation, including coordination with ESO, DSOs, iDNOs/iDSOs, and local energy systems, and providing support services for wider network operation (e.g., voltage management). |
| Network Operation | Ensuring secure and efficient real-time operation of distribution networks by operating within acceptable thermal, voltage and short circuit ratings, reducing losses and efficiently using connected resources, and taking into account equipment outages and condition through operational planning and risk management activities. |
| Planning | Investment Planning | Identifying capacity requirements and ensuring efficient capacity provision to customers through coordination with ESO and Transmission Owners, considering commercial DERs and distribution network investment options. |
| System Defence and Restoration | Provision of local and regional flexible services to enhance whole system security and provide system resilience to high-consequence events through risk-based approaches, with the ability to re-establish the wider synchronous area in case of widespread disruption. |
| Service Optimisation | Ensuring services are available to support network and system operation, by procuring, selecting and optimizing services while considering capacity constraints and promoting flexible services through smart network use. It also involves having backup provisions in place to support network operation if market operation fails.A range of activities including defining distribution network service requirements, supporting market arrangements for these services, assessing value of flexibility, defining new services, co-ordinating potential service conflicts and providing information support to market participants for efficient whole system outcomes. |

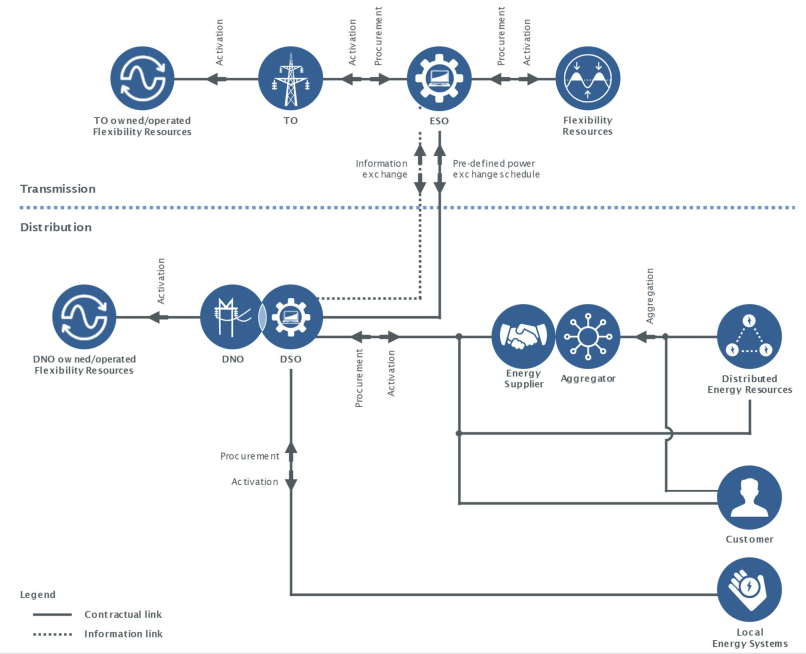
Table A8-2 – High-level summary of five worlds

|  |  |  |
| --- | --- | --- |
| Label | Title | Description |
| A | DSO coordinates | * DSO procures and activates distribution network connected flexibility resources based on pre-defined power exchange schedule agreed with ESO. |
| B | Coordinated procurement and dispatch | * ESO directly procures flexibility resources connected to distribution network in active collaboration and coordination with DSO. * DSO procures flexibility resources connection to distribution network in active collaboration and coordination with ESO. |
| C | Price driven flexibility | * Network access and forward-looking charging reform reduce flexibility that system operators need to procure directly. * Additional commercial services model, used to contract flexibility, is identical to that of world B. |
| D | ESO coordinates | * ESO procures and activates flexibility resources connection to distribution network. * DSO indirectly procures distribution connected flexibility resources via the ESO |
| E | Flexibility Coordinator | * Independent flexibility coordinator(s) organised and operate the flexibility market in a neutral, independent and transparent manner. * ESO and DSO indirectly procure and activate distributed flexibility resources via the flexibility coordinator(s). |

World A – DSO Coordinates

Figure A-1 provides an illustration of the relationships between participants of an electricity system within a World A framework. This world is intended to utilise the DSO to optimise performance of the local network, which will experience significant change during the energy transition. The trade-off is that it might be more difficult to achieve national efficiencies in this operating model, particularly when DNOs in different regions can pursue divergent strategies.

