The Voice of the Networks

energynetworks association

Open Networks Future Worlds

Developing change options to facilitate energy decarbonisation, digitisation and decentralisation

31 July 2018

Foreword

The ENA Open Networks Project is laying the foundations of the smart grid in the UK and is helping to inform similar developments in Ireland. It is a key initiative to deliver Government policy set out in the Ofgem and BEIS Smart Systems and Flexibility Plan, the Government's Industrial Strategy and the Clean Growth Plan, working in collaboration with Ofgem, BEIS, 10 of UK and Ireland's electricity network operators, and other key stakeholders.

This paper is the output of a substantial stakeholder engagement process to map and describe a number of potential system architectures ("Future Worlds") capable of supporting the smart decentralised energy industry that the UK is transitioning towards. The document does not seek to recommend any particular Future World but instead to understand them, creating a common view of how each works allowing informed debate and decisions to follow.

How to use this document

This document provides a range of material which may be of interest and we want to ensure you can efficiently find the sections you need. The following quick links are intended to help you navigate the document and get you to where you want;

Section 2 – The Future Worlds
Presents an overview of each of the five Worlds developed.

Section 3 – The Smart Grid Architecture Model
Provides background on how we have used this industry recognised tool.

Section 4 – The principle of neutral market facilitation
Describes why it is important that system operators (SO) adopt this principle.

Section 5 – Stakeholder insights
Lists what the different Worlds could mean for different stakeholders. Find the page that's relevant for you.

Section 6 – Assessing the Worlds
Describes our intended approach to the Impact Assessment and invites your views.

Section 7 – Key enablers for the future
Presents the key enablers we believe are needed to deliver the Future Worlds.

Section 8 – Proposed next steps
Describes our proposed next steps including our work on Least Regret Analysis to take forward the common changes needed across the Future Worlds.

Whilst we've produced this document to be as accessible as possible we recognise that it does contain some industry terms. A glossary covering these terms is available here.

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opennetworks@energynetworks.org

Foreword

Engagement opportunities during the consultation period

The opportunities and implications of these changes are significant societally, commercially and technically and we recognise it is important to get responses from a wide variety of interested parties to inform the further development of these Future Worlds. We are therefore using a variety of means to reach out to stakeholders during the consultation period. This includes;

– Two dedicated stakeholder events, in London (3rd September) and Edinburgh (29th August), where stakeholders will be able to engage directly with the ENA and its members as well as EA Technology and the SGAM models that form the basis of this work.
– Webinars (21st August and 13th September) during the consultation period summarising the key points from the consultation.

We are also happy to talk directly with parties or organisations to provide further clarity and information on our work. Please contact (opennetworks@energynetworks.org) if you would like such an opportunity.

Responding to this consultation

Through this consultation we ask a number of questions and would value your thoughts. These are presented in full in Section 9 of this document.

We welcome all responses to this consultation ahead of its closing on 25th September. Consultations can be emailed to opennetworks@energynetworks.org.

How we will use your feedback

Your feedback is important to us in the development of our future thinking. We will carefully review all responses to this consultation. We will publish all non-confidential responses and provide a summary overview of these responses at a dedicated webinar in the autumn. Please indicate if you wish us to consider your response as confidential.

This webinar will also describe how we will use your feedback to inform the further development of the Future Worlds. This will include how your feedback is informing our work to assess the Worlds as well as supporting our work on key enablers and market agnostic elements.

Your responses to this consultation will be used to shape the next steps of these three products. Once we have completed work on all these elements, we plan to engage with you further to understand your views on our completed work. This is currently programmed for early 2019.

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1 – Executive summary

The energy industry is changing. In response to the need to decarbonise our energy usage, new decentralised forms of electricity generation have evolved, supported by smart grid technologies. These technologies are also changing the way we use electricity, leading both residential and business users to become increasingly active in their energy usage. The three challenges of decarbonisation, decentralisation and digitisation have the potential to create whole system opportunities by transforming the way distribution networks behave and creating new flexibility market opportunities for potential service providers. These markets will enable flexibility services to compete alongside traditional investment options for all relevant network reinforcements or upgrades of significant value, and to make the most cost-effective investment decisions in the future. Through these services and the broader benefits of more active networks and Customers we can deliver:

– lower carbon energy at the lowest overall cost for Customers
– opportunities for Customers to realise value from services and new technology
– more sustainable energy markets and networks.

This consultation presents a range of potential future industry structures – Future Worlds – that could deliver these benefits. All of these Future Worlds represent a significant change from today's World. Responses to previous consultations have shown that a broad range of stakeholders recognise the need for change in order to deliver the smart and flexible World described above.

Much of this material is presented through the lens of different stakeholders so that the reader can understand what the future options may mean for them. We invite comments on these Worlds to inform their development and also our next stage of work where we assess the Worlds prior to their presentation to Ofgem as an evidence pack. Ultimately, it will be Ofgem and BEIS that make the decision on the most appropriate Future World and how to implement it.

In preparing the Future Worlds material we have taken a layered approach that we believe provides different levels of information, recognising the differing needs of our stakeholder base;

– At the top level, this consultation document provides a high level overview of our work, designed to be accessible to all readers
– At the secondary level, more detailed information on the modelling of the Future Worlds is provided in an associated document produced by EA Technology which can be found on our Future Worlds consultation page. This document is designed for industry experts who wish to understand our work in more detail
– Thirdly, all the models of the Future Worlds are also available via our Future Worlds consultation page, for stakeholders who wish to view and critique the detailed modelling work of the Future Worlds.

We welcome feedback on all these channels.

The Open Networks Project

The ENA Open Networks Project is laying the foundations of the smart grid in the UK and is helping to inform similar developments in Ireland. It is a key initiative to deliver Government policy set out in the Ofgem and BEIS Smart Systems and Flexibility Plan, the Government's Industrial Strategy and the Clean Growth Plan, working in collaboration with Ofgem, BEIS, 10 of UK and Ireland's electricity network operators, and other key stakeholders.

The project works with stakeholders to develop arrangements to meet the smart energy future via a collaborative environment to share innovation and best practice, bringing together experts to develop potential arrangements that deliver new revenue opportunities for stakeholders and value for the end consumer.

As such it will support the enablement of a whole range of new energy technologies that generate, consume and manage electricity, delivering low-carbon energy for the UK.

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1 – Executive summary

The Open Networks Project is organised into five workstreams:

- **Workstream 1 – T-D Processes** focusing on transmission-distribution (T-D) investment and operational planning processes with a focus to put in place improved processes in the shorter term.
- **Workstream 2 – Customer Experience** focusing on improving Customer experience and ensuring that processes and information meet Customer requirements.
- **Workstream 3 – DSO Transition** developing and implementing Distribution System Operator (DSO) functionality to enable the development and use of Distributed Energy Resource (DER) solutions and to support whole system optimisation of investment and operation.
- **Workstream 4 – Charging** assessing network access and charging arrangements and supporting Ofgem's ongoing reviews.
- **Workstream 5 – Communications** leading on communications related to the Open Networks Project to ensure coordinated and effective interactions with stakeholders.

Whilst this consultation is a product of Workstream 3 it has drawn on material from the other workstreams including;

- Workstream 1's 2017 work to develop Market Models as described in their Commercial Principles paper.
- Workstream 2's Customer definitions and plain English glossary
- Workstream 4's work with Charging Futures which has helped define one of the Future Worlds.

Workstream 3

Workstream 3 considers the transition to Distribution System Operator (DSO). Predominately, this workstream is considering how the industry needs to evolve to account for a need for increased active management of distribution networks.

Beginning in 2017, this workstream, as part of the overall Open Networks Project, has introduced real momentum into the development work required to enable the UK's energy networks to deliver a more secure, affordable, low-carbon energy system. It has provided a definition of DSO, given in the table below, and associated functions. DSO is a critical new role that will facilitate new SO roles for distribution networks including the need for whoever takes on this role to be a neutral market facilitator.

Definition of DSO	A Distribution System Operator (DSO) securely operates and develops an active distribution system comprising networks, demand, generation and other flexible DER. As a neutral facilitator of an open and accessible market, it will enable competitive access to markets and the optimal use of DER on distribution networks to deliver security, sustainability and affordability in the support of whole system optimisation. A DSO enables Customers to be both producers and consumers; enabling Customer access to networks and accessible markets, Customer choice and great Customer service.

The workstream, in consultation with stakeholders, has also developed associated functions for the DSO. These DSO functions are presented in Appendix 2 of this consultation and have been used as key founding points for our work in 2018.

As our work developing the Future Worlds has progressed it has become clearer that the DSO is a group of functions between stakeholders and is not yet assigned to an organisation, and the five Worlds represent different ways of implementing these functions, which does have implications on organisational structures. Whilst we do not explicitly invite feedback on the DSO definition in the consultation, we are interested in your views on the principle of neutral market facilitation as described in Section 4 of this consultation document.

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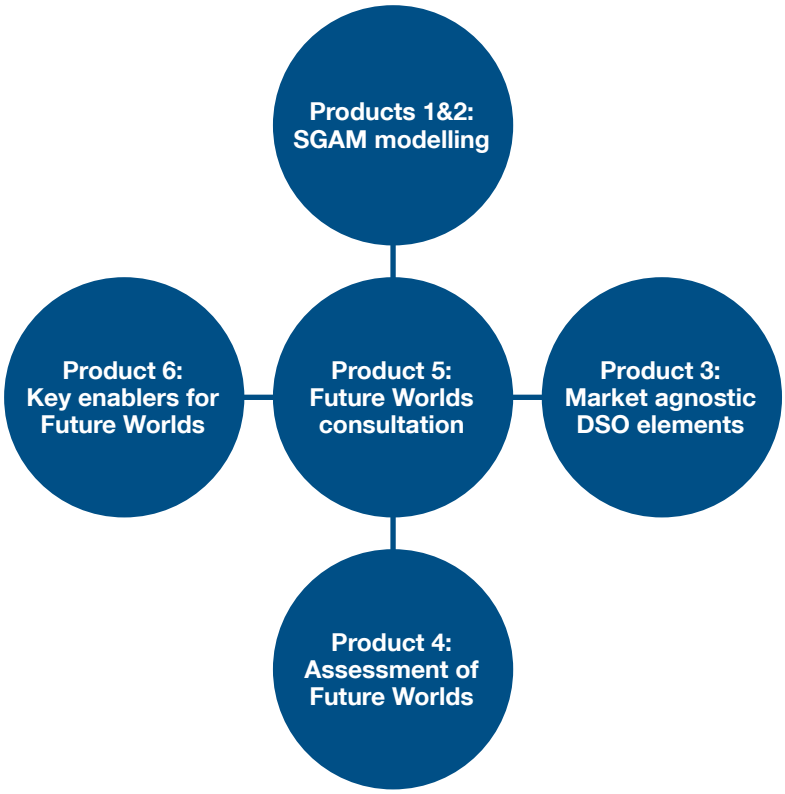
In 2018, this workstream is focused on the following products;

Product No.	Product name	Description
1	Smart Grid Architecture Modelling (SGAM) of DSOs and DER Procurement.	Modelling of the first three Future Worlds.
2	Further SGAM Modelling of DSO Functionality.	Following stakeholder feedback, modelling of two further Future Worlds.
3	Market Agnostic DSO Elements.	Least Regrets Analysis to determine the common changes needed across Worlds that could be initiated quickly.
4	Independent Impact Assessment of Models.	Assessment of the five Future Worlds by independent consultants.
5	DSO Model Validation & Review Including Public Consultation.	The Future Worlds consultation.
6	Key Enablers for DSO.	The activities that need to be established to facilitate any of the Future Worlds.
7	Further Trials to Address Gaps in DSO Functionality.	Understanding the additional initiatives needed to develop DSO functionality.
8	Preferred DSO Models & Proposed Implementation Plan.	Using your feedback to shape how the development of future systems needs to be progressed.

The majority of these products come together in this consultation document to shape our thinking on the potential Future Worlds, as shown in the diagram below. Note that some products are still works in progress and not completed. Indeed, we are directly asking for feedback in this consultation on the 'Assessment of Future Worlds' (product 4) to inform this Impact Assessment.

Figure 1.1:
Open Networks Workstream 3 2018 products



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1 – Executive summary

The Future Worlds and our work

In 2017, the ENA Open Networks Project consulted industry on a number of potential future market models in a Commercial Principles paper. These models considered how future industry structures could best deliver flexibility markets providing services from DER for both national and regional (transmission and distribution) requirements. Feedback to this consultation confirmed the need for change and stakeholders recognised that current arrangements were not sustainable in the long term.

The Open Networks Project Future Worlds consultation has further developed a range of these market models through consideration of other required functions and processes needed to deliver our smart grid future. Through a series of industry workshops it has added depth to the Worlds to ensure they take a whole system view and represent the impacts on a wide range of stakeholders, referred to as actors. Whilst this view has primarily focused on the electricity sector (i.e. transmission and distribution), it has considered cross-vector implications such as Gas and Heat.

Five Future Worlds have been developed through these workshops. Whilst these are not the only options for the future, we believe that they represent a wide range of potential options. These are described in further detail in Chapter 2 of this consultation.

Our Future Worlds are;

World A
DSO Coordinates – a World where the DSO acts as the neutral market facilitator for all DER and provides services on a locational basis to National Grid in its role as the Electricity System Operator (ESO).

World B
Coordinated DSO-ESO procurement and dispatch – a World where the DSO and ESO work together to efficiently manage networks through coordinated procurement and dispatch of flexibility resource.

World C
Price-Driven Flexibility – a World where changes developed through Ofgem's reform of electricity network access and forward-looking charges have improved access arrangements and forward-looking signals for Customers.

World D
ESO Coordinate(s) – a World where the ESO is the counterparty for DER with DSO's informing the ESO of their requirements.

World E
Flexibility Coordinator(s) – a World where a new national (or potentially regional) third-party acts as the neutral market facilitator for DER providing efficient services to the ESO and/or DSO as required.

In order to assess these Future Worlds, the Open Networks Project has contracted EA Technology to develop Smart Grid Architecture Model (SGAM) representations of the Worlds based on the information developed through our stakeholder workshops. The SGAM was originally developed by the Smart Grid Coordination Group as part of a European Commission Mandate, and is a holistic framework for describing smart grid systems, from their functional specification right through to their architectural design. Chapter 3 of this consultation provides further background on SGAM and additional detail can be found in the associated EA Technology report, delivered as part of the project, which can be found on our Future Worlds consultation page. The models have also been made available via our Future Worlds consultation page.

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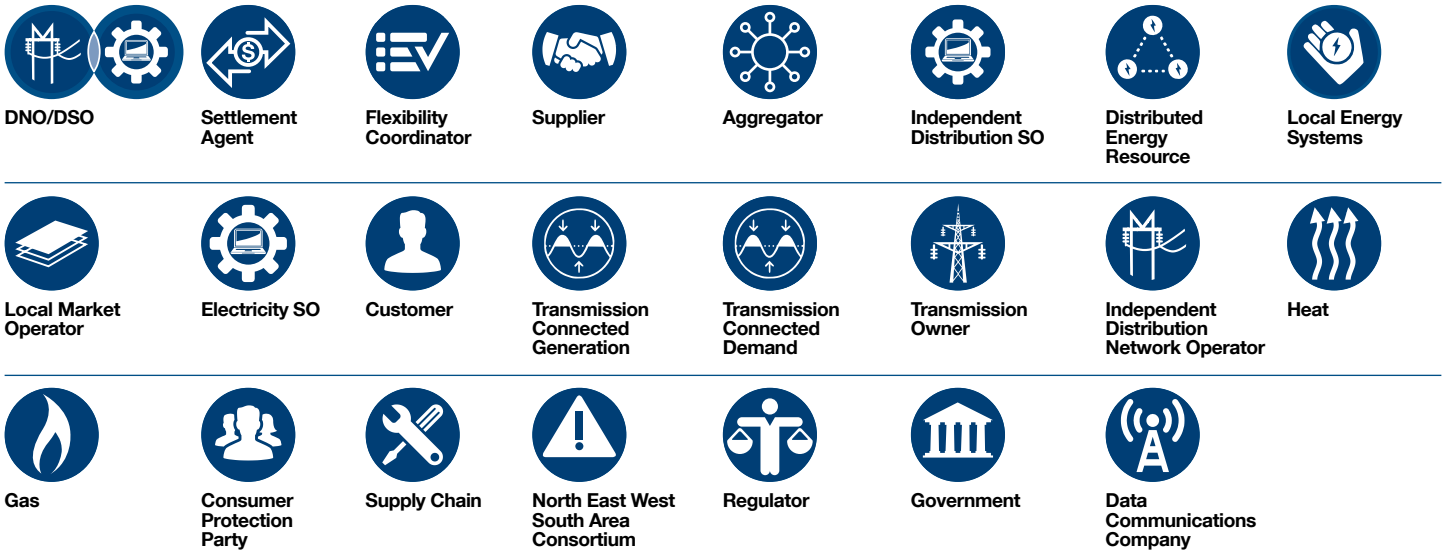
1 – Executive summary

Stakeholder feedback is critical to us and the development of the Future Worlds. You have told us that you want to understand what these Future Worlds will mean for you. Through a series of workshops we have listened to a wide range of stakeholders and developed a range of 23 actors that we believe constitute the full range of parties influenced by the Future Worlds. These actors are shown below, with their corresponding icon used to represent them throughout the consultation document. Our main findings have been presented through the lens of each of these actors and can be found in Chapter 5. We have considered the DNO/DSO actor to be a combined organisation for the purposes of this work. This consideration has not been extended to Independent DNOs (IDNOs), recognising that their evolution to Independent DSOs (IDSOs) could differ depending on network need and business model employed.

Figure 1.2:
Actors represented in the Future Worlds consultation



Your feedback has told us that whilst some stakeholders would like a high level summary, others would prefer a more detailed view. This more detailed level of information can be found in the EA Technology report which is published on our Future Worlds consultation page, together with links to the models.

Whilst the SGAM representations of the Future Worlds will provide detailed information on the structures and processes within the Worlds, further work will be required to establish how to assess the Worlds and progress their detailed development. Our thinking in these areas is also brought out in this consultation document through our work on;

- **Assessing the Worlds (Section 6)** – laying out a framework and inviting views on how we can understand the impacts of each of the Future Worlds and drawing out the criteria we should use for assessment
- **Key enablers (Section 7)** – describing the infrastructure required to enable the delivery of the Future Worlds
- **Proposed next steps (Section 8)** – identifying the common elements across all the Future Worlds that become no regrets items for progression whilst the Worlds are further developed.

Your responses to this consultation will be used to shape the next steps of these three products. Once we have completed work on all these elements, we plan to engage with you further to understand your views on our completed work. This is currently programmed for early 2019.

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1 – Executive summary

How you can help inform our work

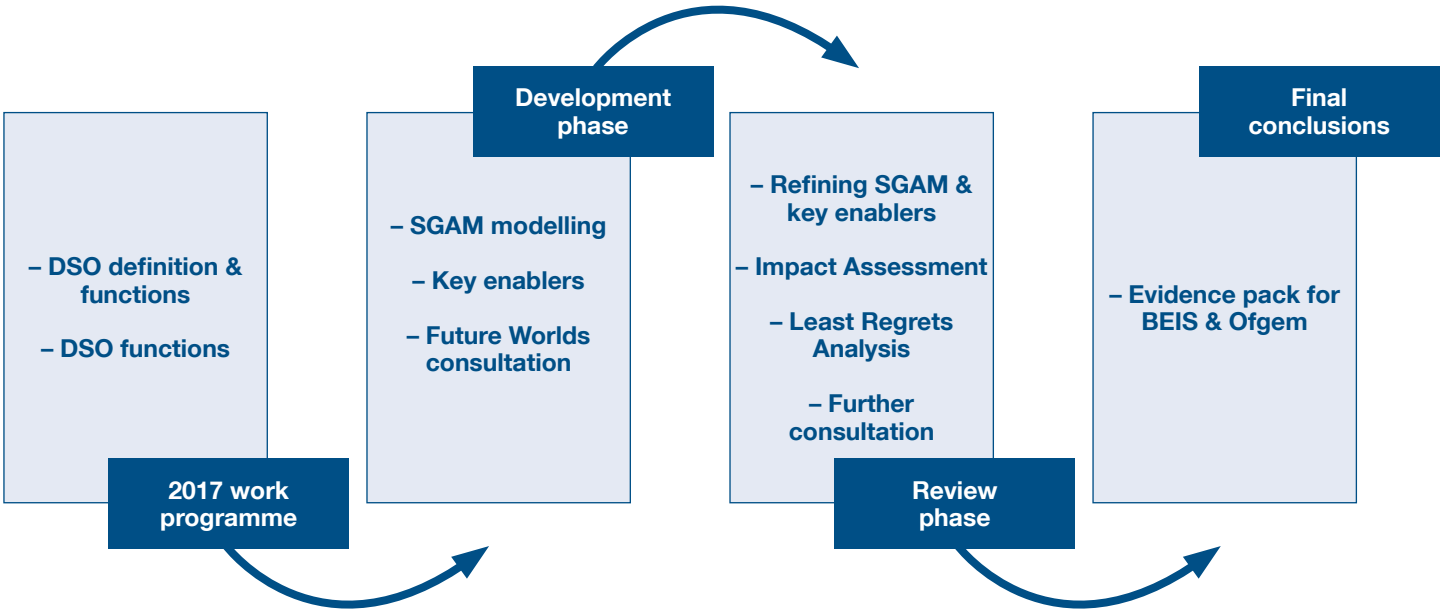
We want to hear from you about the insights provided in this consultation and we welcome all feedback and questions on its material. We will be holding a series of events during the consultation period including seminars and webinars and we look forward to hearing from you. Further details are provided at the start of this document.

This consultation document asks a number of questions on our work to inform our next steps. These questions are listed in Section 9 of this document.

How your feedback will shape our next steps

Following conclusion of this consultation on 25th September, we will enter the review phase of our work as shown in the diagram below.

Figure 1.3:
Workstream 3: Overall timeline



During the review phase, we will use your responses to this consultation to refine our SGAM modelling (noting that further detailed definition would not be appropriate at this time given the range of options under consideration) and work on key enablers.

We will also build on and deliver the thinking defined in this consultation on our independent Impact Assessment. This Impact Assessment will then form part of the evidence pack to both Ofgem and BEIS providing critical support for both parties in making policy decisions on the future direction of the whole electricity system.

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2 – The Future Worlds

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2 – The Future Worlds

Industry structure will need to change to meet the challenges of decarbonisation, decentralisation and digitisation and to facilitate arrangements that work for future Customers, service providers and business models. In its 2017 Commercial Principles paper, the Open Networks Project laid out a number of different structures to facilitate flexibility markets and invited stakeholder views. The responses received were helpful, clearly recognising the need for change and the non-viability of current arrangements going forwards.

Industry

Industry structure will need to change to meet new challenges

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2 – The Future Worlds

Using this information, the Open Networks Project Workstream 3 has further developed a number of these models into more rounded Future Worlds that consider not just the impact of flexibility markets but also the other requirements of a neutral market facilitator, whether a DNO acting as a DSO or some other party. These functions are described in detail in Appendix 10.2 and are listed below for reference;

- **System Coordination** Whole system coordination for efficient planning and operation
- **Network Operation** Safe and secure operation of networks
- **Investment Planning** Efficient design and development of the system
- **Connections and Connection Rights** Providing fair and cost-effective options that meet Customer requirements and system needs
- **System Defence and Restoration** Ensuring coordinated emergency response and system resilience
- **Services/Market Facilitation** Facilitation of markets for flexibility
- **Service Optimisation** Ensuring system needs can be met efficiently
- **Charging** Ensuring fair recovery of network and operational costs.