Figure A-1 - Illustration of World A: DSO Coordinates



**Market Design**

* Central ancillary services market for flexibility resources connected at transmission network.
* Regional market for flexibility resources connected at distribution network.

**ESO Role**

* Organises and operates central market and is responsible for balancing the electricity transmission system.
* Directly procures and activates flexibility resources connected to transmission network via the central ancillary services market.
* Commercial relationship with DSO for procurement of distribution connected flexibility on its behalf to support balancing of transmission system.
* Active exchange of information with DSO to maximise synergies across transmission and distribution networks and minimise potential conflicts associated with flexibility service delivery.
* Offers flexibility services, via the TO, to the DSO from a portfolio of smart grid network solutions.

**DSO Role**

* Facilitates a regional flexibility market for distribution network connected resources, directly procuring and activating resources for transmission and distribution network management.
* Contributes to whole system balancing by actively managing distribution system according to pre-defined power exchange schedule agreed with ESO.
* Maintains direct commercial relationship with flexibility resources.
* Active exchange of information with ESO to maximise synergies across transmission and distribution networks.
* Responsible for pre-qualification process, which guarantees that activation of resources does not cause additional constraints at transmission network.
* Offers flexibility services to the ESO from a portfolio of smart grid solutions.

**DER Role**

* Offers flexibility services directly to DSO or indirectly via an aggregator of choice.

**Aggregator/supplier/local energy system role**

* Combines resources at distribution level and offers aggregated output as service to DSO

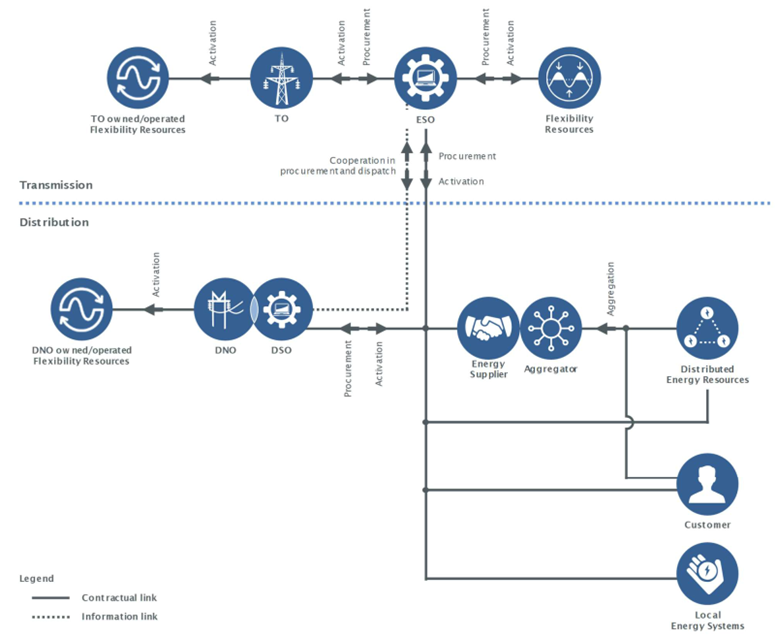
**Customer role**

* Provide behind-the-meter resources which can be offered direct to DSO or indirectly via an aggregator of choice.

World B – Coordinated procurement and dispatch

Figure A-2 provides an illustration of the relationships between participants of an electricity system within a World B framework. This is intended to be a balanced approach, which can optimise both local and national solutions. This model also allows market participants more routes to market and greater revenue opportunities. This could also cause a greater level of conflicting interest, which will require significant measures to alleviate.

Figure A-2 - Illustration of World B: Coordinated procurement and dispatch



**Market Design**

* Central ancillary services market for transmission and distribution connected resources
* Regional market for distribution connected resources.