Workstream 3 took the view, informed by stakeholder feedback to the Commercial Principles paper, that current arrangements should not be modelled. After further feedback on the Open Networks draft 2018 work programme it was agreed to develop five Future Worlds:

- **World A: DSO Coordinates** – a World where the DSO takes a central role for all distribution connected parties acting as the neutral market facilitator for all DER and provides services on a locational basis to the ESO
- **World B: Coordinated DSO-ESO Procurement and Dispatch** – ESO procurement and dispatch – a World where DSO and ESO work together to efficiently manage networks through coordinated procurement and dispatch of flexibility resource
- **World C: Price-Driven Flexibility** – a World where changes developed through Ofgem's reform of electricity network access and forward-looking charges have improved access arrangements and forward-looking signals for Customers. This World has been built with flexibility arrangements as described in World B, but it is recognised that charging and access developments could be similarly progressed in other Worlds
- **World D: ESO Coordinate(s)** – a World where the ESO takes a central role in the procurement and dispatch of flexibility services as the neutral market facilitator for DER with DSO's informing the ESO of their requirements
- **World E: Flexibility Coordinator(s)** – a World where a national (or potentially regional) third-party acts as the neutral market for DER providing efficient services to the ESO and/or DSO as required.

These Future Worlds have been developed through discussion with stakeholders at a series of workshops. Through these workshops it has become clear that, at this stage, there are a wide range of options that exist within these Future Worlds. For example, would the Flexibility Coordinator be a national role or would there exist a number of regional co-ordinators? Such ambiguity is to be expected at this stage and hence, whilst we have made some assumptions about each of these Worlds, further work would be required to develop the Worlds in detail. We do not believe this work to be appropriate ahead of presenting the 'evidence pack' to Ofgem and BEIS for their consideration.

There are some common principles that apply across all the Worlds. This includes the principle of neutral market facilitation as described in Section 4 of this consultation. It also includes the need for network owners and operators to work together to ensure safe, secure and efficient design and operation of systems, including optimisation of existing network assets and management of network congestion and capacity.

We recognise that Ofgem, through their review of 'Future of Supply Market Arrangements[1]', are reviewing the Supplier Hub model. These Future Worlds have been built on the assumption that the existing Supplier Hub model remains largely consistent with the World today.

With the exception of World C (which has diagrams representing charging arrangements), diagrams are provided to illustrate the flexibility market arrangements in each World. They are not representative of the links for other functions and activities that exist within each World.

[1] https://www.ofgem.gov.uk/publications-and-updates/future-supply-market-arrangements-call-evidence

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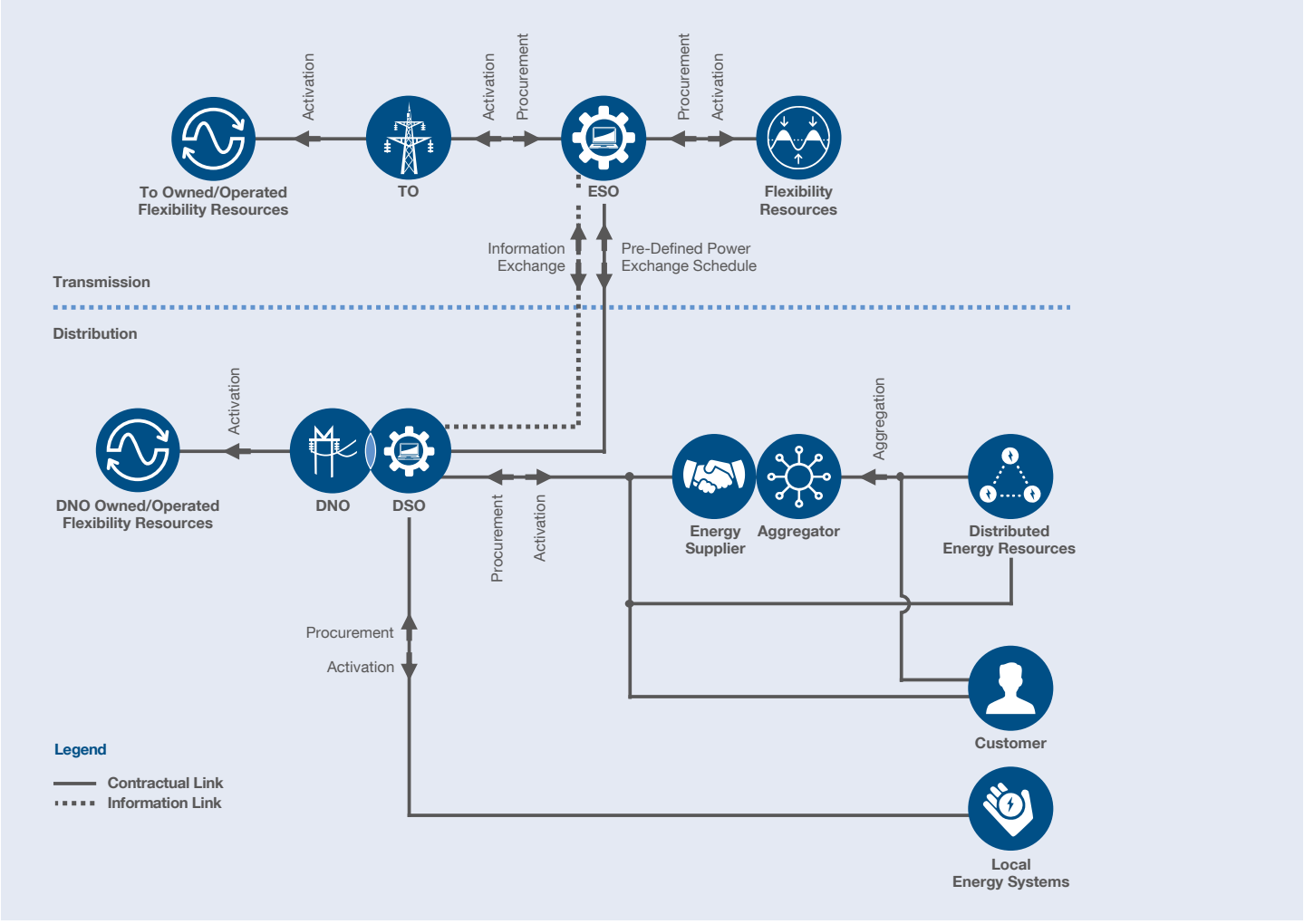
2.1 – World A: DSO Coordinates

In this world, the DSO takes on a central role for all active Customers and DER. It procures and activates distribution network connected flexibility resources for distribution network constraint management and for providing services to the ESO for regional and national requirements. The DSO also schedules flows to and from the electricity transmission system based on a pre-defined power exchange schedule agreed with the ESO. From a transmission perspective, the DSO behaves in a similar manner to other transmission connected parties and the services it can provide from DER connected within its networks are evaluated on a regional transmission and national level by the ESO in a non-discriminatory manner along with other transmission connected service providers. Figure 2.1 below shows the main relationships in this World from a flexibility services perspective.

Figure 2.1:
World A – DSO Coordinates – Flexibility market arrangements



The impact of World A on;

Getting connected and commercial arrangements
All Customers wishing to connect to distribution networks will discuss their development with their local DSO (or IDSO). The DSO will have clear boundary flow limits at each interface point with the transmission system and will innovate its connection offers around this limit to facilitate new parties wishing to connect. In the event that these limits need to be revised, the DSO will co-ordinate revised requirements with the ESO. Developers wishing to connect to transmission networks would speak to the ESO who would develop a connection offer in collaboration with the host TO. In World A, charging and access arrangements will remain similar to the World today, however a World A with price-driven flexibility could be developed (similar to World C building on World B, see World C below).

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2.1 – World A: DSO Coordinates

Flexibility market arrangements
DER can provide services to their local DSO or IDSO through local markets which would also provide access for national and regional needs with appropriate recompense including the ability to stack revenues. The DSO will optimise procurement of these services in a transparent manner for its geographic area of responsibility. In its role as a neutral market facilitator the DSO will act as a non-commercial Aggregator over a defined geographic area, offering regional and national services to the ESO and neighbouring DSOs. The ESO will consider these services alongside the services of other transmission connected parties to ensure efficient services are procured. The DSO will therefore become a balance responsible party from a national energy balancing perspective and will also be required to establish its own settlements systems to confirm requested services have been delivered.

System coordination and operation
In this World, the DSO will actively manage flows across the interface with the transmission system. These pre-defined limits, if varying with time, could help reduce the level of transmission constraints and regional actions required by the ESO, although there will still be some need. The coordination of national services such as frequency management and electricity balancing would continue to remain the responsibility of the ESO.

World A will also see the DSO take more of a leading role in major emergencies through Black Start capabilities within their networks working with the ESO to co-ordinate regional and national response. Operational liaison will still require the ESO to work closely with the DSOs to securely manage networks. The ESO will also need to ensure that DSOs manage flows from and onto the transmission network in accordance with a predetermined schedule.

Network design and development
Network requirements at the transmission – distribution interface will be managed in the short term by flow limits at each transfer point which could vary by time. Any changes to these limits will be discussed in liaison between SOs. If, as a result, further assessment is required, then this will follow a similar connection modification process to that of other transmission connected parties. Similarly the DSO will, like other transmission connected parties such as generators, be able to provide potential solutions to wider system requirements through a transparent assessment process.

SOs would continue to have responsibility for the strategic design of their responsible networks. In the case of the ESO, this would require discussions with TO on detailed development requirements. A transparent process would exist to look at solutions to transmission needs from non-network and distribution options.

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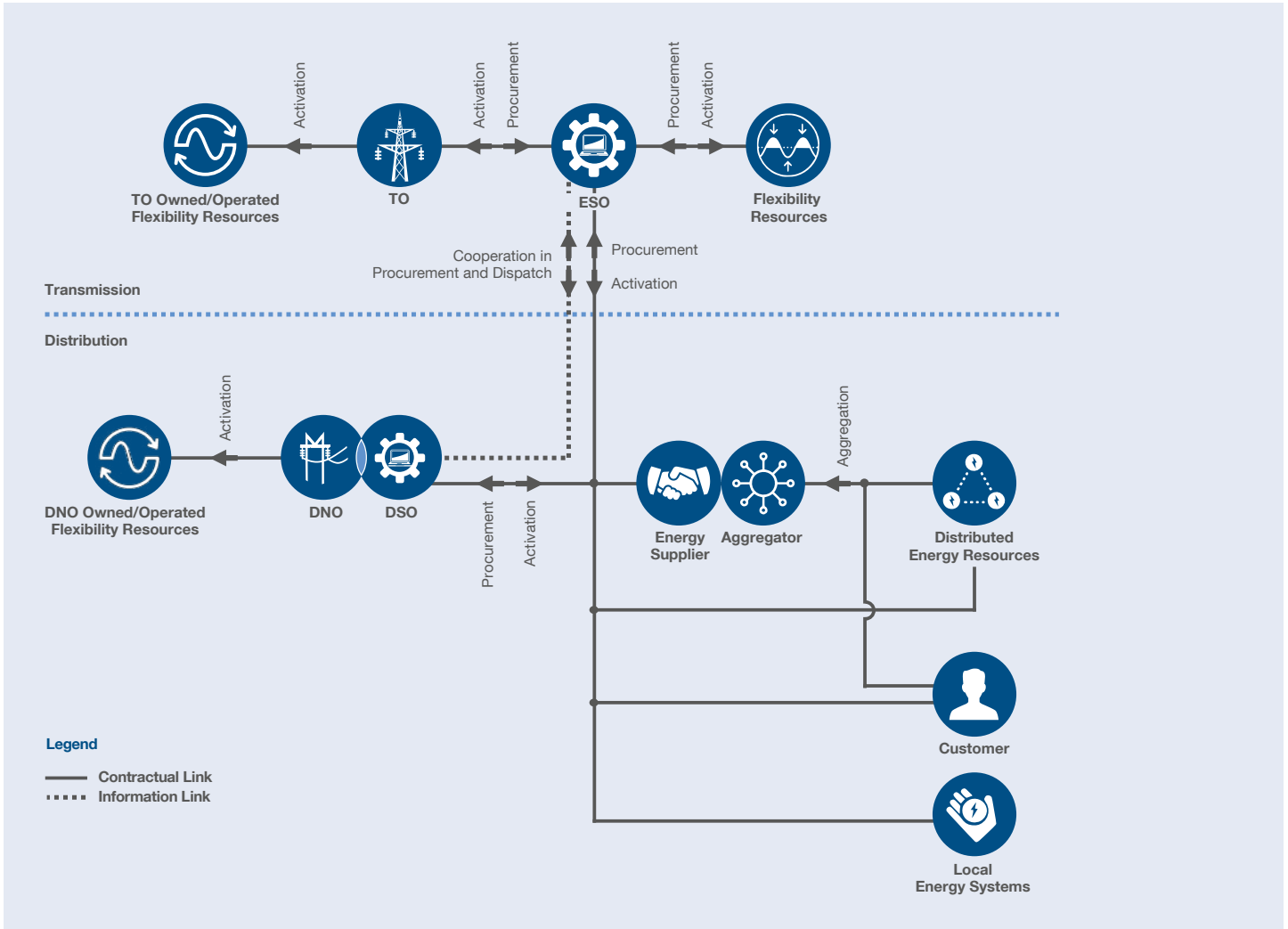
2.2 – World B: Coordinated DSO-ESO Procurement and Dispatch

In this World, flexibility resources can provide services to multiple SOs and are able to stack revenues from these differing SOs. It is recognised that, on occasion, the needs of different SOs will conflict and it will be the joint responsibility of these SOs to coordinate service procurement and dispatch activities. This will be done in a transparent manner which creates the most efficient outcome for the end consumer. Figure 2.2 illustrates the flexibility market arrangements for this World.

Figure 2.2:
World B – Coordinated DSO – ESO Procurement & Dispatch – Flexibility market arrangements



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2.2 – World B: Coordinated DSO-ESO Procurement and Dispatch

The impact of World B on;

Getting connected and commercial arrangements
All Customers wishing to connect to distribution networks will discuss their development with their local DSO (or IDSO), as in World A. Where this causes potential issues across the transmission – distribution interface the DSO will discuss with the ESO and submit a 'Transmission Impact Assessment' (or similar) request to ensure coordinated development of networks. Developers wishing to connect to transmission networks would speak to the ESO who would develop a connection offer in collaboration with the host TO. World B has not seen significant change to charging and access arrangements (these having taken place in World C).

Flexibility market arrangements
In this World, there could be a central ancillary services market for flexibility resources connected at the transmission and distribution networks providing services to the ESO and some DSOs similar to the current Balancing Market. The ESO will procure services for both national needs and also regional transmission requirements. Additionally, there could be coordinated regional and local markets for flexibility resources connected to the distribution networks facilitated by the host DSO. The ESO and DSOs will work together to ensure efficient procurement and dispatch decisions are made across these markets to optimise procurement in a transparent manner and manage any conflict of service provision.

System coordination and operation
System coordination and operation interfaces will remain similar to today with DSO and ESO control rooms working together to ensure security of supply and asset safety. It is recognised that the future will have an increased number of active participants connected to distribution networks. This will increase the requirement for coordination between SOs whose processes will need to evolve to manage increased uncertainty in system flows and demands. Emergency restoration processes will also need to evolve recognising the increased number of options through the availability of Black Start DER.

Network design and development
Technical and commercial discussions between SOs will continue to be held similar to existing processes to ensure overall efficient network development. There will be an increased need for overall coordination of network and non-network solutions to meet future system needs.

SOs would continue to have responsibility for the strategic design of their responsible networks. In the case of the ESO, this would require discussions with the TO on detailed development requirements. A transparent process would exist to look at solutions to transmission needs from non-network and distribution options.

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2.3 – World C: Price-Driven Flexibility

World B considered a World based on enhanced contracted flexibility arrangements. In World C, changes are made to price flexibility arrangements such that active parties vary their demand or generation in response to either or both energy price and network signals, such as time and location.

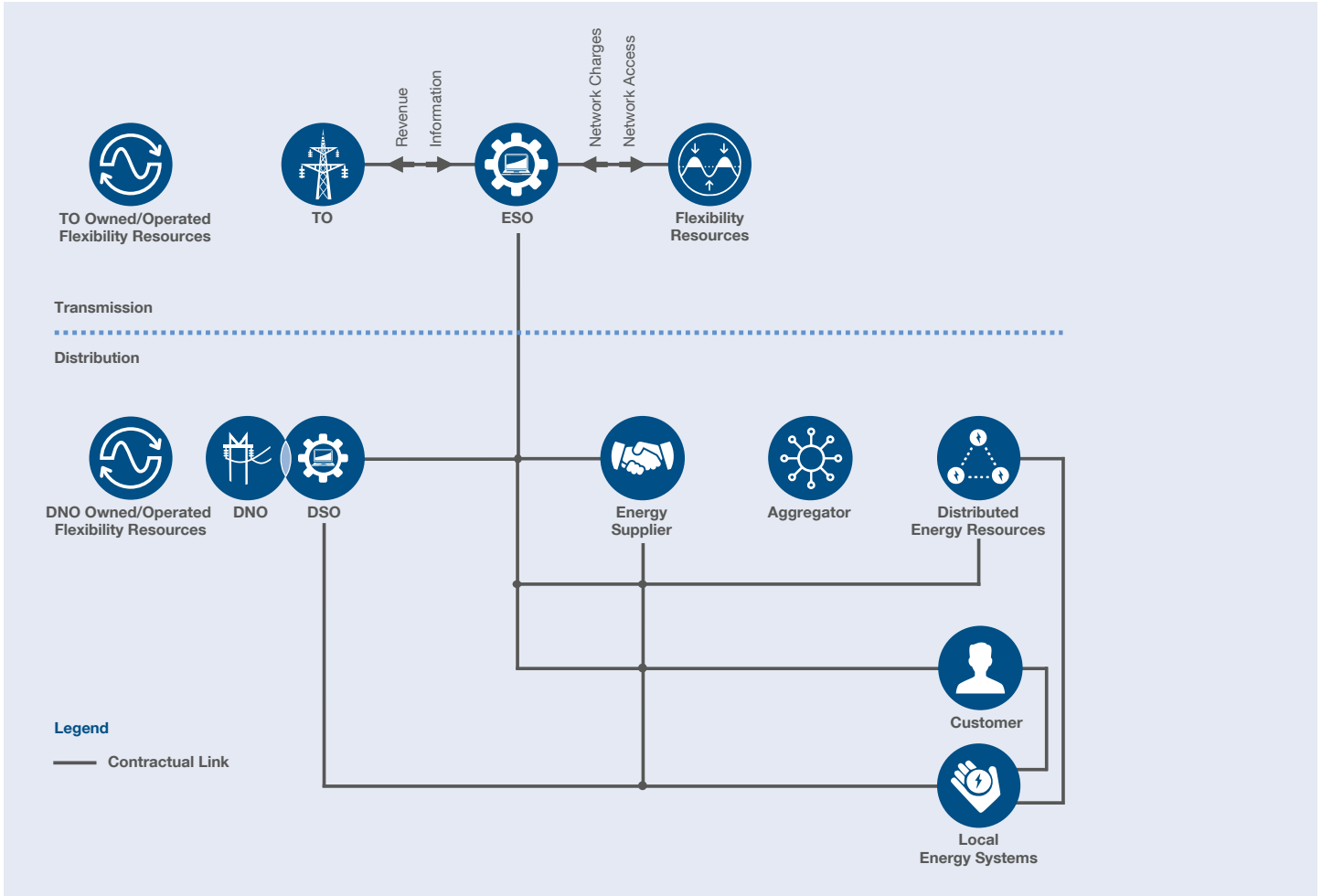
This World has been developed cognisant of Ofgem's reform of electricity network access and forward-looking charges programme and considers potential changes to future charging and access arrangements. Given the relatively early stage of this programme and the nature of the SGAM modelling it has not been possible to define a detailed option. The World does consider high level principles for changes to charging and access arrangements that are consistent with the work of Charging Futures including;

- Ensuring greater alignment of arrangements between transmission and distribution
- More effective influencing of user operations through network charging arrangements
- More appropriately influencing user investments through access and user commitment arrangements
- Consideration of connection rights and arrangements.

The diagrams below illustrate the current communication requirements in charging and access arrangements (Figure 2.3a) and the equivalent requirements in the Price-Driven Flexibility World (Figure 2.3b).

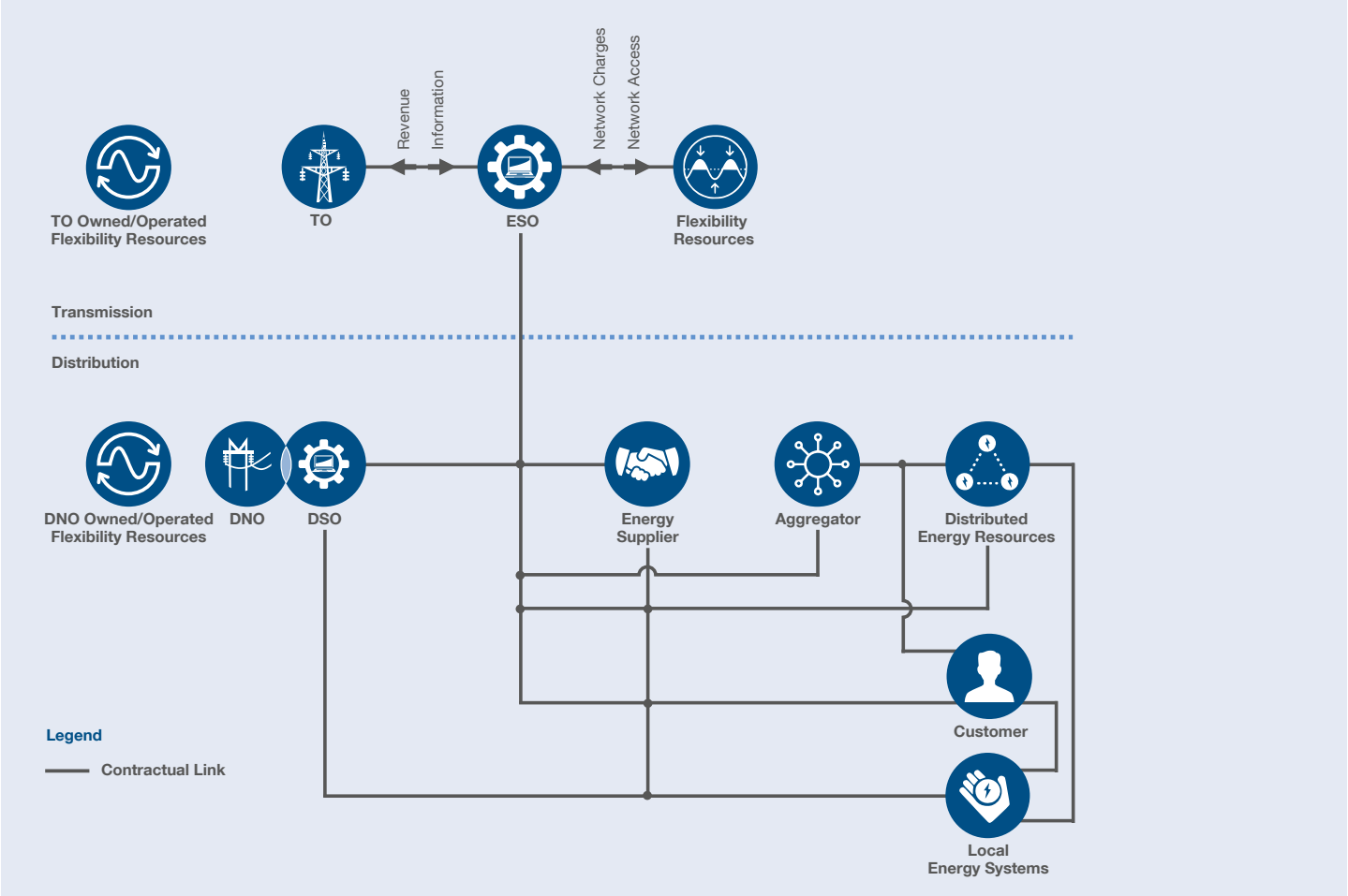
It is recognised that, even with these developments, there will be a need to still develop contracted flexibility arrangements to facilitate increased volumes of DER, although this requirement could be reduced. Therefore, these arrangements in World C mirror those of World B (similarly it would be possible to layer over price flexibility arrangements in Worlds A, D and E). The diagram for these flexibility market arrangements can be found in Figure 2.2.

Figure 2.3a:
World C – Price-Driven Flexibility – 'Price Flexibility' arrangements
(a) Present network access and charging



2.3 – World C: Price-Driven Flexibility

Figure 2.3b:
World C – Price-Driven Flexibility – 'Price Flexibility' arrangements
(b) Future network access and charging



The impact of World C on;

Getting connected and commercial arrangements
Consistent with current arrangements, Customers would discuss a prospective connection with the appropriate SO. Whilst the depth of connection charges might alter to improve consistency across networks the need for information exchange would continue. Similarly, network charging arrangements would also move to be more consistent, the primary difference in this World is that all parties would be liable for network and/or SO charges based on an equivalent basis.

Flexibility market arrangements
Arrangements would be similar to World B, where there could be a central ancillary services market for flexibility resources connected at the transmission and distribution networks, providing services to the ESO and some DSOs. Additionally, there would be separate coordinated regional and local markets for flexibility resources connected to the distribution networks facilitated by the host DSO. The ESO and DSOs will work together to ensure efficient procurement and dispatch decisions are made across these markets to optimise procurement in a transparent manner and manage any conflict of service provision.

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2.3 – World C: Price-Driven Flexibility

System coordination and operation
Again, arrangements would be similar to World B, where system coordination and operation activities will remain similar to those in the World today, with DSO and ESO control rooms working together to ensure security of supply and asset safety. As parties would be responding to enhanced pricing and network signals there is an expectation that there would be less need for SO intervention than in World B. Emergency restoration processes will also need to evolve recognising the increased number of options through the availability of Black Start DER.

Network design and development
Technical and commercial discussions between SOs will continue to be held similar to existing processes to ensure overall efficient network development. There will be an increased need for overall coordination of network and non-network solutions to investment needs. Network charging arrangements will better reflect the cost of these solutions, allowing Customers to make informed investment decisions.

SOs would continue to have responsibility for the strategic design of their responsible networks. In the case of the ESO, this would require discussions with the TO on detailed development requirements. A transparent process would exist to look at solutions to transmission needs from non-network and distribution options.

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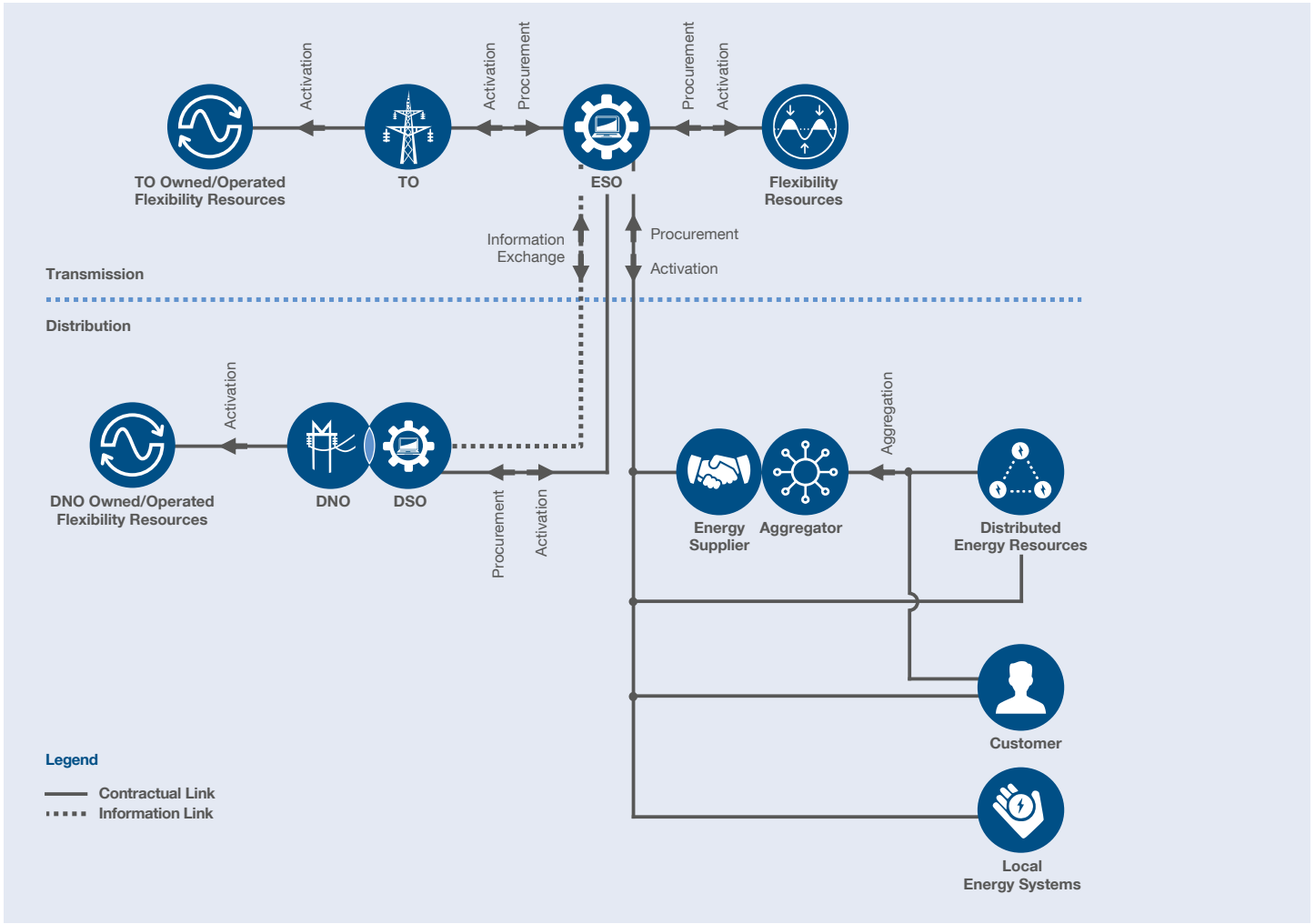
2.4 – World D: ESO Coordinate(s)

In this World, the ESO takes a more central role than in previous Worlds in many of the Customer facing activities of an SO. This potentially includes connection and charging arrangements as well as flexibility services (Figure 2.4). The DSO role would become more focused on identifying short term and long-term service opportunities from third-party providers which would be passed as service requests to the ESO for procurement.

Figure 2.4:
World D – ESO Coordinate(s): Flexibility market arrangements



The impact of World D on;

Getting connected and commercial arrangements
Arrangements for connecting to distribution networks could be through tripartite arrangements between SOs and the individual. Alternatively, these arrangements could look similar to current transmission arrangements with Customers (potentially down to a minimum threshold) contacting the ESO in the first instance for a connection, with the ESO holding the connection agreement (the physical connection activity being the responsible of the relevant network owner). Network charging arrangements could also look similar to current transmission arrangements where the SO would level network charges (or possibly a single network charge) and would also be responsible for the charges associated with operational costs. An ESO Coordinate(s) World could be created with price-driven flexibility principles consistent with World C.

Flexibility market arrangements
The ESO would be the central party for all flexibility services, or potentially down to a minimum level. DSOs would submit their requirements to the ESO who would present these needs, alongside national and regional transmission requirements, to service providers and optimise overall procurement in a transparent manner. The ESO would also be responsible for both dispatch (in coordination with the relevant DSO) and the settlement process.

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2.4 – World D: ESO Coordinate(s)

System coordination and operation
In this World, DNOs would continue to have operational responsibility for their networks including optimisation of assets and use of smart technology as well as identifying requirements from third-party flexibility providers. The ESO would work with these DSOs to ensure overall efficient network operation and manage security of supply. The ESO would also take a lead role in managing national security of supply including Black Start restoration plans involving support from DER.

Network design and development
DNOs would continue to have responsibility for design and development of their networks. The ESO would have responsibility for strategic development on a regional basis considering efficient solutions from all parties, both network and non-network. In the case of the transmission system, the ESO would discuss detailed development requirements with the TO. A transparent process would exist to look at solutions to transmission needs from non-network and distribution options.

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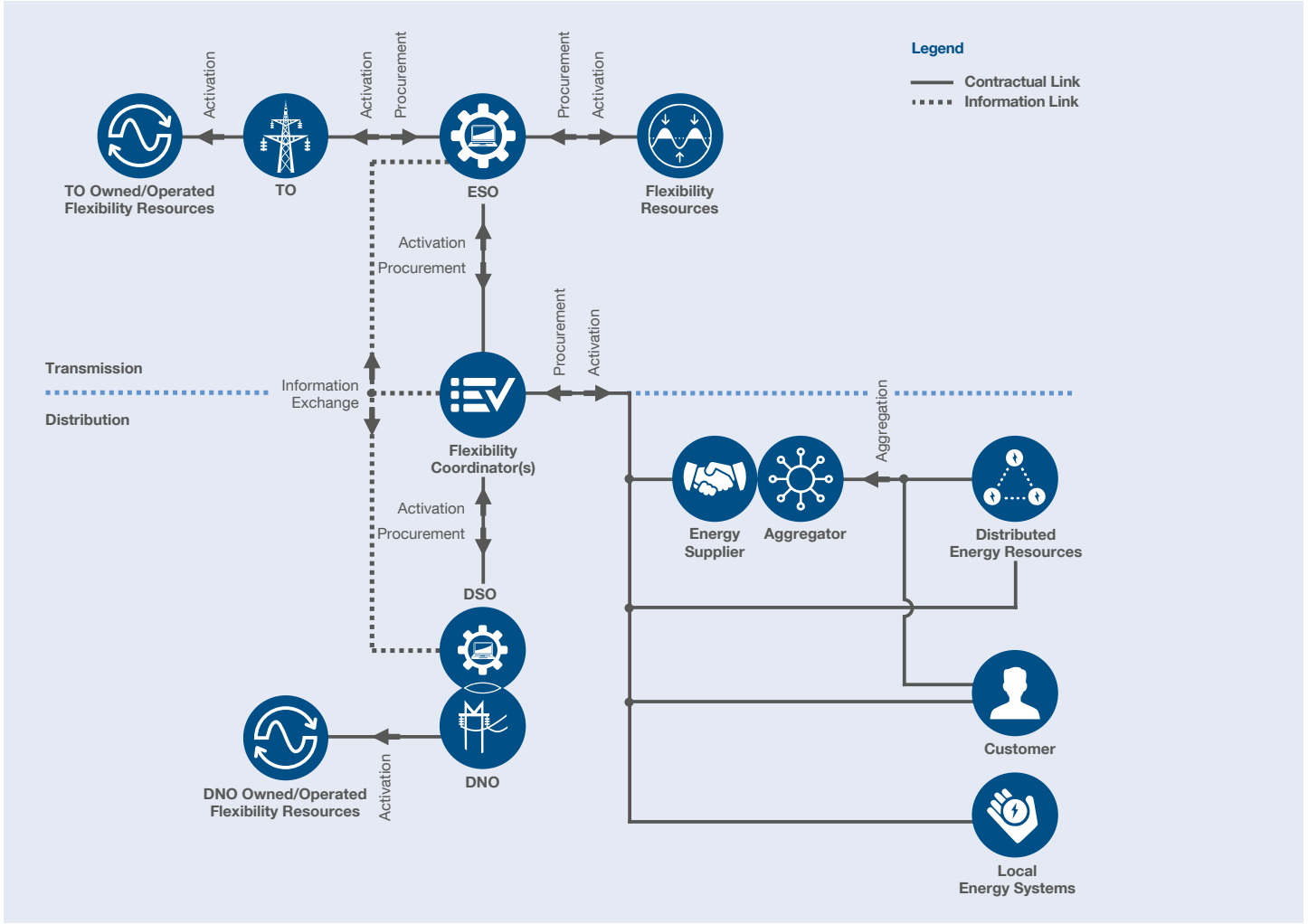
2.5 – World E: Flexibility Coordinator(s)

In this World, a new party, the Flexibility Coordinator, acts as an independent, neutral market facilitator for all flexibility markets. This party could either be a national entity or one of a number of standardised regional monopoly entities. The Flexibility Coordinator(s) is responsible for collecting service requirements from both DSOs and the ESO, optimising the requirements and identifying the most efficient solution. This is achieved through the use of a common platform(s) which aids transparent decision making. The Flexibility Coordinator(s) also needs to work closely with SOs through design and operation processes to ensure a coordinated system is efficiently developed and security of supply is maintained.

Figure 2.5:
World E - Flexibility Coordinator(s): Flexibility market arrangements



The impact of World E on;

Getting connected and commercial arrangements
Developers wishing to connect to distribution networks would continue to apply directly to the existing DSO who would provide a connection offer, potentially after discussion with the ESO if there was potential for an impact on the transmission system. Developers wishing to connect to transmission networks would speak to the ESO who would develop a connection offer in collaboration with the host TO. Charging arrangements recovering the costs of regulated networks and the ESO would continue to be calculated and recovered by the DSO (at a distribution level) and the ESO (at a transmission level). The operational costs of flexibility services would be recovered by the Flexibility Coordinator(s). A Flexibility Coordinator(s) World could be created with price-driven flexibility principles consistent with World C.

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2.5 – World E: Flexibility Coordinator(s)

Flexibility market arrangements
Service providers connected to distribution networks would offer flexibility services to the Flexibility Coordinator(s) via a common platform. This could be directly or through a third-party commercial Aggregator. The Flexibility Coordinator(s) would consider these services against the needs of both DSOs and the ESO, including the required service optimisation, to arrive at an efficient outcome. In this World, the ESO would maintain its existing role for procuring national and regional transmission services either from transmission connected parties or via the Flexibility Coordinator's central platform. Both processes and the outcomes would be transparent. The Flexibility Coordinator(s) would also be responsible for dispatch of DER through the common platform and would have accountability for the settlement process for these parties.

System coordination and operation
DSOs and the ESO would continue to have responsibility for operating safe and secure systems and would need to coordinate their activities to optimise system outputs. Flexibility needs from third-party service providers would be communicated to the Flexibility Coordinator(s). The Flexibility Coordinators would similarly communicate with all SOs through this process to advise of flexibility actions planned and taken, with accountability for network reliability residing with the appropriate SO. In the event of a system emergency, such as Black Start, the operation of the Flexibility Coordinator's common platform would cease and DSOs and the ESO would work together to resolve the issue before the platform operation recommenced.

Network design and development
SOs would continue to have responsibility for the strategic design of their responsible networks. In the case of the ESO, this would require discussions with the TO on detailed development requirements. A transparent process would exist to look at solutions to transmission needs from non-network and distribution options.

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2.6 – Questions: The Future Worlds

Having read about the five Future Worlds we'd like you to consider the following three questions. Further detail of how to respond to these questions can be found in Section 9 of the consultation document.

Questions

1. **We have set out five potential Future Worlds. Do you believe these provide a reasonable spread of potential futures?**
2. **Are there other areas of potential Future Worlds you would like us to consider to inform our thinking?**
3. **Do you have any key concerns with any of the Future Worlds we have set out?**

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3 – The Smart Grid Architecture model

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3.1 – What is the Smart Grid Architecture Model?

The Smart Grid Architecture Model (SGAM) methodology is a way to represent a complex electricity system and break it down into its individual parts. It is three dimensional, which allows complex aspects of the electrical network to be considered from a variety of perspectives. It also helps separate exactly what impacts the specific aspect being considered. For more detail on the SGAM methodology, please refer to Appendix 2.

3.2 – Why was the SGAM methodology used?

SGAM is a powerful way to capture complex models and allows specific aspects to be considered in as much detail as appropriate. The SGAM was originally developed by the Smart Grid Coordination Group as part of a European Commission Mandate, and is a holistic framework for describing smart grid systems, from their functional specification right through to their architectural design. Our SGAM model has been created in Sparx Enterprise Architect software which helps maintain stringent governance around the data and makes it easier to maintain and use the model in the future. Sparx Enterprise Architect also has a specific SGAM toolbox which facilitates model development.

The purpose of the SGAM modelling is twofold: firstly, to compare and contrast the five Future Worlds, and secondly to act as a base model for DNOs to build their required architectures, interfaces and business processes around for the DSO transition. To enable detailed comparison of the Future Worlds, the interactions between actors are captured and categorised as part of the SGAM work.

It is worth noting that not all the layers have been populated at this point. There are more inputs required from trials and, as the modelling becomes more detailed, it is more appropriate that each network organisation models their particular system specifically to account for regional differences. The SGAM model can enable further development of the systems and business processes that will underpin the DSO transition. To help populate the SGAM models further, this will initially be carried out by the Transition, Electricity Flexibility and Forecasting System (EFFS), and Fusion (TEF) Network Innovation Competition (NIC) projects.

3.3 – How the SGAM model was built

The model was built using a top down approach, starting with the main functions of a DSO as a neutral market facilitator, including:

- System coordination
- Network operation
- Investment planning
- Connections and connection rights
- System defence and restoration
- Services/market facilitation
- Service optimisation
- Charging.

These are then broken down into specific activities which help achieve each of these functions. For a detailed description of all the specific activities, please refer to Appendix 1, and our Future Worlds consultation page for links to the EA Technology report and the models.

The next stage was to populate each activity with processes of differing timescales. To capture this, ENA ran five workshops with a broad cross section of stakeholders to help inform these processes. The outputs from the workshops captured in the SGAM model.

From this information, data flows were created in the model between each of the actors in each World. This process allows each of these data flows to be interrogated and allows specific actors to analyse the specific activities that impact them.

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3.4 – Limitations of SGAM

The SGAM methodology focuses on the physical architecture of the electricity network, the systems that underpin it and the industry wide business interactions required for it to successfully operate. It does not focus on the Customer side of the meter or interactions outside of the electricity system.

There are two main aspects of the Future Worlds that SGAM does not model well.

1. SGAM cannot model the details of market operation. While it can capture market operation at a high level, for example how the market can operate and who will be active within it, it cannot capture the intricacies of how this market may operate.
2. SGAM does not capture human behaviour. Actors such as Customers (both active and passive) and Local Energy Markets may not always act in a logical way to financial incentives or direct instructions to change behaviour. Although the specific behaviour of these actors, or the detailed market interaction, may not be captured, providing this is kept in mind while integrating the models, then the main purpose of the models can be carried out. However, it is important to recognise that to understand these specific aspects further social science and market modelling will be required.

3.5 – How are the SGAM models going to be used?

The SGAM models will be used to support future work, particularly the Impact Assessment that is being carried out as part of Workstream 3. They will also allow for some quantitative analysis between the Worlds.

TEF innovation projects will inform further development of the models. TEF projects will themselves benefit from using SGAM models as this will help identify where key aspects are not being tested and where further modelling work is appropriate to ensure key implementation challenges are captured. This approach will demonstrate the extent to which all actors' needs are correctly addressed.

For future maintenance of the models, the Open Networks Project team intends to develop and update the models when outputs from other works can inform this. They have been designed with ongoing update governance in mind to help with this. This will also help network organisations develop and maintain the models for DSO transitions.

The full Sparx Enterprise Architect models are available on request and we actively invite academia and others to explore and comment of them. This is in addition to the HTML links on our webpage.

3.6 – Questions: The Smart Grid Architecture Model

We are interested in your views on the SGAM methodology we have employed and invite you to respond to the following questions. Further details on how to respond can be found in Section 9 of this consultation document.

Questions

1. **Is there anything missing from the SGAM methodology that has been implemented?**
2. **How can SGAM modelling be used in further work to extract maximum value?**
3. **What are the limitations of using the SGAM modelling for informing the Impact Assessment?**

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4 – The principle of neutral market facilitation

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4.1 – Neutral market facilitation

The UK is one of the most competitive energy markets in the World, and certainly the most deregulated and unbundled, with a multitude of businesses participating in the market across many different roles. The transition to a smart energy grid needs to build on that position. One of the biggest challenges surrounding the transition to a smart grid is how we create a market for flexibility that will simultaneously protect the competitive nature of our energy market whilst delivering meaningful, new choices for consumers around how they consume energy and embrace low-carbon technologies in their homes and lives.

To achieve this, an energy market needs to create the visibility that all participants require from a smart grid. A highly unbundled market with a lot of participants and multilateral commercial arrangements can look daunting.

However, that complexity can be reduced if:
– policy, legislation and regulation are coherently aligned;
– there is clarity over the roles and responsibilities of market participants;
– the mechanisms are defined for how information is shared;
– there is a common interface in place that supports those market arrangements.

ENA is clear that it is important to define market rules and establish how the SOs (and the Flexibility Coordinator in World E) can interact with the market to ensure it operates effectively. An effective approach could reduce the complexity of operating in a market that requires SOs (and the Flexibility Coordinator in World E) to manage the many commercial arrangements that exist in highly unbundled and competitive markets. Reduced complexity represents significant potential for reducing or removing costs associated with managing these processes.

In the development of flexibility markets there will be multiple parties seeking to procure flexibility services. There will also be many parties seeking to offer services either directly or indirectly through some third-party agent. A critical role in the development of flexibility markets will be that of the market facilitator engaging with the platforms that provide visibility of the opportunities for buyers and sellers of flexibility and managing any resulting conflict from service provision.

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4.2 – The need for SOs (and the Flexibility Coordinator in World E) to be neutral

As natural monopolies owning critical national infrastructure, networks are already heavily regulated and benchmarked against each other to ensure efficiency and fairness. It is essential that they deliver value for money to consumers, and to this end, networks are increasingly promoting competition in connections and exploring the innovative use of ancillary services. As DNOs transition to support the ESO in system operation, this is becoming increasingly important, as many new services and developments are happening at local distribution level. The responsibility of SOs (and the Flexibility Coordinator in World E) is to facilitate the market whilst demonstrating neutrality to ensure benefits are realised for all consumers through competition. For the market to be effective it needs to enable competition, and for competition to be effective there needs to be a level playing field for all. Neutral market facilitation enables this level playing field.

ENA is therefore clear that SOs (and the Flexibility Coordinator in World E) must act as neutral market facilitators performing regulated core activities and not activities that can efficiently and practicably be left to a competitive market. This approach is important because:

- Competitive markets are generally better than regulated markets in delivering outcomes that provide best value for money for consumers;
- When SOs get involved in competitive activities there is a risk that they would favour their service over potentially cheaper services thereby raising costs and deterring investment and innovation;
- SOs could unfairly favour different types of consumers if they are direct market participants for these services; and
- Confidence in the neutrality of the SOs is a key element of a functioning market.

Ensuring SOs (and the Flexibility Coordinator in World E) act as neutral market facilitators is therefore key to the energy transition. SOs (and the Flexibility Coordinator in World E) will make significant use of the flexibility market even though they will not own it.

The market will be used concurrently by the SOs and other organisations for many different purposes:

- traditional energy supply;
- operation of the energy networks in smarter ways;
- and the provision of low-carbon energy services.

The key role of the SOs (and the Flexibility Coordinator in World E) as neutral market facilitators will be to ensure the transparency of network needs/service requirements, so that market participants are able to react to opportunities and offer solutions.