**ESO Role**

* Organises and operates central market and is responsible for balancing the electricity transmission system.
* Directly procures and activates flexibility resources connected to transmission network via the central ancillary services market.
* Directly procures flexibility resources connected to distribution network for transmission system management and energy balancing, in collaboration with DSO.
* Active exchange of information with DSO to maximise synergies across transmission and distribution networks and minimise potential conflicts associated with flexibility service delivery.
* Offers flexibility services, via the TO, to the DSO from a portfolio of smart grid network solutions.

**DSO Role**

* Facilitates a regional flexibility market for distribution network connected resources, directly procuring and activating resources for distribution network management in active collaboration with ESO.
* Cooperates with ESO to perform coordinate dispatch of flexibility resources which have been procured during respective activities, working to target synergies between network service requirements.
* Offers flexibility services to the ESO from a portfolio of smart grid solutions.

**DER Role**

* Offers flexibility services directly to ESO and DSO or indirectly via an aggregator of choice.

**Aggregator/supplier/local energy system role**

* Combines resources at distribution level and offers aggregated output as service to ESO and DSO

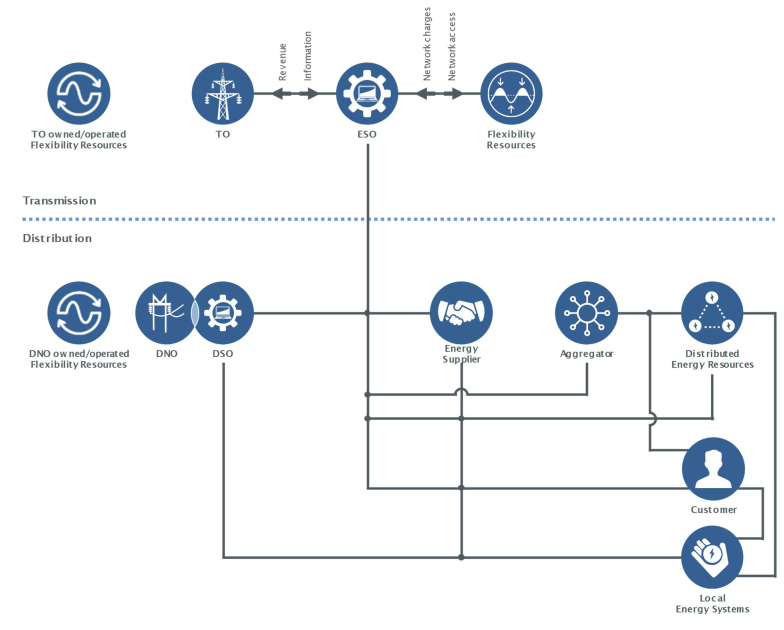
**Customer role**

* Provide behind-the-meter resources which can be offered direct to ESO and DSO or indirectly via an aggregator of choice.

World C – Price driven flexibility

Figure A-3 provides an illustration of the relationships between participants of an electricity system within a World C framework. This approach provides stronger price signals than currently exist, which should act to encourage flexibility from market participants. Layered on this will be some contracted flexibility, put in place to ensure security of supply. This approach could be complex to implement, particularly producing real-time signals that are easily visible and understandable to all participants. However, if correctly implemented a market-led solution should help to deliver the lowest cost.

Figure A-3 - Illustration of World C: Price driven flexibility



**Market design**

* Central wholesale market supported by:
  + Strengthened spatial and temporal pricing signals.
  + Access arrangement whereby parties looking to trade locally are exempt from national costs.

**ESO Role**

* Administers recovery of costs of national infrastructure (TO).
* Manages access rights to national products and markets.

**DSO Role**

* Develops and sends price signals through DUoS charges, signalling efficient use of distribution networks.
* Responsible for costs of connection at GSPs, passing signals for future investment back to connected parties.

**Supplier role**

* Administer charges to bulk of customers connected to distribution networks.

**Aggregator role**

* No liability for network costs unless involved in wholesale market.
* Liability for operational cost recovery.

**Local energy system role**

* Facilitate P2P energy trading via local market platforms (with net balances traded on wholesale market).
* Option to access national services but will be liable for appropriate charges.

**DER role**

* Contribute for their network access requirements.

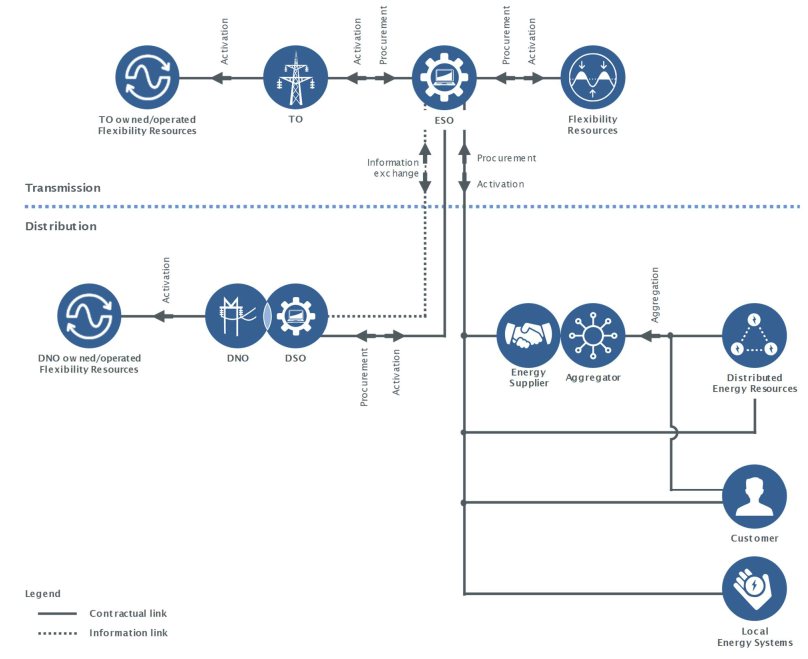
**Customer role**

* Can be registered through supplier, or individually with direct communications to networks.

World D – ESO Coordinates

Figure A-4 provides an illustration of the relationships between participants of an electricity system within a World D framework. This is positioned as the market model best suited to deliver on national objectives and large-scale flexibility. This would also provide a consistent approach, rather than a set of regional solutions which could be misunderstood. However, there is a risk that this approach will overlook contributors on the small-scale, unless links between DSO and ESO are clear and timely.

Figure A-4 - Illustration of World D: ESO Coordinates



**Market design**

* Central ancillary services market for transmission and distribution connected resources.

**ESO Role**

* Organises and operates the central market and is responsible for balancing the transmission system
* Directly procures and activates transmission connected resources for balancing TO.
* Directly procures and activates distribution connected resources for transmission and distribution management and energy balancing via the central market.
* Maintains direct commercial relationship with distributed flexibility resources.
* Active exchange of information with DSO to maximise synergies across transmission and distribution networks.
* Responsible for pre-qualification process, which guarantees that activation of resources does not cause additional constraints at distribution network.
* Offers flexibility services to the DSO from a portfolio of smart grid solutions.

**DSO Role**

* Responsible for safe and secure distribution network operation following active network management approach.
* Commercial relationship with ESO for procurement of distribution connected flexibility on its behalf to support constraint management of the distribution system.
* Active exchange of information with ESO to maximise synergies across transmission and distribution networks and minimise potential conflicts associated with flexibility service delivery.
* Offers flexibility services to the ESO from a portfolio of smart grid network solutions.

**DER Role**

* Offers flexibility services directly to ESO or indirectly via an aggregator of choice.

**Aggregator/supplier/local energy system role**

* Combines resources at distribution level and offers aggregated output as service to ESO