To that end we believe that these are the following requirements for a neutral market facilitator:

- Ensures non-discriminatory and technology neutral solutions: favouring solutions that are optimal rather than unfairly favouring particular technologies;
- Uses market mechanisms that are fair, transparent and competitive, providing a level playing field for providers of network services and providers of energy products/services in order to deploy the most efficient and effective solutions;
- Supports flexible and innovative solutions in response to future Customer requirements and develops the network services they require, including enabling and facilitating innovation by others; and
- Delivers value to Customers and communities.

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4.3 – The DNO/DSO as a neutral facilitator of markets

As our work developing the Future Worlds has progressed it has become clearer that the DSO is a group of functions between actors and is not yet assigned to an organisation, and the five Worlds represent different ways of implementing these functions, which does have implications on organisational structures. The Open Networks Project supports the concept of neutrality for all actors undertaking these functions, building on the work in this area to clarify how a DNO as a DSO will operate as a neutral facilitator of markets. It is important to note that the principle of neutral facilitation will apply to such DSOs in all Future Worlds as they will have a key role in facilitating local solutions either directly (World A) or in support of the ESO or Flexibility Coordinator (Worlds B, C, D and E). In 2017, at the outset of the project, neutral facilitation was enshrined in the definition of such a DSO, its roles and responsibilities and its principles of operation:

DSO definition
A Distribution System Operator (DSO) securely operates and develops an active distribution system comprising networks, demand, generation and other flexible Distributed Energy Resources (DER). **As a neutral facilitator of an open and accessible market it will enable competitive access to markets and the optimal use of DER on distribution networks to deliver security, sustainability and affordability in the support of whole system optimisation.** A DSO enables Customers to be both producers and consumers; enabling Customer access to networks and markets, Customer choice and great Customer service.

DSO roles and responsibilities
– Maintain distribution network resilience and security
– Support whole system stability
– Provide fair and cost-effective distribution network access
– Provide capacity in an efficient, economic, coordinated and timely manner
– Support whole systems optimisation
– Enable and facilitate competition in energy markets
– Provide and maintain systems, processes and data to facilitate markets and services.

Principles of operation
– Ensures non-discriminatory and technology neutral: favouring solutions that provide the most optimal solutions rather than particular technologies;
– Uses market mechanisms that are fair, transparent and competitive, providing a level playing field for providers of network services and providers of energy products/services in order to deploy the most efficient and effective solutions;
– Supports flexible and innovative solutions in responding to Customers' future requirements and in developing the network services they require, including enabling and facilitating innovation by others; and
– Delivers value to Customers and communities.

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4.3 – The DNO/DSO as a neutral facilitator of markets

Subsequently, as the Open Networks Project explored the role of the DNO as a DSO, and the specific role it would undertake, service and market facilitation was identified as a key function consisting of:

- Interface with the ESO and other network operators to enable the development of distribution capacity products, the creation and operation of local network service markets and to enable DER access/participation in wider services for whole system optimisation
- Facilitate local and national markets to access and settle services through auctions and other market arrangements for whole system efficiency
- Ensure these arrangements are fair and transparent. Provide information and control system infrastructure to facilitate local and national markets and service provision.

Under the service and market facilitation function, the DNO as a DSO will define distribution network service requirements and support the market arrangements put in place to provide these and other services. Activities will include assessing the value of flexibility, the definition of new services and supporting the operation of the markets and systems needed to provide these services. Such DSOs will also support the market participants by providing information to the market, including system needs. Wider coordination aspects under this function include the mitigation of potential service conflicts and the design and implementation of service arrangements to provide efficient whole system outcomes.

The clear challenge for DNOs as they transition to DSOs is to ensure that there are no potential conflicts of interest as they help facilitate the market. ENA is clear that visibility, transparency and regulation will all be essential in mitigating the risk of conflict and ensuring market participants are able to compete in an unencumbered market.

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4.4 – Questions: The principle of neutral market facilitation

We are interested in your thoughts on the principle of neutral market facilitation and invite you to respond to the following questions. Further details on how to respond to this consultation can be found in Section 9 of this document.

Questions

1. How do you believe neutral market facilitation for SOs can be achieved?
2. What are the possible conflicts of interest that SOs need to be aware of when facilitating the market?
3. What additional requirements would be appropriate to ensure the neutrality of SOs in facilitating the market?

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5 – Stakeholder insights

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5 – Stakeholder insights

In Section 2 of this consultation we describe the five potential Future Worlds developed by a series of stakeholder workshops, and through the SGAM modelling.

Whilst there are common elements in these Worlds, there are also significant differences to roles, responsibilities and interactions. In Section 8 of this document we will describe how these interactions vary and provide more detail as to the common elements. In this chapter we focus on the key industry actors in each World, describing:

– The current role each actor plays
– How their roles and responsibilities will evolve to meet the challenges of decarbonisation, decentralisation and digitisation
– How the five different Future Worlds will affect each actor.

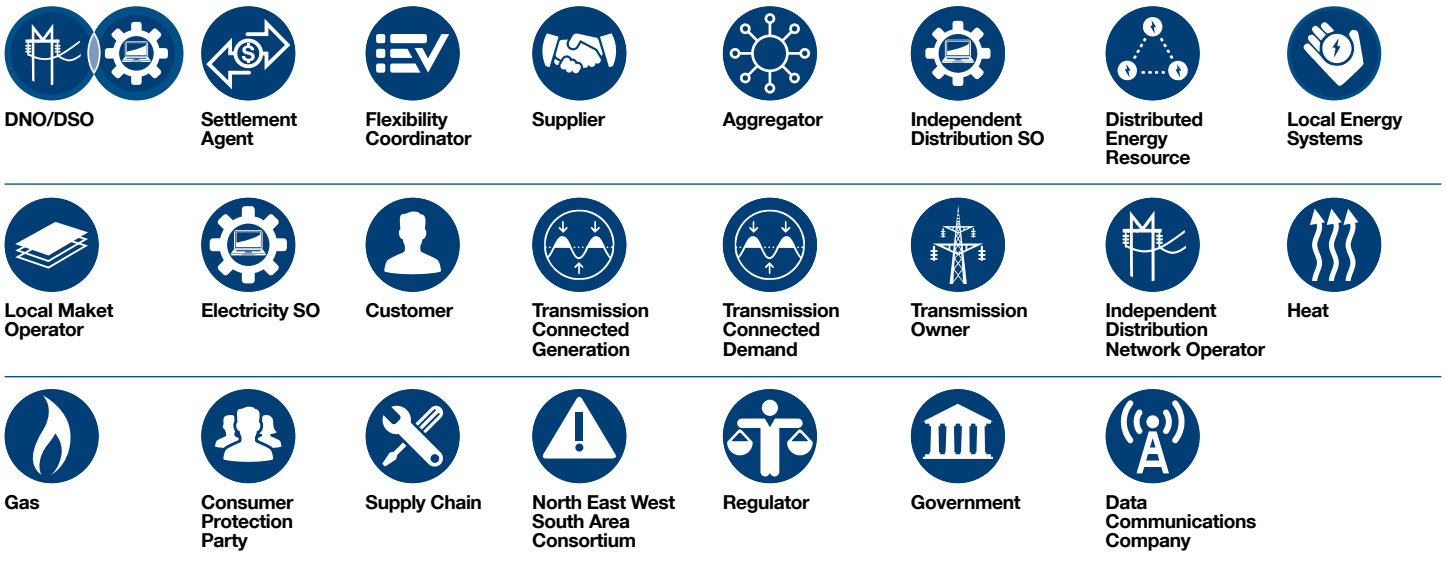
This section has been intentionally drafted through the lens of each actor and there is a page devoted to each actor describing how the Worlds will affect them. The SGAM modelling has focused on interactions between actors and the differences in these interactions between different Worlds. This analysis will not identify the relative size of markets or the level of information through each transaction, although such elements may be picked up in our Impact Assessment. Our assessment is therefore primarily based on the changes in actor interactions between the Worlds.

We would value your feedback on the views provided through the questions asked below.

Introducing the actors

The diagram below shows the 23 actors identified through the SGAM modelling. All of these actors are included in the SGAM Worlds and it is the links between these actors that have been used in our analysis so far (see Section 8). As we move towards our smart, decentralised systems of the future, many of these actors will see significant change and evolution of their roles. For some, these changes will be largely consistent across the five Future Worlds, for others, there is considerable difference.

Figure 5.1:
The 23 actors identified through the SGAM modelling



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5 – Stakeholder insights

Through the workshop process the number of actors and their descriptions has evolved. We're conscious that you may not readily recognise your role as one of the existing 23 actors. To help you identify your role we have provided a table with alternative descriptions.

Actor	Includes the following parties
Customer	Active and passive Customers
Data Communications Company	Mobile data providers
Distributed Energy Resource (DER)	System service providers and active participants including distributed generation, flexible demand providers, and distribution connected energy storage
Equipment Manufacturer	Equipment Suppliers
Government	Local and regional bodies
Local Energy System	Community Energy Groups
Local Market Operator	Platform provider

Questions:
As you read through this section we would value your thoughts on the following questions. Further details on how to respond to this consultation can be found in Section 9 of this document.

Questions

1. **Which SGAM actor(s) best describes your future role(s)?**
2. **Do you have any thoughts on the insights gained on this role(s) in each of the Worlds?**
3. **Do you have any comments on the insights drawn on any of the other roles described?**
4. **If you do not feel represented by any of the actors, how do you believe we should capture your role?**

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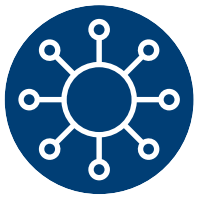
5 – Stakeholder insights



Aggregator

What is an Aggregator?

An Aggregator is a company who acts as an intermediary between active parties such as DER and active Customers who can offer flexibility services, and SOs who wish to obtain such services for efficient management of networks. The Aggregator groups distributed service providers into a single entity for the purpose of flexibility service provision. This can be through national aggregation or on a more regional basis.

How will the future look for an… Aggregator

How will its role evolve in the future?
In the future, we expect there to be an increased need for flexibility services, particularly to resolve distribution network issues. This will provide greater opportunities for Aggregators.

In addition, there may be increasing numbers of active consumers wishing to create value through flexibility services, thereby increasing the numbers of flexibility providers for Aggregators to engage with.

There will be increasing competition to provide an aggregation service with a variety of actors and business models involved.

How could different Future Worlds affect Aggregators?
For Aggregators, the main difference between the Worlds is how broadly they can aggregate and sell on flexibility services. For example, in World A, where the DSO coordinates, Aggregators will be able to aggregate their portfolio within a DNO's network (potentially a single connection point to the transmission network) but broader (such as national) aggregation as exists today may need to evolve (the existing direct relationship with the ESO will disappear for example). Aggregators will still be able to supply services to the ESO from assets on the distribution network, however only through the DSO. There would be a need for standardisation across DSO systems.

In World B, Aggregators will be able to stack revenues freely from different flexibility services at both distribution and transmission level and likely remain able to aggregate their portfolio across DNO networks. This could be through common or multiple platforms. Strong coordination between SOs will mean that any conflict of services are resolved seamlessly for the Aggregator.

World C would create some differences for an Aggregator:
- An increase in price based flexibility could result in a lower requirement for contracted flexibility
- An increasing number of Customers could move to become active, creating new market opportunities.

In World D, if DSO control is maintained over lower voltage systems, then Aggregators will have to log service provision separately with the ESO and DSO. However, if the ESO becomes the central party at all voltages then Aggregators could have little relationship with the DSO, and instead may only deal with the ESO. In either case, functionality for both proposals could be similar to World B with the ESO taking more of a lead for conflict resolution management. This distinction is also present in World E where the Flexibility Coordinator coordinates flexibility services within lower voltage systems and again Aggregators may have little relationship with the DSO.

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Consumer Protection Party

What is a Consumer Protection Party?

A Consumer Protection Party (CPP) is a party responsible for acting as the voice of the consumer, for example Citizens Advice.

Such a party may represent consumers in general or may focus on the needs and concerns of a defined subset, for example large energy users.

How will the future look for a… Consumer Protection Party

How will its role evolve in the future?
The transition of passive Customers to active Customers will create both transitional and enduring concerns for a CPP. The transition of consumers to become active participants will be a topic of interest for CPPs who will have a role in ensuring that all consumers are given the opportunity to transition in a fair and accessible manner. On a long-term/continuing basis, the CPP will also lobby to ensure that those Customers who remain passive are treated fairly and not disadvantaged.

How could different Future Worlds affect a Local Market Operator?
For the CPP, World C will likely present a greater focus on pricing arrangements, such as network charging, than the other Worlds. Its role will not vary greatly between other Worlds, although its relationship between actors may differ depending on their specific functions. In relation to flexibility services, a CPP will be neutral to whose role it is to facilitate markets. Rather they will want to ensure that arrangements work for consumers, ultimately generating value.

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Customer

Who is a Customer?

Traditionally, Customers have been passive entities taking power from networks for use in their homes and businesses. Through smart meters, microgeneration and storage, these parties will have the choice whether to become active in their use of electricity or remain passive. The Open Networks Project has defined both of these Customer types.

How will the future look for a… Customer

Passive Customers represent domestic or smaller non-domestic end-use electricity Customers with little or no ability to engage with low-carbon technology based products and flexible energy market services. For example, passive Customers would include end-user electricity Customers in social housing with or without access to a community energy supply contract via their landlord.

Active Customers represent domestic or smaller non-domestic end-use electricity Customers that are energy conscious and therefore have invested in off-the-shelf low-carbon technologies to derive revenue from renewable energy schemes, to reduce their overall costs or for social responsibility reasons. Generation or demand is unlikely to be actively managed and is installed on a passive 'fit and forget' basis. Low-carbon technology equipment includes solar panels, Heat pumps, electric vehicles, electric battery storage. These Customers are likely to be exporting to and importing from the distribution network and would seek to benefit from Suppliers' time of use tariffs.

This actor also includes parties acting on behalf of Customers such as developers and Independent Connection Providers.

How will its role evolve in the future?
Passive Customers will be offered opportunities to better manage the cost of their consumption through smart metering, half-hourly energy tariffs and may even gain benefits from export back to the grid. As a result, passive Customers may increasingly move to become active Customers. Care needs to be taken to ensure that Customers that do remain passive are appropriately protected and have the opportunity through smart appliances to automatically optimise their consumption. Otherwise, in the future, passive Customers may bear a share of the costs of smart networks without receiving the benefits.

Active Customers may choose to provide flexibility services through their energy Supplier or an Aggregator, or potentially even directly to a SO or Flexibility Coordinator.

How could different Future Worlds affect Customers?
All Customers will see a difference in World C as changes to price signals will increasingly incentivise active Customers to manage their electricity usage to reduce bills, potentially through automated means. As a result, passive Customers, depending on their consumption profile, could be more greatly exposed to network and energy costs.

For many active Customers the route to market for flexibility services will be through Suppliers or Aggregators. From this perspective, active Customers may see little difference between the Future Worlds, unless Worlds differentially affect their ability to interact with flexibility markets. This is similar for passive Customers who do not engage with flexibility markets.

For those Customers who choose to provide services directly, to either a market or SO, relationships will vary to a greater degree between Future Worlds. Worlds A and B will see Customers provide services more frequently directly to their local DSO. World D has the potential to build a similar relationship through the ESO. In World E, the Flexibility Coordinator would be the party an active Customer would contact to offer potential services.

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Data Communications Company

What is a Data Communications Company?

A Data Communications Company (DCC) is a party responsible for establishing and managing the data and communications network that connects smart meters to the business systems of energy Suppliers, network operators and other authorised service users of the network. The DCC is a monopoly company regulated by the energy Regulator.

How will the future look for a… Data Communications Company

How will its role evolve in the future?
All our Future Worlds describe futures that meet the challenges of decarbonisation, decentralisation and digitisation. The use of smart meters and smart grid technologies will be widespread in such futures creating advanced needs for data and communications networks. The DCC will need to set up and maintain such networks and ensure they keep abreast of future technological developments.

How could different Future Worlds affect a DCC?
Many of the needs and requirements of a DCC will be consistent between Worlds.

In all Worlds, the DCC will need to set up communications with;
- Service providers and their commercial agents (e.g. Suppliers, Aggregators), including the need to facilitate automatic actions in response to price signals
- Platform developers and operators
- SOs for both real-time operation and network design purposes.

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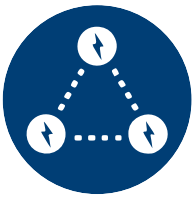

Distributed Energy Resource

What is a Distributed Energy Resource?

Distributed Energy Resources (DERs) are smaller scale power generation technologies (typically in the range of up to 10MW and including electric energy storage facilities) and larger end use electricity consumers (e.g. industrial and commercial) with the ability to flex their demand (i.e. demand-side response) that are directly connected to the electricity distribution network.

How will the future look for a… Distributed Energy Resource

The Open Networks Project has defined DER as either 'Active Participants' or 'System Service Providers'. Active Participants participate in the wholesale electricity market and/or local electricity markets. System Service Providers provide flexibility services to SOs (e.g. ESO, DSO, etc.) for electricity system balancing and network constraint management. These parties may enter into bilateral contracts with SOs for system support services.

How will its role evolve in the future?
In all Future Worlds, as the volume of DERs increases so does the need to ensure arrangements work for this actor and that the benefits that DERs provide are harnessed for the end consumer. This includes for connection arrangements, where there will be an increasing need to innovate and provide Customer choice. DER will also play a more significant role in the operation and development of networks including under emergency conditions such Black Start.

The opportunities for DER to provide flexibility services will increase and it will be easier for parties to do so whether as Active Participants or System Service Providers. Arrangements will increasingly facilitate direct participation in markets, although many parties will continue to see a benefit in having a commercial agreement with a Supplier or third-party commercial Aggregator.

How could different Future Worlds affect DER?
In World C, DER will increasingly respond to price-driven flexibility signals in their consumption and generation pattern. There will still be a need for DER to actively offer contracted flexibility to SOs in this World, either as an Active Participant or a System Service Provider.

In most Future Worlds, DER will discuss their connection with their local DNO as they currently do today. This could be different in World D where the ESO takes a more central role in the connection process (similar to current transmission arrangements).

For System Service Providers offering flexibility services through Suppliers and third-party commercial Aggregators there will be little change between the Worlds. For other DER, who wish to offer these services directly to a SO or Flexibility Coordinator, the relevant counterparty will change across the Worlds.

In World A, the DER will provide services to the local DSO. The ability to provide regional transmission or national services to the ESO will remain but this will be indirect through the DSO.

In World B, DER will continue to provide services to both the ESO and DSO depending on the SO needs and the revenue streams could be stacked where possible. This would also be the case in World C.

In World D, the ESO would take a more central role, administering services for distribution network needs on behalf of the local DSO. The DER would therefore offer services for both transmission and distribution needs to the ESO.

In World E, the counterparty would be the Flexibility Coordinator who would manage service requirements of both the ESO and DSOs. DER in this World would offer services to the Flexibility Coordinator for both transmission and distribution needs.

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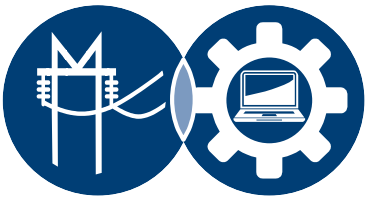

DNO/DSO

Who is a DNO/DSO?

Distribution Network Operators (DNOs) are regulated entities that own and operate electricity distribution networks over a defined geographic area. Historically these networks have been passive in nature, but with increasing volumes of DER they are becoming increasingly active. This together with smart grid technologies is creating opportunities for DNOs to realise consumer value and develop SO functions and become a Distribution System Operator (DSO). The scale of functionality of this DSO entity will vary depending on the Future World that is ultimately implemented. For reference, Independent DSOs (IDSOs) are covered as a separate actor.

How will the future look for a… DNO/DSO

How will its role evolve in the future?
The transition of DNO functionalities to DSOs will continue in all the Worlds considered. A DSO will securely operate and develop an active distribution system comprising networks, demand, generation and other DER. As a neutral facilitator of an open and accessible market it will enable competitive access to markets and the optimal use of DER on distribution networks to deliver security, sustainability and affordability in the support of whole system optimisation. A DSO will enable Customers to be both producers and consumers; enabling Customer access to networks and markets, Customer choice and great Customer service. Many existing DNO roles and responsibilities will also persist.

How could different Future Worlds affect the DNO/DSO?
The evolution of the DNO to DSO will be heavily influenced by whichever Future World is chosen. Its role will be most significant in World A where the DSO will take on a greater number of new roles and responsibilities. In this World, the DSO will be the neutral market facilitator for all parties connected to its network. It will develop deep SO skills ranging from smart network design through to optimisation of assets in real-time operation and Black Start emergency response capability. The DSO will use the services provided by both its assets and those of connected parties to provide services to the ESO and will take on the associated obligations of that role in a similar manner to other transmission connected parties. This will include having a declared commercial capacity potentially at each interface point with the transmission system.

In Worlds B and C, many of these roles will still exist, however the DSO will not be required to facilitate service provision to the ESO for regional transmission and national requirements and instead will co-ordinate procurement and dispatch with that entity.

In Worlds D and E, the DSO has a shallower role in certain aspects, however in both Worlds it will still need to develop SO capabilities to allow it to connect new DER and active Customers and to optimise the design and operation of its networks. In World D, the ESO will procure and dispatch the services required by the DSO, noting that this could be down to a certain voltage level rather than the entire distribution system. In World E, it is the Flexibility Coordinator who performs this role.

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Electricity SO

Who is the ESO?

The Electricity System Operator (ESO) is the actor responsible for the design and operation of the transmission network in Great Britain. This neutral party already fully performs the role of a SO at a transmission level. Historically this has required engagement with transmission connected parties and a few large DERs. However, as more active parties connect to distribution networks the ESO has established relationships with more DER and also with third parties such as commercial Aggregators.

How will the future look for an… ESO

How will its role evolve in the future?
The ESO will continue to have its traditional roles of designing and operating the transmission network. As the volume of potential flexibility service providers increases on distribution networks the ESO will increasingly need these parties to procure efficient services required for regional transmission management, as well as national services such as balancing and frequency response. It will need to work more closely with the emerging DSO entities to ensure a coordinated whole system approach to system operation that will maintain security of supply and deliver value for the end consumer.

How could different Future Worlds affect the ESO?
Many of the existing ESO roles and responsibilities will continue in all Future Worlds. It is the relationship of the ESO with DSOs and distribution connected parties that will vary most strongly.

World A will see the ESO procuring flexibility services from the DSO in a manner similar to other transmission connected parties. These services will be provided by third-party actors connected within the distribution network, potentially through a commercial Aggregator. In this World, there will be a clear distinction between transmission and distribution and with the DSO managing power flows across the interface.

Worlds B and C see the ESO having a similar role with DSOs and distribution connected parties to today. Whilst it will need to establish a higher level of coordination with the DSOs, particularly in service procurement and dispatch, it will continue to procure and activate parties connected to distribution networks.

In World D, the ESO will take on extended roles and responsibilities in relation to distributed parties, potentially through all voltages of the distribution network or possibly down to a particular level. Whilst the DSO would still design and operate its network it would request services from the ESO who would procure them and ensure any conflict with transmission and national requirements was managed.

In World E, the ESO would continue to have a technical relationship with DSOs in the design and operation of the network. However, service procurement and dispatch of DER and active Customers would be done through the Flexibility Coordinator actor.

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Flexibility Coordinator

Who is a Flexibility Coordinator?

World E requires the creation of a new role of Flexibility Coordinator that does not exist today (its functions being picked up by the DSO or ESO in other Future Worlds). A Flexibility Coordinator is the responsible party for the management of the central hub(s) on which SOs request flexibility services and service providers offer their products. In this World, the Flexibility Coordinator would be responsible for management of conflict of services. Whilst this actor could be a national monopoly party, there could also be several regional Flexibility Coordinators.