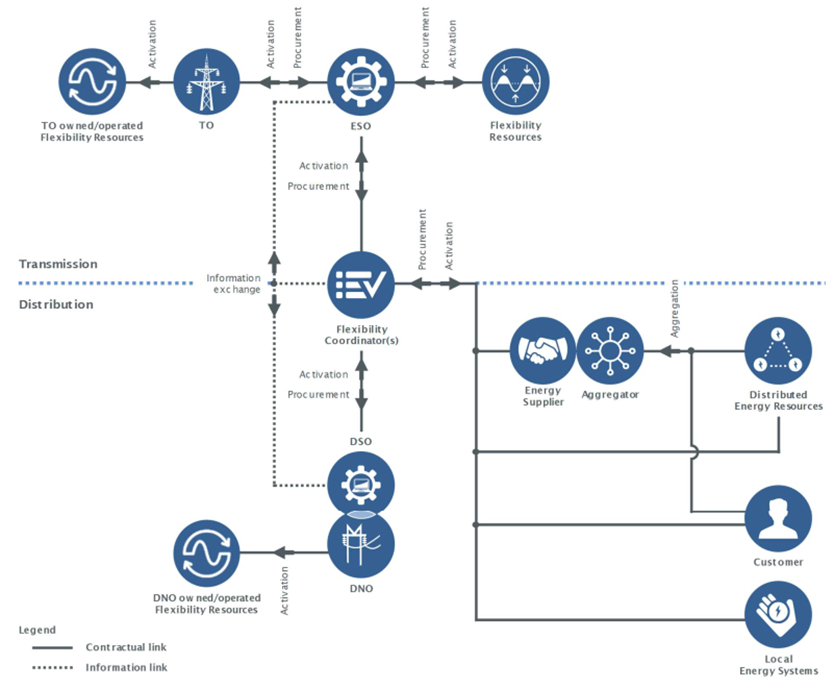
**Customer role**

* Provide behind-the-meter resources which can be offered direct to ESO or indirectly via an aggregator of choice.

World E – Flexibility coordinators

Figure A-5 provides an illustration of the relationships between participants of an electricity system within a World E framework. This model is created in response to the conflict resolution issues posed in World B, by created an independent flexibility coordinator. This approach should provide a clearer messaging with transparent separation of market and network activities. However, the issues of who assumes risk and responsibility for the network needs to be addressed.

Figure A-5 - Illustration of World E: Flexibility Coordinators



**Market design**

* Central ancillary services market for transmission connected resources.
* One or more flexibility markets for distribution connected resources.

**Flexibility coordinator(s) role**

* Organises and operates the flexibility market in a neutral, independent and transparent way.
* Responsible for pre-qualification, contract, activation and settlement process in coordination with ESO and DSO.
* Procures and dispatch distribution connected resources for distribution constraint management and transmission balancing through a whole system optimisation platform.

**ESO role**

* Organises and operates central market for ancillary services.
* Responsible for balancing transmission system, directly procuring and activating transmission connected resources for this purpose.
* Indirectly procures and activates distribution connected resources for transmission system management and balancing via the flexibility coordinator(s).
* Actively exchanges information relating to investment planning, operational planning and system operation states and requirements on the transmission network.

**DSO role**

* Indirectly procures and activates distribution connected resources for distribution constraint management via the flexibility coordinator(s).
* Actively exchanges information relating to investment planning, operational planning and system operation states and requirements on the distribution network.

**DER Role**

* Offers flexibility services directly to the flexibility coordinator(s) or indirectly via an aggregator of choice, which in turn offers them to the ESO and DSO.

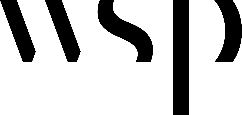
**Aggregator/supplier/local energy system role**

* Combines resources at distribution level and offers aggregated output as service to the flexibility coordinator(s), which in turn offers them to the ESO and DSO

**Customer role**

* Provide behind-the-meter resources which can be offered direct to ESO and DSO or indirectly via an aggregator of choice.

|  |
| --- |
| Open Worlds Consultation |



Appendix B: Open Worlds Consultation

This appendix provides additional detail on the key themes raised in the responses to the Open World impact assessment consultation, as introduced in section 3.1. A total of 31 responses were received in this consultation, all of which were considered when preparing this appendix.

World A validity

Several stakeholders interviewed raised concerns or reservations about World A: DSO Coordinates being a valid model for the future operation of the power networks. In total, 12 responses voiced some level of opposition to the inclusion of World A in either the impact assessment or future analysis, with nine of these representing strong opposition and a further three indicating some level of reservation.