How will the future look for a… Flexibility Coordinator

How will its role evolve in the future?
World E is a World where a national (or potentially regional) third-party acts as the counterparty for DER providing efficient services to the ESO and/or DSO as required. The Flexibility Coordinator therefore organises and operates the flexibility market for distributed flexibility resources. Flexibility needs from third-party service providers would be communicated to the Flexibility Coordinator.

The Flexibility Coordinator is responsible for the facilitation of pre-qualification, contracting, activation and settlement of distributed flexibility resources, in coordination with the DSO and ESO. This is with the purpose of constraint management on the distribution and transmission networks and system balancing. The Flexibility Coordinator has both commercial and technical responsibilities in this respect.

Responsibility for operating safe and secure systems would remain with the ESO and DSOs.

How could different Future Worlds affect the Flexibility Coordinator?
The role of Flexibility Coordinator only appears in World E and so cannot be contrasted between Future Worlds. However, a Flexibility Coordinator World could be created with price-driven flexibility principles consistent with World C.

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Gas

What is Gas?

Gas represents an energy system from which useful Gas energy resources can be extracted or recovered, either directly or by means of a conversion or transformation process (e.g. conversion of natural Gas and derivatives into chemical energy). Gas can be stored either for use in a different location or a different time.

How will the future look for… Gas

How will its role evolve in the future?
Existing cross-vector impacts will continue in the future. At a transmission level, if the volume of Gas fired power stations decreases then so would the interaction with Gas. However, if the predictability of such power station output reduces, for example due to increased renewables output, then the need to consider interactions increases.

Increasing numbers of parties will arbitrage their energy use across vectors. Also, use of smart technologies will advance the potential for all Customers to take up this opportunity.

How could different Future Worlds affect other energy vectors?
The price based flexibility of World C could see Gas interactions developing in different ways to other Worlds, reflecting cost avoidance measures taken by parties in this World. The differing market models for the other Worlds will only indirectly affect Gas, although its use could ultimately differ depending on the model.

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Government

What is Government?

This actor represents both local, devolved and UK national Government bodies.

This includes local authorities and local enterprise partnerships (LEP) which are formed by a variety of stakeholders such as employers, landlords, policy-makers, energy consumers and energy generators. They promote the social, economic and environmental well-being of their community. They participate in the implementation of national energy policy that delivers secure, clean and affordable energy supplies through the application of measures that reduce energy use, promote the extensive use of renewable sources and tackle fuel poverty.

It also includes BEIS, the department of energy that is responsible for the design and implementation of national energy policy.

How will the future look for a… Government

How will its role evolve in the future?
Energy use will continue to be placed high on the political agenda and the challenges of decarbonisation, digitisation and decentralisation will remain prominent. Government will be keen to ensure policies are developed that support this agenda and will work with the Regulator and other parties in their development.

How could different Future Worlds affect Government?
On all levels, Government will be keen to ensure that policies work for their constituents, irrespective of the eventual Future World that is implemented.

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Heat

What is Heat?

Heat represents an energy system from which useful Heat energy resources can be extracted or recovered either directly or by means of a conversion or transformation process (e.g. conversion of Heat exchanging fluids into thermal energy). Heat can be stored either for use in a different location or a different time.

How will the future look for… Heat

How will its role evolve in the future?
Existing cross-vector impacts will continue in the future.

Increasing numbers of parties will arbitrage their energy use across vectors. Larger industrial Customers will achieve this between Heat and electricity. Also, use of smart technologies will advance the potential for all Customers to take up this opportunity.

How could different Future Worlds affect other energy vectors?
The price based flexibility of World C could see Heat interactions developing in different ways to other Worlds, reflecting cost avoidance measures taken by parties in this World. The differing market models for the other Worlds will only indirectly affect Heat, although its use could ultimately differ depending on the model.

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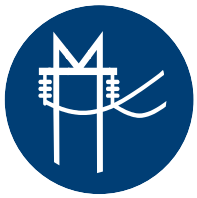

Independent DNO

Who is an Independent DNO?

An Independent DNO (IDNO) is a network company licensed by the energy Regulator to own, develop, operate and maintain (including fault repair service) local electricity distribution networks. IDNO networks are directly connected to the DNO networks, or indirectly via another IDNO. IDNOs are regulated in the same way as DNOs, however, the IDNO licence does not have all the conditions of a full DNO licence.

How will the future look for an… Independent DNO (IDNO)

How will its role evolve in the future?
Many of the resources connected to an IDNO's network, including DER, will play an increasingly significant role in the operation and development of networks, including under emergency conditions, such as Black Start. IDNOs will face a choice of utilising these flexibility resources to become IDSOs or remaining as network owners, possibly contracting SO capabilities (The IDSO role is explained separately). IDNOs will continue to need to manage their own networks effectively, efficiently, and safely.

How could different Future Worlds affect IDNOs?
The role and responsibilities of IDNOs does not tend to vary across the five Future Worlds. They will also continue to facilitate, maintain their networks and, depending on need and the Regulatory process at the time, upgrade their capacity.

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Independent DSO

Who is an Independent DSO?

An Independent Distribution System Operator (IDSO) is an Independent Distribution Network Operator (IDNO) who has developed SO capabilities to optimise its network and facilitate the requirements of its active connected Customers.

An IDNO is a network company licensed by the energy Regulator to own, develop, operate and maintain (including fault repair service) local electricity distribution networks. IDNO networks are directly connected to the DNO networks or indirectly via another IDNO. IDNOs are regulated in the same way as DNOs, however, the IDNO licence does not have all the conditions of a full DNO licence.

How will the future look for an… Independent DSO (IDSO)

How will its role evolve in the future?
Many of the resources connected to an IDSO's network, including DER, will play an increasingly significant role in the operation and development of networks including under emergency conditions, such as Black Start. As such, IDSOs may begin to play more of a role in coordinating those services within their network and making them available for other parties such as, for example, the ESO and DSOs. IDSOs will also continue to need to manage their own networks effectively, efficiently, and safely.

How could different Future Worlds affect IDSOs?
In World C, participants within IDSO jurisdictions will be given more granular price-driven flexibility signals and so will face improved incentives to respond in their consumption and generation patterns. There will still be a need for IDSOs to actively offer contracted flexibility to SOs in this World.

Across most Worlds IDSOs will work closely with the local Distribution System Operator (DSO). This could be different in World D where the ESO takes a more central role (similar to current transmission arrangements) and so the IDSOs may begin to work less closely with the DSO and more with the ESO.

For IDSOs offering flexibility services through Suppliers and third-party commercial Aggregators there will be little change between the Worlds. For IDSOs who wish to offer these services directly to an SO or Flexibility Coordinator, the relevant counterparty will change across the Worlds:

In World A, IDSOs will provide services to the local DSO. The ability to provide regional transmission or national services to the ESO will remain but this will be indirect through the DSO.

In World B, IDSOs will continue to provide services to both the ESO and DSO depending on the SO needs. These revenue streams could be stacked where possible. This would also be the case in World C. Strong coordination between SOs will mean that any conflict of services are resolved seamlessly for the IDSOs.

In World D, the ESO takes a more central role, administering services for distribution network needs on behalf of the local DSO. IDSOs may therefore engage more with the ESO in this World.

In World E, the counterparty the IDSO would primarily deal with would be the Flexibility Coordinator who would manage service requirements of both the ESO and DSOs.

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Local Energy System

What is a Local Energy System?

Local Energy Systems (LES) utilise peer-to-peer trading/local energy market to the benefit of their participants (e.g. communities, companies, individuals). LES participants provide each other with energy and trade out the aggregate 'balance' in the wholesale electricity market. LES can provide flexibility services to Electricity System Operators (e.g. ESO, DSO) for electricity system balancing and transmission and distribution network constraint management. LES can include DER and active Customers. LES can incorporate innovative energy distribution, management and metering, novel business models as well as clean transport systems. LES are emerging actors in the current World and include community energy projects.

How will the future look for a… Local Energy System

How will its role evolve in the future?
Many of the resources that LES participants utilise, including DER, will play a more significant role in the operation and development of networks including under emergency conditions, such as Black Start.

The opportunities for LES to provide flexibility services will increase and it will become easier for parties to do so. Arrangements will increasingly facilitate direct participation in markets, although many LES will continue to see a benefit in having a commercial agreement with a Supplier or third-party commercial Aggregator.

How could different Future Worlds affect Local Energy Systems?
In World C, LES will be given more granular price-driven flexibility signals and so will face increased incentives to respond in their consumption and generation patterns. There will still be a need for LES to actively offer contracted flexibility to SOs in this World.

Across most Worlds, LES will discuss their connection with their local Distribution Network Operator (DNO), as is the case today. This could be different in World D where the ESO takes a more central role (similar to current transmission arrangements) in the connection process.

For LES offering flexibility services through Suppliers and third-party commercial Aggregators there will be little change between the Worlds. For LES who wish to offer these services directly to a SO or Flexibility Coordinator, the relevant counterparty will change across the Worlds:

In World A, LES will provide services to the local DSO. The ability to provide regional transmission or national services to the ESO will remain but this will be indirect through the DSO.

In World B, LES will continue to provide services to both the ESO and DSO depending on the SO needs. These revenue streams could be stacked where possible. This would also be the case in World C. Strong coordination between SOs will mean that any conflict of services are resolved seamlessly for the LES.

In World D, the ESO takes a more central role, administering services for distribution network needs on behalf of the local DSO. LES may therefore engage more with the ESO in this World.

In World E, the counterparty the LES would deal with would be the Flexibility Coordinator who would manage service requirements of both the ESO and DSOs.

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Local Market Operator

What is a Local Market Operator?

A Local Market Operator (LMO) is a third-party actor responsible for building and operating flexibility platforms at the request of a SO or Flexibility Coordinator. These could be for specific products or geographic areas. They are neutral parties with responsibilities limited to the design and operation of the platforms requested.

How will the future look for a… Local Market Operator

How will its role evolve in the future?
Whilst platforms exist for DER to provide flexibility services to the ESO, the development of platforms for distribution system operation needs is still in its infancy and being developed through Open Networks and related innovation projects. Going forwards the need for such platforms and associated Local Market Operators will increase as increasing numbers of active Customers and DER see value in providing flexibility services. Whilst currently such platforms are discrete systems the potential exists for them to become more coordinated and standardized readily facilitating multiple service provision for different system needs and developing the role of a Local Market Operator.

How could different Future Worlds affect a Local Market Operator?
Whilst the needs and structure of flexibility platforms would be common across Worlds, there would be differences in the counterparty using the platform to procure services. Early confirmation of this party could facilitate efficient platform development and delivery.

In World A, the counterparty for flexibility platforms would be the DSO.

In Worlds B and C, platforms would need to be developed to provide services to multiple SOs; to gain efficient outputs these platforms would be developed in a coordinated manner.

In World D, the main counterparty would be the ESO, although there could be parallels with Worlds B and C if the DSO had a deeper role in lower voltage networks.

In World E, whilst the counterparty would be the Flexibility Coordinator, the need to provide coordinated services to multiple SOs would remain.

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North East West South Area Consortium

What is North East West South Area Consortium (NEWSAC)?

NEWSAC is a mutual aid consortium formed by all DSOs. In an emergency, affecting one or more member companies, the NEWSAC group representatives assess the availability of resources (e.g. skilled resources, such as linesmen and engineers) from those companies least affected and agree the allocation of these resources based on the level of damage.

How will the future look for a… NEWSAC

How will its role evolve in the future?
The requirement for NEWSAC will continue, although some skill sets may change to facilitate new technologies and increased volumes of DER on distribution networks.

How could different Future Worlds affect NEWSAC?
There is unlikely to be a material difference for NEWSAC between the Future Worlds.

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Regulator

Who is the Regulator?

The energy Regulator is responsible for regulating the electricity industry. The energy Regulator carries out functions to protect the interests of current and future consumers of electricity supplied by authorised Suppliers, wherever appropriate, by promoting effective competition between persons engaged in, or in commercial activities connected with, the generation, transmission, distribution or supply of electricity. The electricity Regulator works closely with industry in carrying out its functions such as licensing electricity Suppliers, generators, transmission and distribution, setting the levels of return which the monopoly networks companies can make and deciding on changes to market rules.

How will the future look for a… Regulator

How will its role evolve in the future?
Energy use will continue to be placed high on the political agenda and the challenges of decarbonisation, digitisation and decentralisation will remain prominent. The Regulator will support the development of Government policy ensuring that the welfare of consumers is realised.

How could different Future Worlds affect the Regulator?
The Regulator will need to establish its structure in accordance with the industry it regulates. Significant differences in structures between the Future Worlds could therefore have a resultant impact.

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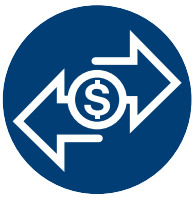

Settlement Agent

What is a Settlement Agent?

A Settlement Agent is responsible for managing the settlement of payments to and from flexibility service providers. The Settlement Agent collects, validates, processes and aggregates metered data from service providers (generation and demand based services); sets up and maintains the systems that collect, securely store, and securely transmit the data necessary for settlement process; manages the settlement of payments by flexibility service providers; calculates payments and charges; and invoices and collects payments due.

How will the future look for a… Settlement Agent

How will its role evolve in the future?
The number of flexibility services will likely increase, in part due to the increasing number of distributed service providers but also due to the increasing need for services at a distribution level. The delivery of these services will need to be paid for and audit systems will need to be established to ensure services have been received. Consequentially we are likely to see an increasing requirement for settlement activities and agents. In the longer term we may see that settlement activities become more standardised potentially through processes similar to the existing Balancing Mechanism.

How could different Future Worlds affect a Settlement Agent?
In World A, the existing settlement arrangements for transmission connected parties would continue, although DSOs may become signatories to the Balancing and Settlements Code (BSC) and required to become balance responsible parties. In turn these DSOs would also need to establish their own settlement processes within their distribution networks, potentially passing through any imbalance costs from the transmission system.

For Worlds B and C, transmission arrangements would continue to be administered by Elexon and ongoing developments to facilitate entry into this market for non-BM parties would continue. DSOs may have a need for other discrete mechanisms for bespoke flexibility markets.

In World D, settlement arrangements would be similar to transmission arrangements with a combination of different settlement processes for different products. There would potentially be an increased volume of activities and move towards greater standardisation.

In World E, there is potentially a need for greater standardisation of the settlement process, potentially increasing the role of Elexon and the BSC.

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5 – Stakeholder insights

Supplier

What is a Supplier?

A Supplier is a company that buys electricity in the wholesale market or directly from generators and sells it on to end use electricity consumers. The Supplier sets the tariffs consumers pay for the electricity they use. Suppliers work in a competitive market where Customers can choose any Supplier to provide their electricity. Suppliers can also be active in flexibility markets; providing services through their Customers.

How will the future look for a… Supplier

How will its role evolve in the future?
A Supplier's retail activities will remain consistent with the existing World today and are not expected to change across the Future Worlds studied.

Over time, a Supplier's Customer base will have an increasing proportion of active Customers wishing to create value through flexibility services. Other entities such as Aggregators will also seek to provide a route to market for such parties and Suppliers will need to evolve to compete in this changing marketplace.

Suppliers could have a large impact on the proportion of consumers who choose to become active and what services they offer. Suppliers are currently charged with the deployment of smart meters and their features and usability will be an important determinant of consumers' decisions to engage more with the industry.

How could different Future Worlds affect Suppliers?
For Suppliers, the biggest difference between the Future Worlds is how freely they can aggregate and sell on their active Customers' flexibility services. For example, in World A, where the DSO coordinates, Suppliers will be able to aggregate their portfolio within a DNO's network (potentially a single connection point to the transmission network) but broader aggregation as exists today may not be as accessible. Despite this, the stacking of revenues for local and national purposes would still be possible. In this World, the existing direct relationship with the ESO will disappear other than for transmission connected parties with even transmission charges potentially being paid through the DSO.

In World B, Suppliers will be able to stack revenues from different flexibility services at both distribution and transmission level and likely remain able to aggregate their portfolio across DNO networks. Strong coordination between SOs will mean that any conflict of services are resolved seamlessly for the Supplier.

World C would be similar to World B from a Supplier's perspective, except that Suppliers would also look for methods to manage Customer demands in response to price-driven flexibility. This will likely include incentivising passive Customers to become more active.

In World D, if DSO control is maintained over lower voltage systems, then the Supplier will have to log Customer bases and service provision separately with the ESO and DSO. However, if the ESO becomes the central party at all voltages then Suppliers could have little relationship with the DSO, and instead may only deal with the ESO. This distinction is also present in World E where the Flexibility Coordinator coordinates flexibility services within lower voltage systems and again Suppliers may have little relationship with the DSO.

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Supply Chain

What is the Supply Chain?

The Supply Chain is responsible for the design, manufacture and supply of equipment and devices to the electricity industry.

How will the future look for a… Supply Chain

How will its role evolve in the future?
There will continue to be a requirement for equipment in the electricity industry to connect parties, control equipment and collect data. It is these final two areas that will present the most new opportunities for Equipment Manufacturers who will be looking to innovate and use smart grid technologies.

How could different Future Worlds affect the Supply Chain?
The Supply Chain will engage with network owners to install new equipment and devices including TOs, DNOs and IDNOs. These field based activities will remain largely unchanged across the Future Worlds.

Control and monitoring equipment will also need to be installed in system operation centres, potentially in either or both network owner or SO locations. This range of options is not defined by a particular Future World, but rather by the arrangements between owner and operator (e.g. TO and ESO).

Commercial systems and equipment will need to be installed in the premises of Customers and also third-party commercial Aggregators and Suppliers. Again, this will be consistent across all Future Worlds. New equipment will also be required by a market facilitator and the counterparty for the Supply Chain in this area would vary from DSO (World A) to ESO (World D) and Flexibility Coordinator (World E). In World B and C, there may be a need to engage with multiple SOs to provide standardised and compatible equipment.

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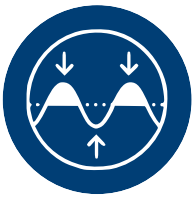

Transmission Connected Demand

What is Transmission Connected Demand?

Transmission Connected Demand is large scale sources of demand (e.g. such as steelworks, refineries, or other major industrial demand) directly connected to the transmission network that supports the ESO balancing supply and demand, and helps manage transmission network constraints. Transmission Connected Demand can act as a source of flexibility to the ESO by reducing demand to make additional volumes of electricity available or by increasing demand to reduce imbalance volumes of electricity.

How will the future look for… Transmission Connected Demand

How will its role evolve in the future?
Transmission Connected Demand will continue to have commercial agreements with the ESO for their connections, although their participation in markets may be through a Supplier or Aggregator. Through increasingly smart technology some will see increased opportunity to avoid high power costs or provide new flexibility services. Others, who are already fully flexible, may need to adapt in the face of increasing competition from other flexibility sources at distribution and transmission levels.

How could different Future Worlds affect Transmission Connected Demand?
The role of Transmission Connected Demand and how it participates will remain largely unchanged between the Future Worlds. Their connection agreements will remain with the SO and they will continue to be able to choose how they participate in markets; either directly with the ESO, through a Supplier or an Aggregator, independent of which World they are in.

This is not to say the different Future Worlds will not have a material difference on this actor. World C will potentially change charging and access arrangements for Transmission Connected Demand. Similarly, other Worlds may result in different volumes of active resource at a distribution level; whether through Distributed Energy Resource or active Customer. This will affect the level of competition Transmission Connected Demand may face in the provision of flexibility services.

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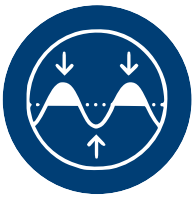

Transmission Connected Generator

What is a Transmission Connected Generator?

Transmission Connected Generators are large scale electricity generators (e.g. nuclear, Gas powered, coal fired power stations, etc.) directly connected to the transmission network that support the ESO in balancing supply and demand and managing transmission network constraints. These generators act as a source of flexibility to the ESO by making additional volumes of electricity available or by reducing the volumes of electricity being generated.

How will the future look for a… Transmission Connected Generator

How will its role evolve in the future?
Transmission Connected Generators will continue to offer services to the ESO for regional and national requirements, including emergency conditions such as Black Start. Contractual and charging interfaces will also remain with the ESO. In both the energy and flexibility markets, this actor will face competition from increasing volumes of smaller Distributed Energy Resource and will need to adapt to compete effectively. Contractual arrangements for the Transmission Connected Generators will remain with the ESO in all Worlds. Transmission Connected Generators may also see opportunities through non-network alternatives to transmission system needs.

How could different Future Worlds affect the Transmission Connected Generator?
The role of a Transmission Connected Generator and how it operates will remain unchanged between the Worlds since contractual arrangements remain with the ESO. This is not to say the different Worlds will not have a material difference on this actor. World C will potentially change charging and access arrangements for a Transmission Connected Generator. Similarly, different Worlds may result in different volumes of active resource at a distribution level; whether through Distributed Energy Resource or active Customer. This will affect the level of competition a Transmission Connected Generator may face.

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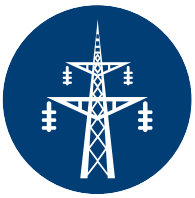

Transmission Owner

Who is a Transmission Owner?

A Transmission Owner (TO) is responsible for investing, building and maintaining their electricity transmission network. The TO provides network Customers with a safe, secure and reliable network ensuring they receive high-quality network services at value for money.

How will the future look for a… Transmission Owner

How will its role evolve in the future?
In the future, TOs will increasingly offer flexibility services to the ESO and the DSO (via the ESO) by utilising TO owned/operated flexibility resources. They will potentially need to build and operate their networks to meet the challenges of decreasing amounts of Transmission Connected Generation.

There are other potential changes to TO activities and incentives that are not the subject of the Future Worlds, for example there may be increased emphasis on competition in TO activities. TOs will need to remain competitive to effectively compete in this changing landscape.

How could different Future Worlds affect Transmission Owners?
The role and responsibilities of the TOs does not tend to vary across the Future Worlds. The TOs will continue to have a close working relationship with the ESO and DNOs within their geographical area. They will also continue to facilitate connections to the transmission network, maintain their networks and, depending on need and the Regulatory process at the time, upgrade their capacity.

This is not to say the different Worlds will not have a material and divergent impact on TOs. Different Worlds may result in differing volumes of active resource at a distribution level; whether through Distributed Energy Resource or active Customer. This will affect the level of competition transmission owned/operated flexibility resources may face in the provision of flexibility services. Similarly, this may affect the scale and location of new connections, how actors behave and required grid capacity. World C will potentially change charging and access arrangements, which may lead to a greater impact than the other Worlds.

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6 – Assessing the Worlds

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6 – Assessing the Worlds

This section describes a draft approach the ENA Open Networks Project proposes to follow to assess the five possible future market frameworks (or 'Worlds') identified in earlier sections and asks for input from all stakeholders. It outlines a draft approach to deliver a comparative Impact Assessment for the five Worlds and seeks feedback on the proposed methodology, areas for assessment, data requirements, stakeholder involvement and timescales.

Stakeholder input to the approach and content of the Impact Assessment, as well as input to the Impact Assessment itself later in the year, is essential to ensure that we build a robust and accurate assessment.

6.1 – The Impact Assessment

Workstream 3 is to commission independent consultants to deliver a comparative Impact Assessment of the five Future Worlds described in Section 2 of this consultation which combines an economic analysis with a full benefits analysis.

We will be asking our consultants to deliver an Impact Assessment consistent with the approach taken for HM Treasury's Green Book[2] and we expect their assessment will highlight similarities and differences across the Worlds with sensitivity analysis to test the robustness of the comparative analysis for the five Worlds.