The respondents who specifically addressed these are classified as (using the Open Worlds consultation’s original stakeholder categories):

* Large Energy Companies: 5
* ESO: 1
* Transmission Connected Generation: 1
* Distributed Energy Resource: 1
* Generator/DER: 1
* Local Energy System: 1
* Supplier/Aggregator: 1
* Other: 1

The arguments against World A are summarised here:

* With regional market splitting, it is possible that a “post code lottery” will develop without additional access to an ESO-led marketplace, resulting in market distortions.
* Potential for DSO activities in this world to affect network balancing.
* Impact on business for existing and future commercial aggregators, which may have to close activities.
* Removal of opportunities for independent choice and revenue stacking across various markets.
* Potential for this arrangement to lead to piecemeal and inconsistent arrangements, which could particularly impact boundary regions between networks and produce confusing messaging.
* The world is not in compliance with EU Network Codes and Guidelines: Article 15.1 of the European Balancing Guidelines, which keeps the role of DSOs separate from market participants.
* The solutions created by World A could create sub-optimal balancing solutions, since they do not consider a whole-system approach.

In contrast, two respondents from the Academia group were in favour of World A as the most viable approach on the basis that:

* The ability of the ESO to extend coordination down towards LV levels is not realistic, and DNOs are best placed to take this role.
* Algorithms to solve problems are going in the direction of distributed and decentralised solutions, which is a more natural fit for World A.
* Guidance from BEIS is in the direction of a more distributed energy system, in line with World A.

World C redefinition

The Future World impact assessment took the decision to separate the World C option into a layer that could be applied to each of the other worlds. This approach received reasonable support from the consultation. Of the 31 responses received, 16 indicated agreement that this was a sensible approach. There were no responses which explicitly argued for World C to be reintroduced as a stand-alone proposition. Based on the consultation exercise, this usage of World C as a part of each of the four remaining worlds should be retained for future analysis.

It was expected that adoption of access and charging reform would be required regardless of the organisational and contractual structures created to operate the electricity system and manage procurement of flexibility. In one response, it was suggested that work should be done in the short-term to make this a reality, in parallel to determining other arrangements. Therefore, this could be considered a low regrets option to pursue while the “World” into which the electricity system is transitioning remains uncertain.

World E feedback

World E, using an independent flexibility coordinator rather than a DSO or ESO-centric approach, provoked some useful response from the consultation exercise.

There were four responses that posited that elements of World E should be incorporated into all other worlds, as per the approach taken for World C within the Impact Assessment. More specifically, combining World D and World E as a hybrid approach was suggested by three separate respondents.

World E received positive feedback from some respondents. In one case, it was suggested that this was the only scenario attempting to address and deliver the role of DSOs as a neutral market facilitator. However, there were also concerns about the undefined nature of the neutral coordinator, with some suggesting that further definition would be required before a full assessment could be made.

As a potential solution, it was suggested that the flexibility coordinator could be created from a restructure of existing organisations, rather than the creation of a brand-new establishment. This could resolve potential complexity and risk of pursuing this type of world and would be more aligned to the recent separation of TO and ESO in the UK.

Starting point World

For the most part, there was good agreement (84% of respondents) that the current market arrangements are most closely aligned to World B. This assumption has since been used by Open Networks to validate the transition pathways of the Impact Assessment.

A minority of respondents in the consultation disagreed, with six participants instead citing World D as being more aligned to the present day. The stakeholder groups holding these views are summarised as:

* Settlement agent: 1
* Cross-industry representative: 1
* Distributed Energy Resource: 1
* Large Energy Company: 1
* Generator/DER: 1
* Other: 1

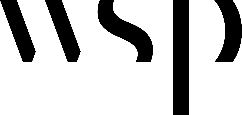
The broad contention made is that, while the ESO has an established framework for the procurement and activation of flexibility, DSOs are currently more limited in their ability to replicate these services. However, it was broadly acknowledged that the direction of travel is towards World B Stage 1 at the present time, and therefore it is quite likely that the transition path will pass towards World B, even if it is not considered to represent the present-day circumstances.