The assessment is expected to include a range of quantitative and qualitative criteria framed against an agreed set of flexibility service scenarios across the timeframes of RIIO-2, 2030 and 2050. We expect that the consultants will bring their own view on what the most appropriate content for the Impact Assessment will be, including what the assessment criteria will be but we expect they will be flexible to take into account stakeholder feedback to this consultation in setting the approach and content of the Impact Assessment.

The analysis is highly dependent on the assumptions made and the robustness of the data, so a key task in developing the Impact Assessment is collating the necessary data. We will ask our consultants to propose what data is required to support the analysis and how the data will be sourced (we expect that will include a data gathering or verification exercise with stakeholders).

[2] https://www.gov.uk/government/publications/the-green-book-appraisal-and-evaluation-in-central-governent

6.2 – Evidence Base Input to Ofgem & BEIS

The Impact Assessment will be provided to Ofgem and BEIS for consideration in their policy making related to DSO transition. It is intended to contribute to their evidence base and will be aligned with HM Treasury's Green Book approach wherever possible to help with this. Ultimately, it will be Ofgem and BEIS that make the decision on the most appropriate model and how to enact this.

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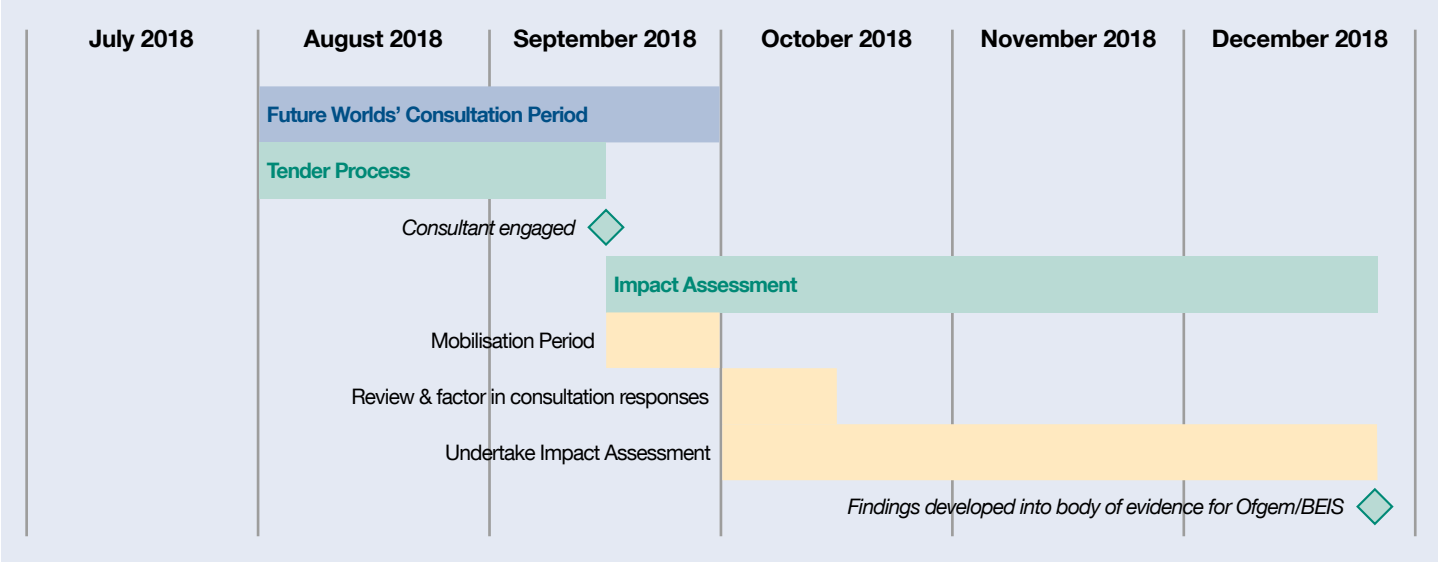
6.3 – Process

In May 2018, the ENA, on behalf of Open Network Workstream 3 Product 4 group, issued an expression of interest seeking information from consultancies on the availability of qualified consultants to deliver an independent Impact Assessment with support from the product team and the likely costs of the work to inform the tender process. The responses to the expression of interest were very encouraging and so in early August 2018, the ENA will invite a selected set of consultancies to respond to a tender to deliver the Impact Assessment for the five Worlds between September 2018 and December 2018. We plan to engage with you further to understand your views on our completed work in early 2019.

The intention is to commission the consultants in September with a short period of a couple of weeks to mobilise in advance of their analysis of stakeholder responses to this consultation to build the Impact Assessment.

Figure 6.1:
Impact Assessment Timeline



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6.4 – Impact Assessment draft approach

The aim is for the independent consultants to undertake an Impact Assessment of the five possible future market models of:

World A: DSO Coordinates
World B: Coordinated Procurement and Dispatch and dispatch
World C: Price-Driven Flexibility
World D: ESO Coordinate(s)
World E: Flexibility Coordinators

It is proposed that the consultants, selected from the ENA procurement process, will complete an independent comparative Impact Assessment of the five Worlds, engaging stakeholders throughout the assessment process. It is expected the development of the Impact Assessment will follow the steps of:

1. Mobilise
2. Analyse and incorporate
3. Develop the Impact Assessment model
4. Collate the data for the Impact Assessment
5. Publish results from analysis.

Initially, an assessment will be made of the availability and robustness of public data followed up by defining and engaging with all stakeholders, not just ENA members involved in the Open Networks Project, to obtain their data. A range of engagement methods will be used to collate data from stakeholders as shown in Section 6.6.

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6.5 – Draft assessment criteria

The five Worlds will be assessed across a number of common areas that seek to capture the comparative strengths and weaknesses of each World in a structured way. The product team have considered a first draft set of high level criteria which have formed the basis of the draft criteria set out below.

We have then considered the structure of HM Treasury's Green Book which sets out five cases which should be considered when assessing proposed major changes and we have allocated the draft criteria into those five cases to show where they might be captured in assessment in the Green Book approach. We recognise that this isn't a complete and compliant structure at this early stage, but our intention is to publish where we have got to at this stage and, most importantly, get stakeholder feedback on this before the consultants start to work on the Impact Assessment. We are seeking your views on how appropriate these criteria are and if they are suitable for comprehensively assessing the effectiveness of future arrangements.

Under each of the five cases below are a subset of proposed characteristics that describe the criteria and will be used for assessment purposes. The full list of assessment criteria, grouped into the five cases of the Green Book, is shown below, including a short explanation of each characteristic.

1. Strategic case:
How well does each model address the "case for change"?

Enhanced Customer experience is characterised by the following sub-criteria:
- Choice: will assess how well each World provides Customers with relevant choices for how they interact
- Fairness: how well each World achieves a level playing field for all system users and an assessment of how each World will support cost-reflective charges for all Customers
- Affordability: an assessment of how well each World will enable Customers to get the services they need at a price they can afford
- Confidence and trust: assessing transparency and predictability of future arrangements under each World.

Greater environmental sustainability is characterised by the following sub-criteria:
- Facilitates greater energy efficiency: how well each World will support measures to achieve energy efficiency and reduce overall energy demand
- Facilitates decarbonisation of electricity generation: ability of each World to support the decarbonisation of electricity generation
- Facilitates decarbonisation of Heat/transport: ability of each World to support the decarbonisation of Heat and transport
- More electricity consumed closer to point of generation i.e. lower losses: an assessment of the impact each World may have on the level of technical losses in the energy system.

2. Economic case:
How efficiently does each model address the "case for change"?

Financial benefits are characterised by the following sub-criteria:
- Cost of implementation vs benefits: an assessment of how efficiently each World achieves its expected benefits in terms of upfront investment
- Cost of operation vs benefits: an assessment of how efficiently each World achieves its expected benefits in terms of ongoing operational costs
- Expected benefits: assessing the relative expected benefits of each World and how they relate to each actor in the system.

Whole system optimisation is characterised by the following sub-criteria:
- Supports whole system optimisation: refers to degree that the World delivers whole system optimisation
- Optimises locally: relates to degree that the World delivers local optimisation
- Brings more flexibility into the system: is the ability of the World to attract new flexibility service providers to participate in the network services market and/or in the energy market
- Manages conflicts: relates to the degree the World is able to resolve conflict between expected/forecast/actual actions
- Avoids duplication: is the degree to which the World ensures that there are no issues with duplication of flexibility services
- Exploits synergies: is a measure of whether the World is able to co-ordinate actions that deliver synergies.

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6.5 – Draft assessment criteria

3. Commercial case:
How deliverable is each model – are the markets viable and regulation appropriate?

– Market viability: where elements of each World rely on market arrangements, are the markets viable and liquid enough to provide the required services?
– Appropriate regulation: are appropriate Regulatory frameworks available to be applied where necessary in each model?

4. Financial case:
How viable are the funding arrangements for each model?

– Regulatory funding: where roles in each World are regulated, are they compatible with Regulatory funding arrangements such as the RIIO model?
– Market facilitation: are there funding models to support market facilitation where necessary?

5. Management case:
How viable/achievable is each model in terms of complexity and alignment of responsibilities/actions with roles?

Industry structure and organisation is characterised by the following sub-criteria:
– Rules and regulation: relates to level of rules and regulations required for the World to function efficiently
– Facilitates neutral, fair and transparent markets: is the degree that the World delivers fair and transparent flexible service markets
– Complexity: refers to level of complexity of the World and is a measure of the difficulty for industry participants to operate in the World
– Implementation: is the measure of the difficulty to implement the World
– Future proof: is the degree to which the World can facilitate change with ease.

Technical performance is characterised by the following sub-criteria:
– Safety risk: is the degree to which the new World facilitates safe operation of the electricity network
– Service reliability and availability: is a measure of the reliability and availability of electricity experienced by Customers
– Security: is a measure of the physical security of network assets, and the cyber security of both operational and non-operational IT and communications infrastructure
– Resilience and recoverability: is a measure of how resilient the system is to failure, and how safe and recoverable it is in the event of failure
– Clear dischargeable accountability for technical performance: is the degree to which the World ensures that all parties have clear visibility of and accountability for performance, and the network owner/operator is capable of addressing & managing performance risk i.e. is able to manage the risk either of non-provision or over provision of flexibility services.

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6.6 – Data sources

The Impact Assessment will rely on good quality data and information to help quantify, where possible, and assess the comparative strengths of each of the five Worlds. Some of this information already exists in the form of publicly available datasets and as the output from the Open Networks Project itself. The table below captures some of these potential data sources that can be used to support the Impact Assessment.

Criterion	Potential source(s)/analysis
Enhanced Customer experience	Outputs from SGAM models regarding interactions with users. Reliability data (e.g. IIS)
Greater environmental sustainability	Supplementary analysis of ability to support carbon targets. Assessment of network losses. Renewable Energy Sources.
Financial benefits	Public datasets – Ofgem annual report, Elexon. Information request to relevant operators (DNOs, TNOs, SO, Aggregators etc.). Arora balancing costs forecast.
Whole system optimisation	Outputs from SGAM models regarding interactions between SOs.
Industry organisation	Supplementary analysis regarding Regulatory requirements and market viability.
Technical performance	Supplementary analysis of impact on various components of energy system. Reliability data (e.g. IIS)

To supplement this, further data sources and analysis will be identified by the appointed consultants and the product team and we will be seeking engagement with stakeholders to improve the Impact Assessment by helping to provide further supporting data to ensure a robust and consistent assessment. As part of this product, the product team and the appointed consultants will identify the requirements for the additional information/analysis and develop a plan to capture it. To assist with the collation of input data we are considering whether to form a sub-group and involve stakeholders.

Types of sources to be explored

At this early stage, the product team have identified some broad areas where extra data or analysis will be required for the Impact Assessment as described below. The development of the assessment criteria described above will also guide the scope and nature of the information to be gathered.

Existing information sources

Much of the information regarding existing arrangements and cost bases will be readily available from public sources. Examples of this include energy network cost data from Ofgem's annual report and system balancing data from Elexon. This information will help inform the materiality of the various areas being assessed.

Additional information sources (potential data requests)

For some information relating to future arrangements, there will be a degree of subjectivity and the selected consultants will seek to source information from a wide range of sources to ensure a reliable view is determined. For example, the future cost of implementing the necessary enablers for each World may need estimating, the project team will reach out to informed stakeholders to gather views and evidence for these expected costs.

Other projects/models for consideration

We are aware that there is considerable work being done in this area through other international projects and through the development of various models. Where possible, the product team will seek to include any relevant outputs from these projects/models where they support the assessment.

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6.7 – Questions: Assessing the Worlds

Questions

1. Do you agree with the proposed approach and timescales for delivering the assessment? Are there any improvements you would suggest?
2. Do you agree with the proposed assessment criteria and allocation into cases? What further development would you suggest to the criteria (e.g. any additional criteria) or structure and content of the Impact Assessment?
3. Is there any data you could provide or suggest we collect to support the assessment?
4. Do you believe that there are any tensions between different criteria and if so how should priority be built into the assessment?
5. Are there any functions/roles that need to be considered as a priority area for assessment?
6. We are considering forming a sub-group to assist with the collation of data for the Impact Assessment; do you think this would be worthwhile and if so would you volunteer to be part of the sub-group?

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7 – Key enablers for the future

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7 – Key enablers for the future

Future Worlds such as those described in this consultation document can only be efficiently delivered if certain key enablers are developed and implemented. These key enablers are characterised as activities that go beyond the incremental activities that are already taking place in the short term, many of which are being progressed through the Open Networks Project Workstream 1 products.

These key enablers are considered independent of the Future Worlds described in Section 2. It is intended that they would be developed to be agnostic of any developing arrangements, noting that this isn't always possible. We are interested in your views of areas of difference between the Future Worlds.

Whilst it is considered that the majority of the changes relate to DNO activities – at least in the short term – it is recognised that the future DSO is not the exclusive domain of DNOs. Indeed, the eventual Future World requires much closer DSO-ESO interaction and will include many new participants and it is one of the characteristics of the eventual Future World to provide neutral market facilitation for new markets and new market entrants.

The key enablers that have been identified to date are:

1. Changes to industry structure:
- Regulatory changes
- Organisational changes.

2. Developing a market-based approach:
- Market engagement
- Contract requirements
- Funding.

3. Facilitating information and data exchange
- Communications infrastructure
- IT systems
- Network visibility and control.

We are interested in your views on whether further key enablers exist and should be considered. The following sub-sections explain each of the above key enablers in more detail.

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7.1 – Changes to industry structure

Changes to industry structure include changes to the Regulatory framework as well as changes to the structure of organisations operating within that framework.

7.1.1 – Regulatory changes

The Government and Regulator Strategy is set out in the BEIS/Ofgem Smart Systems and Flexibility Plan (July 2017). The Open Networks Project is referenced in this strategy and its output will form an evidence pack for BEIS and Ofgem in their consideration of next steps.

Central to the Regulatory approach is the promotion of effective markets and competition to allow the best flexible solutions to flourish and help deliver a secure, affordable and clean energy system. The Regulator wants to see competition that is as far reaching as possible to make sure consumers benefit from a more efficient system. The Regulator also wants to help energy consumers gain control of their bills and how much energy they use. Smart technologies have a central role to play in this and can provide consumers with greater control and choice as well as enabling innovative businesses to be able to offer new technologies and new services to consumers. This means facilitating competition between new types of flexibility (e.g. storage and demand-side response) and other solutions, including interconnection, generation, energy efficiency or network infrastructure.

The objective is for providers of flexible solutions to be able to realise the true value of their flexibility. This means maximising access to the existing range of markets (capacity, wholesale, balancing and ancillary services), alongside new markets or revenue streams (e.g. for services at distribution network level, or for new services) and being able to stack value across them wherever appropriate. It could mean more fundamental changes to market structures or signals, to make it simpler for providers to combine value streams.

Achieving this increased level of competition and a market-led system will require improved visibility and transparency between buyers and sellers of flexibility. This is needed to give buyers and sellers of flexibility improved understanding of the markets, and market signals which inform their long- and short-term investment and operational decision making.

A smart system can deliver energy security at a lower cost than would otherwise be the case, as it introduces new options that can compete with the traditional solutions. As new smart technologies and solutions emerge, the SO and the energy market will have a more diverse range of options for balancing supply and demand. At the same time, it is essential that a smart system remains a secure system. A smart system will need to mitigate new risks, such as cyber risks, because it will be more complex and more driven by data and communication technologies.

A key role for the Government and Ofgem is to create an environment for new ideas to flourish by removing barriers to innovation. The energy system needs technologies and infrastructure that are both cheap and clean, but it also needs innovation in processes, transactions and consumer offerings. This is a fundamental part of the Government's Industrial Strategy (Nov 2017) and Ofgem's approach to regulation.

Additionally, Ofgem has set out a number of complementary workstreams in its Forward Work Programme. These include Ofgem's strategy for regulating the future energy system, Electricity SO Reform, and a Targeted Charging Review.

We do not believe it appropriate to seek views on Government or Regulatory policy in this consultation so do not invite views, but set out some of the objectives above for context.

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7.1.2 – Organisational changes

The SGAM modelling carried out so far by Workstream 3 is based on a detailed process mapping exercise of the high level functions used to define the role of the DSO.

These functions are defined in terms of actor inter-relationships and as such are not assigned to any particular organisation. Indeed, the DSO mapping exercise of the different Future Worlds has highlighted that the inter-relationships change significantly between the Worlds, implying that organisational structures will need to be flexible and adapt in order to optimise these inter-relationships. For example, recognising natural boundaries between monopolistic-type activities (such as market facilitation) and competitive, market-based activities. One of the key principles to emerge from the analysis to date is that of neutral market facilitation. This is not necessarily a single organisation, but any organisation adopting this role will need to adopt the core characteristics of this actor.

7.2 – Developing a market-based approach

The introduction of a market-based approach requires market engagement and the introduction of new contract requirements. All this inevitably raises the important question of funding for these changes. Market engagement, contract arrangements and funding are described in more detail below.

7.2.1 – Market engagement

Within the context of achieving both a successful DSO transition and the broader aspirations contained within the BEIS and Ofgem Smart Systems and Flexibility Plan, market engagement will be a driver to achieve greater participation in the existing range of markets (capacity, wholesale, balancing and ancillary services) with the associated increased market liquidity and competition aiding system security and reducing the cost of secure system operation.

Revisions to access arrangements and charging should build further confidence and surety for potential and existing investors and it is upon these that a growth of market participation can be built. The role of market engagement can be to leverage these developments and raise awareness amongst the broadest possible range of industrial, commercial, community and domestic Customers of the economic potential associated with participation in current or future energy markets.

Targeted campaigns to market the opportunities presented by greater participation, and increase awareness of the services required across the networks, will be key to reaching and engaging new market participants. Open access will require market mechanisms and settlement arrangements suitable to ease participation, along with information sharing and dispatch facilities compliant with the market model adopted.

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7.2.2 – Contract requirements

Secure and economic operation of the power system brings with it a need to commercially procure services to satisfy a series of technical requirements such as real-time voltage, frequency, constraint and fault level management. Additional services are also required associated with maintaining the resilience of the network or its restoration after a shutdown, Black Start.

There is a mature but continually evolving market for commercial Balancing Services to achieve secure and economic operation of the transmission system. A successful DSO transition will also require the further development of a similar market for services to achieve secure and economic distribution system operation. Commercial provision of distribution system level services already exists but market engagement to achieve greater penetration, competition and liquidity of services across the distribution network will aid a successful transition.

Inherent are certain requirements for contract arrangements associated with such commercial services:

- Specification of technical need
- Engagement with potential service providers
- Open access for all potential providers
- Defined payment mechanism
- Mechanism to quantify service delivery
- Settlement arrangement.

7.2.3 – Funding

Funding arrangements need to be considered for parties involved in potentially new Regulatory arrangements and this is a key enabler for transition to DSO. However, these arrangements are a matter for the affected parties and the Regulator and should be progressed through their Regulatory funding processes. We do not therefore comment further on them in this consultation document nor do we seek views.

RIIO-T1 (the first transmission price review) ends in 2021 and RIIO-ED1 (the first distribution price review) ends in 2023. The process of developing the next price control (RIIO-2) is already underway, starting with a review of the price review framework. Amongst other things, the framework will support the regulated companies in proactively managing and shaping the significant changes that need to occur across the energy system in the long-term interests of consumers.

The DSO road map, previously developed by the Open Networks Project, identified the Regulatory framework and Government policy changes as key foundations for the DSO transition. The Government has recently issued several Calls for Evidence in terms of electric vehicles, low-carbon Heating, energy storage, flexibility and smart grids in order to inform future Government policy. Similarly, Ofgem has begun the consultation process on the RIIO framework review and is due to report on its findings this summer.

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7.3 – Facilitating information and data exchange

The new market-based activities will change the way parties interact with each other, with much more exchange of information and data. This will need a whole new communications infrastructure and IT systems to support these new processes, which will also require much more network visibility and control.

7.3.1 – Communications infrastructure

Whilst the design of the energy sector is yet to be determined, it is clear that communications and IT systems will need to fundamentally change, irrespective of model selection. The DSO transition will create a large increase in the exchange of information and data. For example, between the following actors in both directions:

- TSO – DSO
- DSO – Customers/Aggregators/Suppliers/DER
- TSO – Customer/Aggregators/Suppliers/ DER
- DSO – Network Assets
- TSO – Network Assets
- DSO – IDNO/IDSO.

The transition to a DSO will require an integrated solution, with faster, more reliable communication. The transition to a DSO will result in a significant increase in telecommunication links between different internal stakeholders (asset management, SOs, network operators etc.) and external stakeholders (e.g. TSO, operators of distributed generation, Aggregators etc.) to provide DSOs with improved tools and information to monitor and operate the electricity network more effectively. Due to the important role telecommunications will play in future operation of the electricity network, it is essential that cyber security is fully considered and adequate controls are put into place to mitigate against the risk of future cyber-attacks.

7.3.2 – IT systems

To identify and manage the impact on the distribution network of DERs operating in the system services markets, network operators will require significant IT advancements. These will include, but are not limited to:

- Determining the ability of DERs to provide system services
- Forecasting DER outputs over various timescales on the distribution network
- Enabling active network management
- Increasing operational efficiency
- Providing congestion management services on the distribution network.

With the requirement for greater visibility and control of the distribution system, the need for a sophisticated Distributed Energy Resource Management System (DERMS) that can handle and fully integrate a wide variety of system tasks will increase.

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7.3.3 – Networks visibility and control

Enabling markets and facilitating low-carbon technology (LCT) uptake, such as electric vehicles (EVs), Heat pumps and solar panels, will need a significant expansion in the DSOs' and ESOs' roles regarding network visibility, monitoring and control to achieve optimal whole system benefits for Customers. These roles will need to become more sophisticated in a number of ways:

- Multiple constraints and DERs will need to be monitored and analysed simultaneously in order to provide network operators with a view of the ability of DERs to provide system services
- Forecasting network utilisation and DER behaviours over various timescales will become critical in order to allow the procurement and utilisation of DER flexibility efficiently
- Contingency analysis will need to become more sophisticated, considering more network configurations and accounting behaviours of the various network operators and DERs, in order to achieve efficient whole system planning.

In particular, investment is required at low voltage (LV) networks. Historically, network visibility, monitoring and control were not considered cost-effective at this network level, as load growth was more predictable. However, this is changing given the rise of LCTs and the expected clustering effect. Therefore, the roll-out of visibility and control across LV distribution sites is key to enable Customer adoption of LCTs and deliver decarbonisation at lowest cost.

For those interested in more detail associated with IT, communications and network visibility and control, a technical appendix is included at the end of this document.

7.4 – The way forward

Part of the Impact Assessment, described in Chapter 6, will include an assessment of the key enablers. Through the questions below we also invite feedback on the material presented in this consultation to inform our next steps.