Timescale issues

Some of the responses from the Impact Assessment consultation registered concerns about the timeframes being proposed for at least one of the transition paths presented. In summary, the points raised were:

* Concern that timelines proposed would not allow customers to realise benefits until too late.
* World D maturity date should be much earlier, given that current arrangements for procuring flexibility have traditionally been led by the ESO.
* Disagreement that a World E transition could happen earliest, given the complexity of creating this solution.
* Identification that trigger points, such as deployment of renewable technologies and grid constraints, will be reached at different times across different regions of the UK. This point was noted by two of the DSOs surveyed.

|  |
| --- |
| Stakeholder consultation questions |



Appendix C: Stakeholder consultation questions

This appendix details the questions posed as part of the stakeholder engagement exercise.

1. What are the biggest barriers in the present day for flexibility coordination between ESO and DSOs?
2. What additional challenges will become most prevalent for flexibility coordination between these parties as the energy system evolves towards net zero?
3. What are the main drivers for delivering a system based around whole system coordination, as opposed to ESO-led or DSO-led coordination, in a future energy system?
4. What constraints/challenges would whole-system coordination impose on participants, and what mitigations might be appropriate?
5. What are the boundaries of accountability in a whole-system coordination model?
6. What are the necessary commercial arrangements between parties in a whole-system coordination model which will allow for efficient network operation and ease of market access?
7. What are the necessary information transfers between parties (primarily, ESO and DSOs) in a whole system coordination model to allow for efficient network operation and ease of market access?
8. Do you foresee a requirement for a common data management system to enhance communications between ESO and DSOs (e.g. common forecasting solution)?
9. Considering the three use case conflicts highlighted by ENA Open Network’s “Primacy Draft Rules”, who do you believe would be best positioned to have primacy in each situation, and why?
10. Are there any additional conflicts which we should consider within our assessment (focusing on the most impactful examples)? If so, do you have a preferred resolution strategy in these cases?
11. What changes to network charging will be required to facilitate effective whole system flexibility coordination?
12. How effective is whole system coordination when considering local variations in energy system characteristics (e.g. EV/HP deployments, network constraints), and in promotion and development of local flexibility markets?
13. Is restructuring of DSOs required to mitigate concerns around conflict of interest, and if so, how would you envisage any restructure taking place?
14. What are the advantages and disadvantages of formalising cross-vector flexibility coordination under new organisational structures?

|  |
| --- |
| WSP House 70 Chancery Lane London WC2A 1AF  **wsp.com**  WSP UK Limited makes no warranties or guarantees, actual or implied, in relation to this report, or the ultimate commercial, technical, economic, or financial effect on the project to which it relates, and bears no responsibility or liability related to its use other than as set out in the contract under which it was supplied. |