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To respond to this consultation by 25th September 2018, please email:
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7.5 – Questions: Key enablers for the future

Questions

- This is the list of key enablers that we have identified:
  - Regulatory changes
  - Organisational changes
  - Communications infrastructure
  - IT systems
  - Network visibility and control
  - Market engagement
  - Contract requirements
  - Funding.

  Are there more key enablers that we should be considering?

- Do you agree with our short-term investment priorities relating to the key enablers of:
  - communications,
  - IT, and
  - network visibility & control?

- Given our short-term priorities, what actions do you consider need to be taken now to address them?

- Considering the different DSO model Worlds that Workstream 3 has considered, do you think the key enablers differ materially between the Future Worlds?

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8 – Proposed next steps

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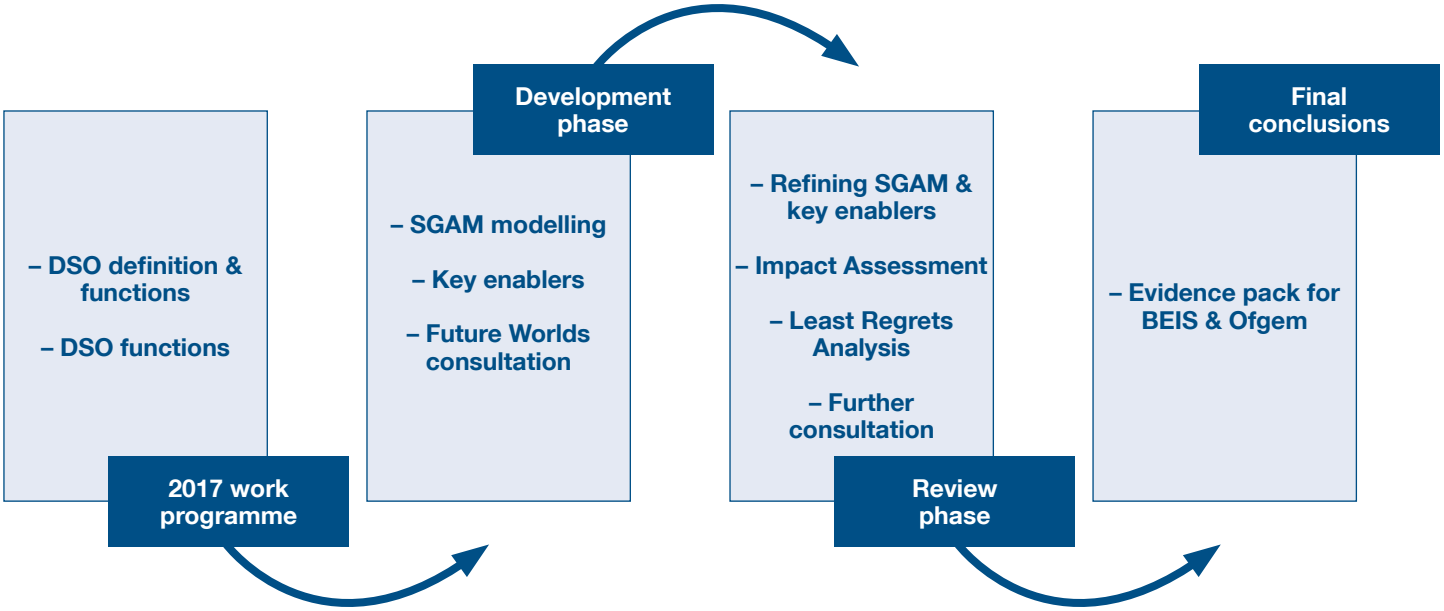
8 – Proposed next steps

The work contained in this consultation and associated documents forms the next phase in our work on DSO transition and forms the development phase of the overall work of Workstream 3. The diagram below shows this stage in the context of the overall timeline for Workstream 3.

Figure 8.1:
Workstream 3: Overall timeline



Following conclusion of this consultation we will enter the review phase of our work. In this phase we will use your responses to this consultation to refine our SGAM modelling and work on key enablers. We will also build on the thinking defined in this consultation to deliver our independent Impact Assessment.

We have already commenced some of this work. Below is a summary of the initial work undertaken to assess the SGAM models for identification of least regrets elements that could be progressed as a priority. We will publish an update of this work along with the outputs of these other next steps in early 2019 and invite further views. Following this we will forward our work to Ofgem and BEIS to inform their next steps.

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8.1 – Least Regrets Analysis

The sheer scale of the Open Networks Project and the task of transitioning to a smart grid could seem insurmountable at first sight. The technical, commercial and Regulatory challenges are many and far-reaching and the job of ensuring the solutions to those challenges align is extraordinarily complex. At the same time, networks have been challenged by Ofgem to demonstrate tangible progress towards a smarter grid, with DNOs transitioning to DSOs, sooner rather than later.

The Smart Grid Architecture Model (SGAM) has provided a tried and tested methodology for managing the scale of the task. In addition to this modelling work, in an exercise entitled **Least Regrets Analysis**, the model has identified some areas of functional commonality between all five Future Worlds. These areas present significant opportunities to implement aspects of the smart grid now; improving network efficiency, realising the opportunities for ancillary service providers and enhancing the experience for Customers. Identifying these areas and prioritising their implementation will form a key next step for the Open Networks Project as these functional areas will be required in whatever Future World is agreed upon.

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8.2 – Our approach to identifying areas of least regrets

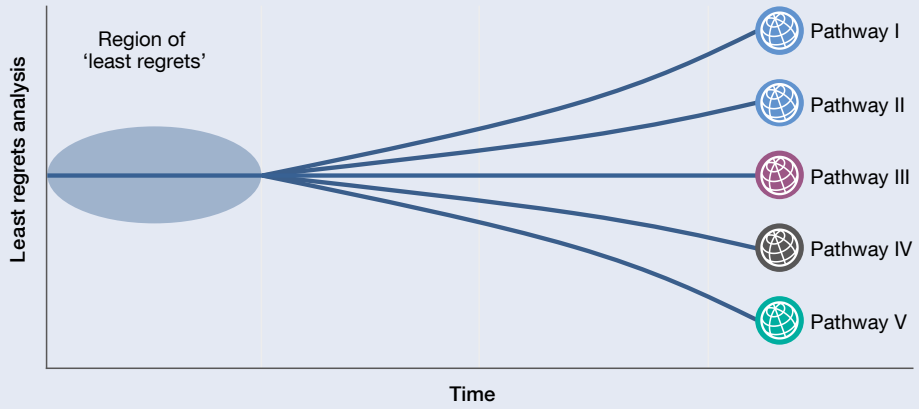
As we have already discussed, SGAM is built upon recognising actors and transactions in the Future Worlds. Where a specific actor initiates a common transaction of the same nature (contract, technology etc.) in multiple Worlds, this provides least regrets opportunities.

The Least Regrets Analysis explores the five alternative pathways for the Future Worlds to identify functional areas that are simultaneously present in (or common to) the different pathways to a greater or lesser extent. These functional areas can be implemented over the short term to assist the transition to a smarter grid irrespective of the ultimate future World that manifests itself.

- A lower number of areas of least regrets can mean a less flexible development process because it locks in to a specific pathway earlier when there is higher uncertainty
- A higher number of areas of least regrets can mean a more flexible development process as potential future transition from one pathway to another carries lower risk of additional work and redesign.

Figure 8.2 provides an illustrative example of the approach adopted for the identification of the areas of least regrets.

Figure 8.2:
Illustrative example of the least regrets assessment



In order to explore the potential areas of least regrets that can be taken forward irrespective of the Future World implemented, the information exchanges captured in the stakeholder workshops, as part of the DSO functions and activities, were compared across all Future Worlds to assess the levels of similarity that exist and the number of areas that are unique to different Worlds.

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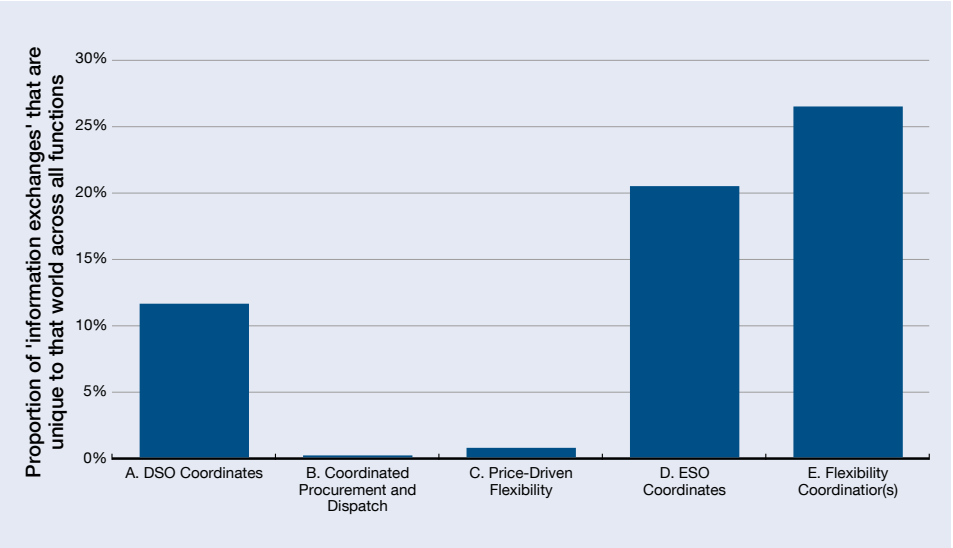
8.2 – Our approach to identifying areas of least regrets

Figure 8.3 below shows the proportion of the information exchanges within each World that are unique to that one World; i.e. that the relationship transferring information between actors was not also found in any other World when the workshops were carried out. It should again be noted that these figures are indicative rather than absolute because workshop participation varied from one World to the next and hence individual perspectives can be slightly different. It shows that World E has the greatest proportion of unique links, whilst Worlds B and C have the least.

As far as possible, the various means of capturing the linkages and exchanges have been rationalised using a common modelling language as part of this project, but some variation will always exist.

Figure 8.3:
Proportion of links that are unique to that World



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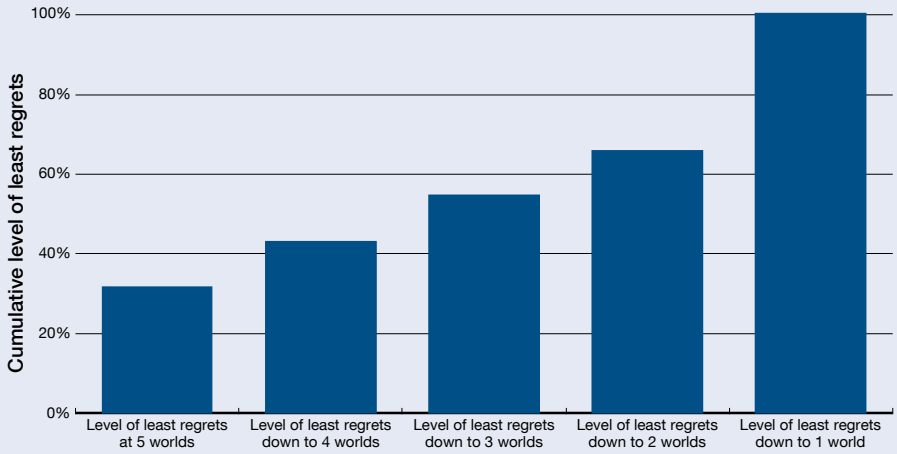
8.3 – Scale of commonality

These least regrets areas offer opportunities that can be pursued irrespective of the selected Future World because they will be common to all outcomes. This allows networks to make investment in the smart grid with the confidence that assets/technology/ processes and procedures will not become stranded.

Figure 8.4 illustrates the changing level of least regrets according to the number of Worlds being compared. Clearly the degree of commonality increases as fewer Worlds are compared. For example, the number of areas of least regrets increases from 183 activities for 5 Worlds to 567 activities for 3 Worlds.

Once this consultation is complete, the impact analysis has been carried out and Ofgem and BEIS have had an opportunity to consider the outputs, the industry may be in a position to reduce the number of Worlds under consideration. Until then the Open Networks Project will be focusing on those areas that are common to all 5 Worlds to ensure there is no wasted effort.

Figure 8.4:
Level of least regrets from 5 Worlds to 1 World



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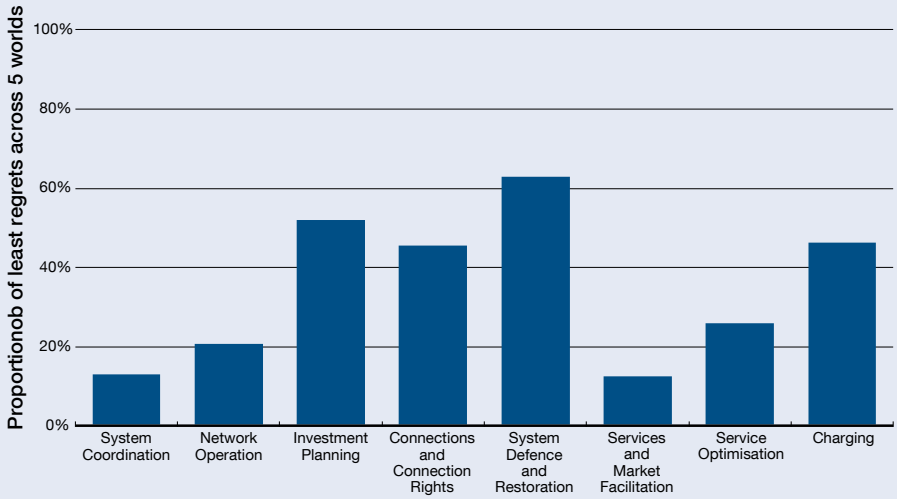
8.4 – Defining the functional areas of least regrets

EA Technology have undertaken some initial work to identify those functional areas of the DSO that have the greatest commonality in all five Future Worlds and offer the greatest opportunity for least regrets investment in support of a smart grid. Figure 8.5 shows the least regrets areas at five Worlds grouped by DSO function and we can highlight some key themes. The Open Networks Project plans to engage with stakeholders in autumn 2018 to help prioritise these functions and ensure there is cross-industry agreement on which aspects of a smart grid should be delivered first.

Figure 8.5:
Least regrets areas at 5 Worlds grouped by DSO function



As you can see from Figure 8.5, the proportion of least regrets varies significantly across the functions. System defence and Restoration and investment planning are over 50% least regrets illustrating that they do not change significantly across the different Worlds whereas services and market facilitation is the most different across the Worlds due to the market arrangements for the different Worlds being fundamentally different. In general, areas of least regrets tend to be aligned with achieving whole-system objectives through long-term planning. Network operation and activities that operate closer to real time vary more widely across the Worlds.

The key areas of least regrets in each function are detailed in Figure 8.6 and these will form the basis of the stakeholder engagement in the autumn, although it should be highlighted that some of these areas already form the basis of products in the 2018 project Initiation Document.

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8.4 – Defining the functional areas of least regrets

Figure 8.6:
Areas of least regrets by function

Function	Key areas of no regret
System coordination	– Coordination of outage planning – Regulatory framework for flexibility service provision – Flexibility compliance to activation/dispatch signals.
Network operation	– Development of network stability mechanism – Outage requests – Real-time network monitoring for thermal and voltage excursions – Activation of flexibilities and smart grid solutions.
Investment planning	– Traditional investment planning – Quality of supply planning standards.
Connections and connection rights	– Regulatory development of standard connection agreements for flexibility – Recovery of unused connection capacity.
System defence and restoration	– Black Start – Islanding – Voltage reduction.
Services and market facilitation	– Assess requirements for flexibility services – Procure and activate flexibility – Conflict mitigation and resolution.
Service optimisation	– Regulatory framework for market failure and last resort measures – Arrangements for activation of last resort measures – Development of smart grid solutions.
Charging	– Exchange of information to determine market charges – Access charges for flexibility resources.

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To respond to this consultation by 25th September 2018, please email:
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8.5 – Questions: Proposed next steps

Questions

1. Do you agree with the proposed next steps?
2. The Open Networks Project is prioritising areas of least regrets to deliver the benefits of a smart grid as soon as possible. Is there a specific activity within the functions that we have prioritised that you would like us to focus on for short-term delivery?
3. Is there any additional work that we need to undertake?

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9 – Summary of questions

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To respond to this consultation by 25th September 2018, please email:
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9 – Summary of questions

In this consultation document we have asked a number of questions which we would value your feedback on. These are summarised below for reference. We would value all responses before the closing of the consultation on 25th September 2018. To respond please email: opennetworks@energynetworks.org

Source	Questions
Section 2: The Future Worlds	– We have set out five potential Future Worlds. Do you believe these provide a reasonable spread of potential futures? – Are there other areas of potential Future Worlds you would like us to consider to inform our thinking? – Do you have any key concerns with any of the Future Worlds we have set out?
Section 3: The Smart Grid Architecture Model	– Is there anything missing from the SGAM methodology that have been implemented? – How can SGAM modelling be used in further work to extract maximum value? – What are the limitations of using the SGAM modelling for informing the Impact Assessment?
Section 4: The principle of neutral market facilitation	– How do you believe neutral market facilitation for SOs can be achieved? – What are the possible conflicts of interest that SOs need to be aware of when facilitating the market? – What additional requirements would be appropriate to ensure the neutrality of SOs in facilitating the market?
Section 5: Stakeholder insights	– Which SGAM actor(s) best describes your future role(s)? – Do you have any thoughts on the insights gained on this role(s) in each of the Worlds? – Do you have any comments on the insights drawn on any of the other roles described? – If you do not feel represented by any of the actors, how do you believe we should capture your role?
Section 6: Assessing the Worlds	– Do you agree with the proposed approach and timescales for delivering the assessment? Are there any improvements you would suggest? – Do you agree with the proposed assessment criteria and allocation into cases? What further development would you suggest to the criteria (e.g. any additional criteria) or structure and content of the Impact Assessment? – Is there any data you could provide or suggest we collect to support the assessment? – Do you believe that there are any tensions between different criteria and if so how should priority be built into the assessment? – Are there any functions/roles that need to be considered as a priority area for assessment? – We are considering forming a sub-group to assist with the collation of data for the Impact Assessment; do you think this would be worthwhile and if so would you volunteer to be part of the sub-group?

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To respond to this consultation by 25th September 2018, please email: **opennetworks@energynetworks.org**

9 – Summary of questions

Source	Questions

Section 7: Key enablers for the future	– This is the list of key enablers that we have identified:
	  – Regulatory changes
	  – Organisational changes
	  – Communications infrastructure
	  – IT systems
	  – Network visibility and control
	  – Market engagement
	  – Contract requirements
	  – Funding.
	  Are there more key enablers that we should be considering?
	– Do you agree with our short-term investment priorities relating to the key enablers of:
	  – communications,
	  – IT, and
	  – network visibility & control?
	– Given our short-term priorities, what actions do you consider need to be taken now to address them?
	– Considering the different DSO model Worlds that Workstream 3 has considered, do you think the key enablers differ materially between the Future Worlds?

Section 8: Proposed next steps	– Do you agree with the proposed next steps? – The Open Networks Project is prioritising areas of least regrets to deliver the benefits of a smart grid as soon as possible. Is there a specific activity within the functions that we have prioritised that you would like us to focus on for short-term delivery? – Is there any additional work that we need to undertake?

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9 – Appendix 1 – DSO functions

The following list of DSO functions were developed by the Open Networks Project in 2017. These have been used as the basis of the SGAM workshops held to develop the five Future Worlds.

No.	DSO functions	Description	Activities	Activities
1	System coordination	Operate local and regional areas and co-ordinate energy and power transfers with other networks and systems to enable whole system planning, operation and optimisation across different timescales. System coordination could include local actions to support thermal, voltage and frequency management across networks, including actions to minimise losses, manage constraints and provide capability.	Coordination with Great Britain System Operator (GBSO).	Managing MW and Mvar demand and generation within a local network area and managing exchanges to and from the GB transmission system within agreed technical and commercial limits.
			Coordination with other DSOs and Distribution Networks (including IDSOs).	Managing MW and Mvar demand and generation within a local network area and managing exchanges to and from other distribution networks within agreed technical and commercial limits. These distribution networks will include networks operated by the same DSO, other DSOs, DNOs and Independent DNOs.
			Coordination with Local Energy Systems, including industrial networks, community schemes, smart cities etc.	Managing MW and Mvar demand and generation within a local network area and managing the interfaces to Local Energy Systems and arrangements within agreed technical and commercial limits. These Local Energy Systems and arrangements might include community energy arrangements, smart city arrangements as well as the private networks used to supply industrial complexes.
			Coordination of networks to enable cross-vector energy exchanges.	Managing the distribution network so that cross-vector energy exchanges are facilitated where these are acceptable technically and commercially.
			Coordination of local network services.	Contributing to the management of other networks and wider systems (e.g. transmission voltage management, overall frequency management) through the facilitation and coordination of local network services provided by DER.

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9 – Appendix 1 – DSO functions

No.	DSO functions	Description	Activities	Activities
2	Network operation	Operate the electricity distribution network to maintain a safe and secure system. Ensure that network powerflows remain within limits and that the network operates within acceptable voltage limits. Ensure that the network remains secure against credible events such as circuit trips and generation loss. Identify and manage current and future risks. Coordinate and collaborate with the GBSO to manage potential conflicts to support whole system optimisation. Respond to Customer needs.	Operate network within thermal ratings.	Use network asset rating and powerflow information and operate local distribution network assets within ratings.
			Operate network within voltage limits.	Model network powerflows and operate distribution network assets within secure voltage limits.
			Operate network to maintain dynamic stability.	Operate distribution networks such that the network and its connected resources (e.g. generators) remain stable for secured faults.
			Operate network within fault level limits.	Model network infeeds and contingencies to ensure that equipment and connected resources remain within short circuit ratings and within protection limits.
			Operate network to meet other power quality criteria.	Review and monitor potential for other power quality problems including harmonics and unbalance and operate network to avoid these.
			Operate network taking account of ongoing asset condition.	Monitor the condition of assets and adjust operation on the basis of latest condition.
			Operate network to minimise losses.	Model network powerflows to ensure that losses on distribution network are minimised.
			Enable network outages to provide access to assets and resources.	Forward planning and ongoing operation to ensure that network security is maintained during network outages and outages of key DER.
			Optimised use of assets and dispatch of services.	Utilise available resources in the most efficient way to operate within network limits.

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9 – Appendix 1 – DSO functions

No.	DSO functions	Description	Activities	Activities
3	Investment planning	Identify capacity requirements on the distribution network and secure the most efficient means of capacity provision to Customers. Coordinate with the GBSO and Transmission Owners to identify whole system options. These would include commercial DER options as well as distribution network investment.	Traditional investment planning.	Offering connections and upgrades for new Customers and for load growth based on the provision of network asset based solutions.
			Whole system planning.	Coordinate with the GBSO and Transmission Owners to determine the most efficient options for whole system optimisation.
			Non-traditional investment planning.	Providing alternative solutions to traditional asset based investment including active network management systems to manage areas of constraint, DER contracts and dispatch etc.
			Security of supply (D&G).	Ensuring security of supply and network resilience is maintained in accordance with Regulatory planning and design codes.
4	Connections & connection rights	Provide fair and cost-effective distribution network access which includes a range of connection options that meet Customer requirements and system needs efficiently.	Connection agreements.	Providing connections for Customers with defined terms and conditions for network access. Defining the roles and responsibilities for each party involved in the connection.
			Connection access rights/ principles/information.	Agreeing how capacity constraints on the transmission and distribution networks that affect all Customers will be managed by network operators and how this information will be disseminated.
			Queue management/priorities.	Managing clear, consistent and non-discriminatory arrangements for how Customers waiting for new capacity will be treated.
			Commercial arrangements for constraints.	The mechanisms for managing network constraints through commercial means.