1. DER refers to distributed generation, storage and demand response. [↑](#footnote-ref-2)
2. A coordination scheme is defined by i) a set of roles and responsibilities for each relevant entity in the energy system; ii) a map of interfaces and information exchanges between the entities; iii) a list of primacy rules and/or specific guidelines for access to DERs and iv) any other relevant criteria [↑](#footnote-ref-3)
3. Commercial Principles paper: [Creating tomorrow’s networks – Energy Networks Association (ENA)](https://www.energynetworks.org/creating-tomorrows-networks/) [↑](#footnote-ref-4)
4. Future World Impact Assessment, Baringa Partners LLP, February 2019, [Insert report title in document properties (energynetworks.org)](https://www.energynetworks.org/industry-hub/resource-library/open-networks-2019-ws3-future-world-impact-assessment-report.pdf) [↑](#footnote-ref-5)
5. ENA, “Primacy Rules for Service Conflicts Use Case Prioritisation Supporting Slides”, [Open Networks Project (energynetworks.org)](https://www.energynetworks.org/assets/images/Resource%20library/ON21-WS1A-P5%20Primacy%20Rules%20for%20Service%20Conflicts%20-%20Use%20Case%20Prioritisation%20Supporting%20Slides%20(22%20Dec%202021).pdf) [↑](#footnote-ref-6)
6. [SSEN Transition (ssen-transition.com)](https://ssen-transition.com/) [↑](#footnote-ref-7)
7. <https://www.nationalgrideso.com/future-energy/projects/power-potential#:~:text=Power%20Potential%20is%20a%20ground,in%20a%20live%20system%20trial> [↑](#footnote-ref-8)
8. <https://www.spenergynetworks.co.uk/pages/fusion.aspx> [↑](#footnote-ref-9)
9. <https://www.spenergynetworks.co.uk/userfiles/file/on22-ws1a-p5-primacy-rules-cost-benefit-analysis-final-report-13-dec-2022.pdf> [↑](#footnote-ref-10)
10. <https://www.nationalgrid.co.uk/projects/effs> [↑](#footnote-ref-11)
11. <https://www.nationalgrid.co.uk/innovation/projects/optimal-coordination-of-active-network-management-schemes-and-balancing-services-market> [↑](#footnote-ref-12)
12. <https://www.nationalgrideso.com/industry-information/balancing-services/system-security-services/megawatt-dispatch-overview> [↑](#footnote-ref-13)
13. https://www.nationalgrideso.com/document/140756/download [↑](#footnote-ref-14)
14. https://www.nationalgrideso.com/document/248186/download [↑](#footnote-ref-15)
15. [Proposals for a Future System Operator role - GOV.UK (www.gov.uk)](https://www.gov.uk/government/consultations/proposals-for-a-future-system-operator-role) [↑](#footnote-ref-16)
16. Now the Department of Energy Security & Net Zero [↑](#footnote-ref-17)
17. <https://www.ofgem.gov.uk/publications/call-input-future-local-energy-institutions-and-governance> [↑](#footnote-ref-18)
18. The national arrangements are considered as part of the work on the FSO [↑](#footnote-ref-19)
19. [Consultation: Future of local energy institutions and governance | Ofgem](https://www.ofgem.gov.uk/publications/consultation-future-local-energy-institutions-and-governance) [↑](#footnote-ref-20)
20. <https://www.ofgem.gov.uk/publications/call-input-future-distributed-flexibility> [↑](#footnote-ref-21)
21. ISGAN- Discussion Paper: Lessons learned from international projects on TSO- DSO interaction [↑](#footnote-ref-22)
22. SmartNet -TSO-DSO Coordination For Acquiring Ancillary Services From Distribution Grids – May 2019: The SmartNet Project Final Results [↑](#footnote-ref-23)
23. https://smartnet-project.eu/consultations/index.html [↑](#footnote-ref-24)
24. ISGAN- Discussion Paper: Lessons learned from international projects on TSO- DSO interaction [↑](#footnote-ref-25)
25. Deliverable D1.3 – Definition of scenarios and products for the demonstration campaigns [↑](#footnote-ref-26)
26. https://eu-sysflex.com/documents/ [↑](#footnote-ref-27)
27. https://nodesmarket.com/project/norflex-1/ [↑](#footnote-ref-28)
28. https://publications.jrc.ec.europa.eu/repository/handle/JRC130070 [↑](#footnote-ref-29)
29. https://en.gopacs.eu/ [↑](#footnote-ref-30)
30. [↑](#footnote-ref-31)
31. https://nodesmarket.com/ [↑](#footnote-ref-32)
32. https://publications.jrc.ec.europa.eu/repository/handle/JRC130070 [↑](#footnote-ref-33)
33. https://eepublicdownloads.azureedge.net/clean-documents/SOC%20documents/SOC%20Reports/210957\_entso-e\_report\_neutral\_design\_flexibility\_platforms\_04.pdf [↑](#footnote-ref-34)
34. https://www.energynetworks.org/industry-hub/resource-library/on22-ws1a-p5-primacy-draft-rules-increment-1-(28-apr-2022).pdf [↑](#footnote-ref-35)
35. Source: ENA Open Networks, Future Worlds, [open-networks-2018-ws3-14969-ena-futureworlds-aw06-int.pdf (energynetworks.org)](https://www.energynetworks.org/industry-hub/resource-library/open-networks-2018-ws3-14969-ena-futureworlds-aw06-int.pdf) [↑](#footnote-ref-36)