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9 – Appendix 1 – DSO Functions

No.	DSO functions	Description	Activities	Activities
5	System defence & restoration	Enhance whole system security through the provision of local and regional flexible services. Provide system resilience to very low probability but high consequence events using risk based approaches. Provide the means to re-establish the wider synchronous area in the event of widespread disruption.	Loss of Mains & other protection arrangements.	Ensuring the design and implementation of DER connection arrangements that have adequate resilience to network disturbances. This includes the specification of connection interface protection arrangements (including Loss of Mains) and compliance testing.
			Network Contingency Planning for High Impact Low Probability (HILP) events.	Forward planning to ensure network has the capability to remain resilient against high consequence events such as extreme weather.
			Resilience (Voltage reduction, Low Frequency Demand Disconnection (LFDD), and High Frequency Generation Disconnection (HFGD)).	Providing whole system network resilience and defence through the design and implementation of mechanisms including voltage reduction, LFDD and HFGD.
			Resilience (Islanding).	Providing local and whole system network resilience and defence through the design and implementation of islanding mechanisms to enable local areas of network to remain in service in the event of a wider system incident.
			Black Start.	Enabling whole system network re-establishment following a major system incident through the staged energisation of local networks. This could include the block loading of larger generators as part of wider Black Start plans.

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9 – Appendix 1 – DSO functions

No.	DSO functions	Description	Activities	Activities
6	Services/market facilitation	Interface with the GBSO and other network operators to enable the development of distribution capacity products, the creation and operation of local network service markets and to enable DER access/ participation in wider services for whole system optimisation. Facilitate local and national markets to access and settle services through auctions and other market arrangements for whole system efficiency. Ensure these arrangements are fair and transparent. Provide information and control system infrastructure to facilitate local and national markets and service provision.	Define distribution network service requirements including scope, timescale and locational aspects.	Establish the principles behind the planning, contracting and dispatch of services to support distribution network operation. Signpost requirements for services through information provision. Define service requirements including scope, location, timescales and technology aspects.
			Assess value and facilitate services to utilise flexibility sources to support distribution network operation.	Assess the value of flexibility for distribution network operation and signpost requirements. Facilitate services and markets to provide flexibility.
			Facilitate the operation of Distributed Energy Resource Management systems (DERMs) and Local Energy Markets (LEMs) that are transparent.	Put in place the infrastructure/ platforms that enable network operators to access the technical capability of DER and to commercially optimise and settle payments for DER services.
			Interaction with Aggregators and other non-traditional actors.	Enable the operation of new market roles (e.g. Aggregators) within the GB energy systems. This may include commercial and regulation requirements and the provision of information/ data exchange.
			Support the implementation of non-traditional market models for local energy supply.	Enable the operation of non-traditional business models within the GB energy systems (e.g. local energy markets, peer to peer trading). This may include commercial and regulation requirements and the provision of information/ data exchange. Provide information to enable settlement of these markets.
			Service conflict mitigation/resolution.	Identify, manage and mitigate service conflicts (e.g. GBSO and DSO use of resources). Enable sharing of services where feasible.
			Transmission and distribution coordination for transparent and consistent whole system outcomes.	Enable a more coordinated approach to the operation of services and markets and enable consistent whole system outcomes through enhanced transmission and distribution visibility, coordination and control.

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9 – Appendix 1 – DSO functions

No.	DSO functions	Description	Activities	Activities
7	Service optimisation	Ensure system needs can be efficiently met across all timescales by identifying network requirements, understanding the limitations of network assets and providing network access for additional flexibility services from smart solutions and DER services. Ensure whole system optimisation and resilience through the optimal selection of flexibility services.	Smart grid network flexibility.	Enable flexibility services through novel utilisation of existing network components.
			Service access management.	How services will be selected and managed by network operators depending on capacity constraints. Includes prioritisation methodologies (e.g. LIFO, technical best, economic best).
			Service selection.	Transparency of decisions and actions when choosing the optimal selection of flexibility services. May include a framework/rules/criteria.
			Transmission and distribution coordination.	How issues and solutions on both transmission and distribution are coordinated to enable efficient whole system outcomes.
			Conditions/process of market failure.	Identifying when last resort provisions should be enacted.
			Regulation & competition frameworks.	Identifying the rules for managing and remunerating last resort service provision. Putting in place methodologies to ensure that these continue to be efficient against other solutions.
8	Charging	Sets Distribution Use of System prices for local network. Determines Point of Connection. Determines connections charges and informs of transmission reinforcement charges (if applicable). Consideration to Exit Charging (dependent on size, variations and apportionment).	Distribution Use of System Charges.	Sets Distribution Use of System prices for local network.
			Determines Point of Connection.	Designs incremental capacity increases on the network.
			Determines whole system reinforcement charges.	Reflecting transmission charges and distribution costs in whole system charges.
			Exit Charging (dependent on size, variations and apportionment).	Management of transmission costs at the Grid Supply Point.

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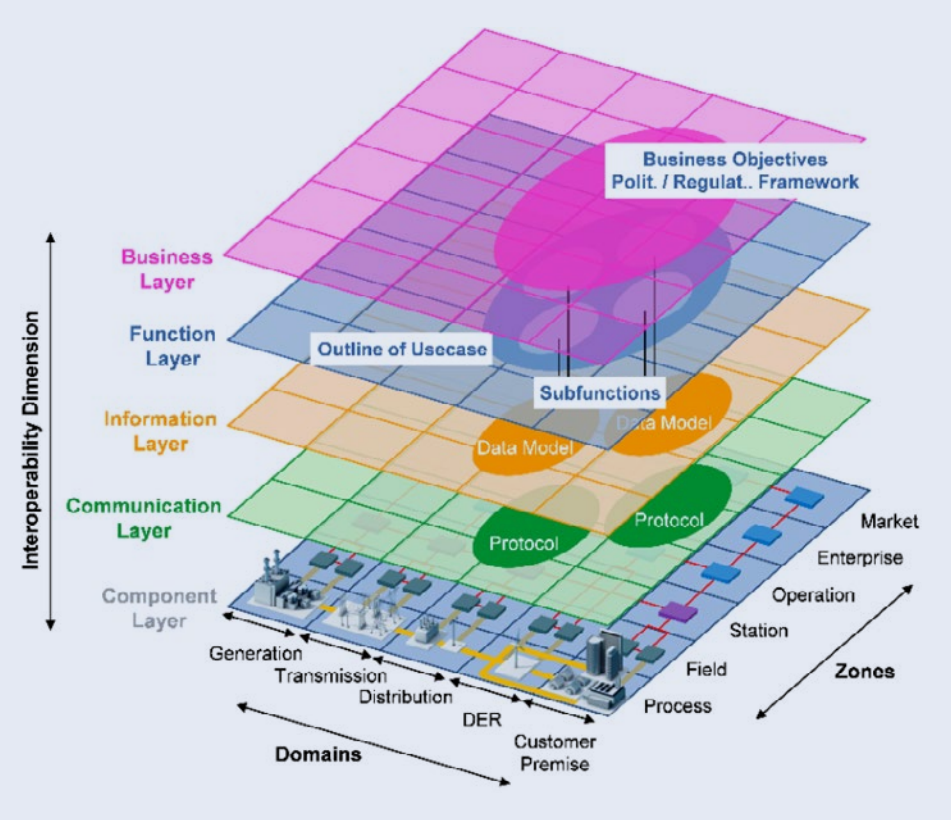
9 – Appendix 2 – Smart Grid Architecture Model (SGAM) supporting information

This appendix provides further detail on both SGAM and also its application in describing the Future Worlds. Further detail is also provided in the accompanying EA Technology report with the models also being available via HTML links.

Background on SGAM

The Smart Grid Architecture Model (SGAM) was developed by the Smart Grid Coordination Group as part of a European Commission Mandate. It is a holistic framework for describing smart grid systems, from their functional specification right through to their architectural design. The structure and composition of this three-dimensional framework is illustrated in Figure 9.1.

Figure 9.1:
Smart Grid Architecture Model



The SGAM framework is structured into five interoperability layers, with each layer represented by the smart grid plane that is composed of domains and zones.

The domains reflect the electricity system's physical components such as generation and distribution.

The zones characterise the hierarchy of power system management, in other words the business area that is responsible.

The five interoperability layers are defined as follows:

Business layer: represents the business aspects of the smart grid system such as business objectives, capabilities and processes, business models, business portfolios, organisational entities, policy and Regulatory considerations. For example, in this case, a DNO transitioning to a DSO.

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Function layer: describes the functions and services, including their relationships, that are required to realise the defined business aspects. For example, network operation.

Information layer: describes the information exchanged between the functions and services that are realised by specific systems and components. The description of the information exchanges is represented as information objects and are informed from the derived data models. For example, rating of an overhead line.

Communication layer: consists of protocols and mechanisms for exchanging the information objects specified in the information layer. For example, SCADA.

Component layer: comprises the physical components, such as power system equipment, Information Communication Technology (ICT) devices, software, which allocate the functions and communicate among themselves using the specified information objects and communication protocols. For example, a Network Management System (NMS).

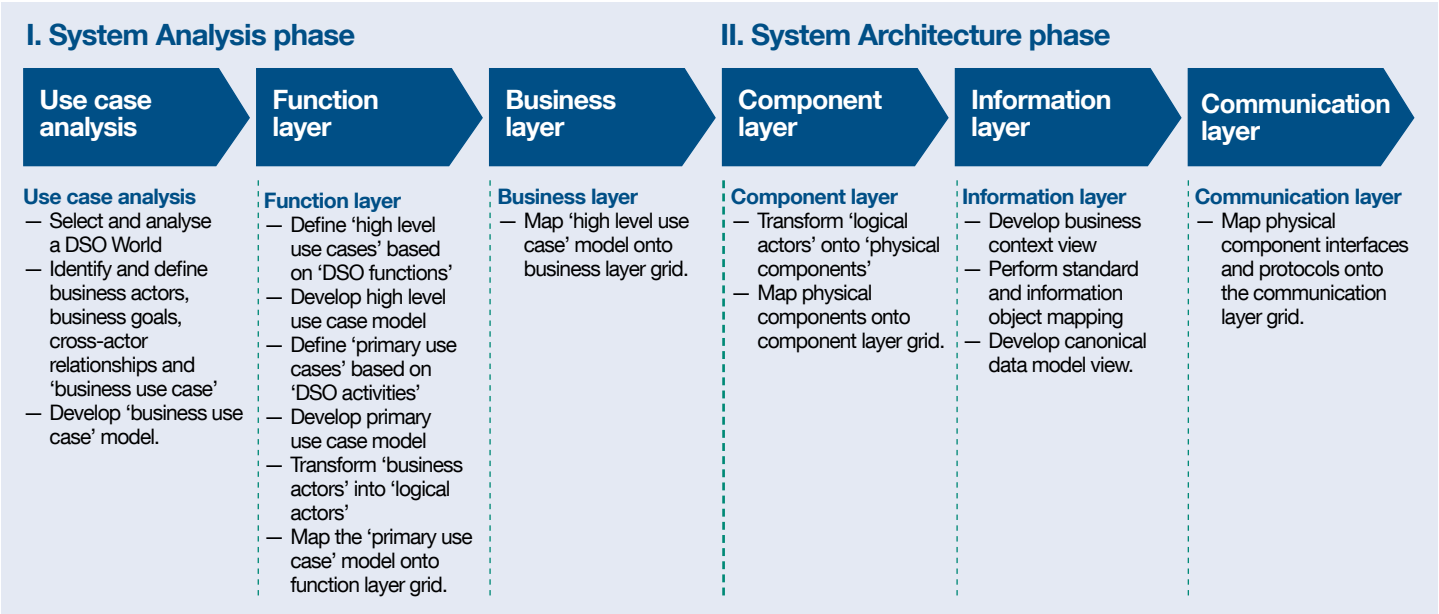
Thus, the SGAM framework allows the representation of smart grid systems and their relationships in the context of their spatial position within the electrical energy conversion chain, information management hierarchies and in consideration of interoperability aspects.

The Open Networks Project use of SGAM

The Open Networks Project commissioned EA Technology (EATL) to develop SGAM to structure five Future Worlds. This was achieved through the use of Enterprise Architect and SGAM Toolbox software tools. Enterprise Architect is a visual modelling and design tool covering all aspects of organisational architecture. The SGAM Toolbox is an add-in software utility that can be added to the Enterprise Architect to facilitate the usage of domain specific concepts, language and architecture relating to the SGAM domain.

EA Technology, in conjunction with the Open Networks Project, developed a methodology to represent the five Future Worlds in SGAM. The methodology records the five Worlds through capturing the interactions between different actors (stakeholders within the industry) from a high-level business layer perspective down to the detail of what information is communicated between equipment/components. Figure 9.2 illustrates the methodology developed for the design and implementation of the SGAM by EA Technology. Given the range of variables within each of the Future Worlds, the bottom layers of the model have not been populated
at this time.

Figure 9.2:
Methodology for the design and implementation of the SGAM – SGAM development process



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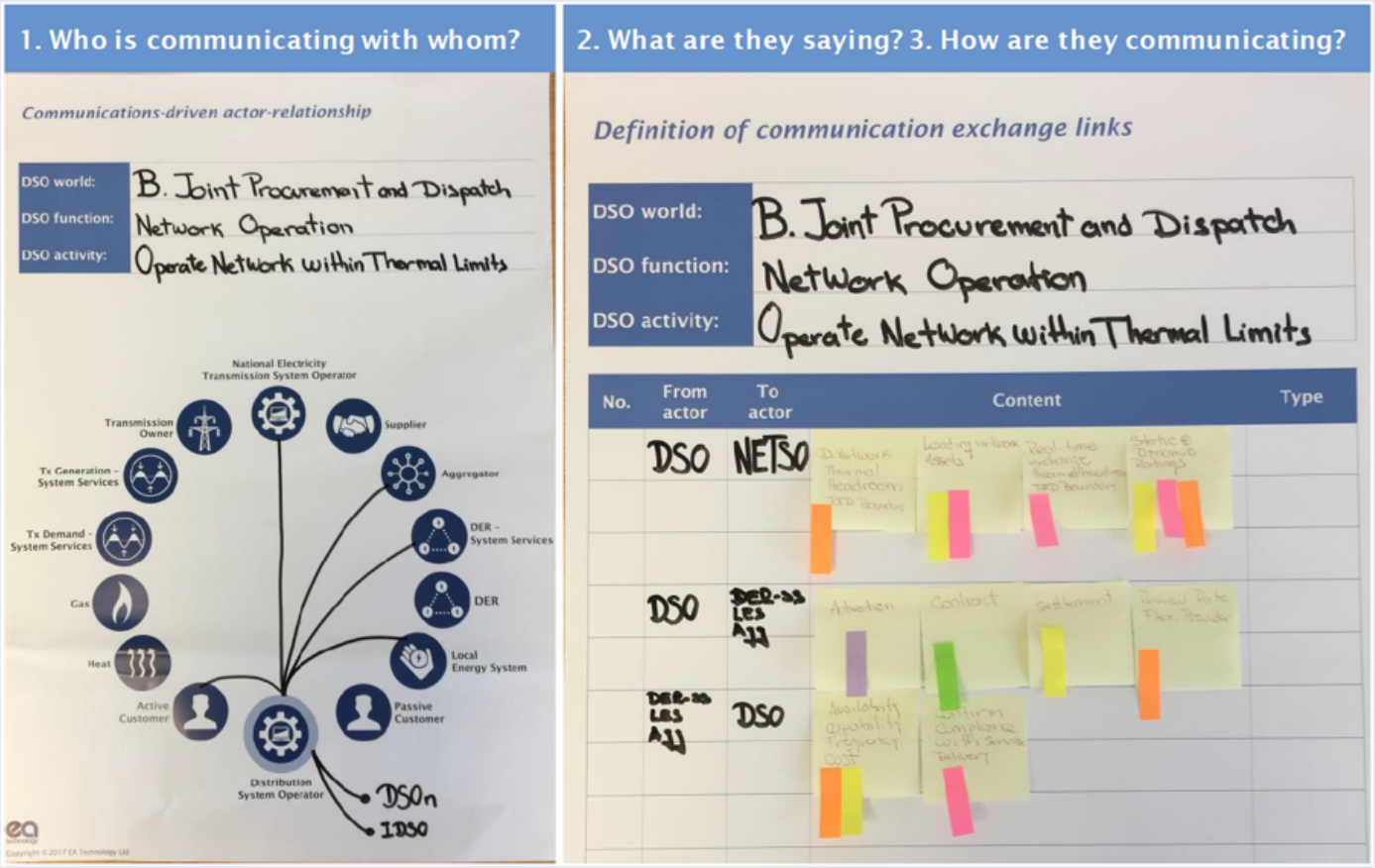
To ensure the Future Worlds were developed in a rounded manner it was decided to capture the base data for these Worlds via a number of stakeholder workshops. These workshops would confirm both the actors and also the communication paths between the actors for each DSO function and activity (as listed in Appendix 2). This was achieved through the use of three questions for each Future World, function and activity:

1. Who is communicating with whom;
2. What are they saying; and
3. How are they communicating (and how often)?

An example of the information gathered is shown in Figure 9.3.

Figure 9.3:
Example of content generated at industry workshops



These workshops have resulted in extensive sources of data. For instance, the SGAM for World B: 'Coordinated procurement and dispatch' has around 155 use cases which EA Technology inputted into SGAM following the workshops and discussion with Workstream 3 of the Open Networks Project.

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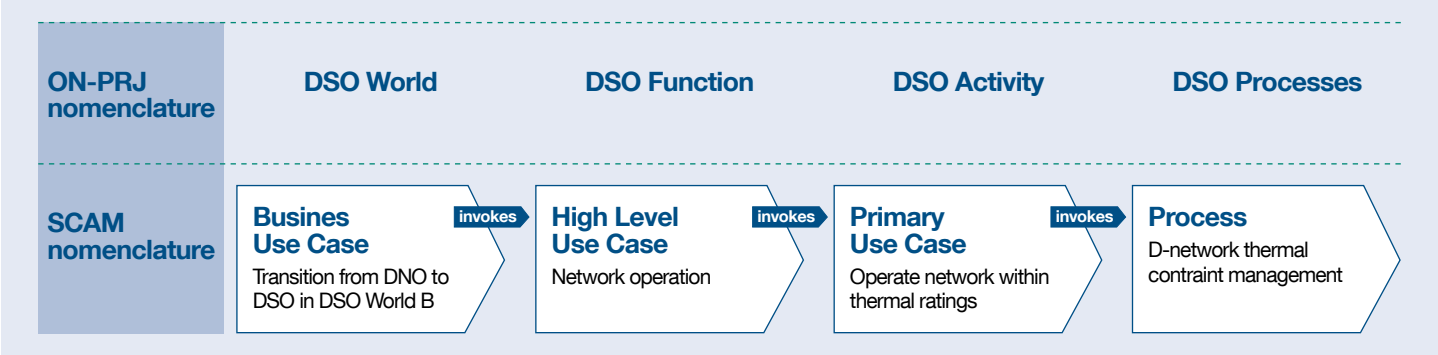
These 'use cases' form the basis of the information contained in SGAM. An example of a use case is presented as follows and also in Figure 9.4:
– Future World: 'DSO World B: Coordinated procurement and dispatch';
– DSO Function: 'Network operation';
– Activity: 'Operate network within thermal limits'; and
– Process: Activation of distributed flexibility resources for 'distribution network thermal'.

Figure 9.4:
Use Case



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9 – Appendix 3 – Key enablers for the future; further information on facilitating information and data exchange

In Section 7 of this consultation we described a number of key enablers for the future. The key enablers are the activities required to underpin the transition to future arrangements and will be required to deliver each of the Future Worlds.

One of the areas we discussed was for facilitating information and data exchange. This section provides further background context on the key enablers required to facilitate this which we believe are;

- Communications infrastructure
- IT systems
- Network visibility and control.

A4.1 Communications infrastructure

The development of new market-based activities will result in much more exchange of information and data. This will need a whole new communications infrastructure to support these new processes, Below we discuss the implications on operational telecommunications, non-critical broadband, and cyber security.

A4.1.1 Operational telecommunications (OT)

The transition to a Future World will not be possible without an integrated OT solution and faster, more reliable communication. Significant expansion of automation and monitoring will drive the need for additional bandwidth with expanded coverage. Wireless solutions with near real-time monitoring and control will be required to operate and control service solutions based on market drivers. In the future, smart grid technology will connect network assets, DERs, Customers and service providers. It will require a common infrastructure to enable device to device communication across the network.

As the numbers of grid edge devices begin to grow and play a significant role in the operation of the electricity networks, secure and reliable telecommunications are required to facilitate greater control and monitoring. This will significantly increase the control and data requirements from the operational telecommunications network. Network connectivity will also need to be assessed as access to data in the operational telecommunications network may need to be shared between multiple parties. It is critical that the telecommunications infrastructure is capable of managing the required level of data throughput while also ensuring the data is transported across the network in a secure manner. The telecommunications network will need to meet the additional requirements arising from the DSO transition and this will differ depending on whether the DSO architecture is centralised or decentralised:

- A centralised network is a type of network where all grid edge devices are directly connected and controlled from a central point, which is the acting agent for all communications. This central point would monitor network infrastructure, carry out all the control functionality and store the necessary data reported back from the grid edge devices
- A decentralised network is a type of network where the grid edge devices are connected to a regional hub which carries out the regional control and monitoring function independently or in collaboration with other regional hubs. The central point then issues supervisory control messages to the regional hubs and monitors them.

The characteristics of a centralised control model network are:

- Reducing downtime of the network and the cost associated to update and/or replace components carrying out the control functionality as they are located in one central location
- Higher physical security of the control elements of the network as it tends to be located in sites with some higher level of physical security already e.g. control centres or data centres
- High capacity telecommunication links and the networking equipment to support transporting high capacity traffic are required
- High resilience required to prevent single point of failure in case of loss of equipment, telecommunication link or the entire site (e.g. fire).

The characteristics of a decentralised control model network are:

- Control functionality is delegated deeper into the network so reduced impact of a single point of failure in equipment, telecommunications link or the entire site
- The telecommunications links to the regional hubs need less capacity than the centralised control model
- The overhead in additional costs and downtime in travelling between the different regional hubs to carry out patching, repairs and configuration will be higher than the centralised control model if unable to be carried out remotely
- Reduced control over physical security as most regional hubs will be located in remote sites.

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It is likely that three key network groups will be required to meet the additional telecommunication requirements: a core network, a wide area network and a non-critical broadband network.

1. Core network
The core network will be the main trunk transport network over which the various DERs and electricity control applications will be transported. As the network continues to grow with the connections of grid edge devices, it is anticipated that a move towards an IP based solution will be required due to obsolescence of TDM-based technology and the need for additional capabilities for remotely monitoring and configuring devices on a large scale.

2. Wide area network
The wide area network is used for future SCADA and automation applications which are deemed too critical to operate over third-party networks. Such applications will require a secure, low latency telecommunications network e.g. demand-side response. With the anticipated growth of IP technologies, there will be a need for greater wide area network capacity. The wide area network is likely to be used for network critical control data and will not be used for the transfer of data which isn't deemed as critical to the operation of the electricity network. This is due to the importance of this network, only a select number of radio equipment would be allowed to connect to minimise cyber security breaches. The development focus for this network is to increase the capacity, resilience and coverage necessary to meet the increasing demand and applications that will require access to this network. The network will migrate from being primarily to support a single application, which is SCADA, to support multiple applications including managed connections for distributed generation and automation schemes.

A4.1.2 Non-critical broadband

Non-critical broadband is required on the network for all other non-critical applications where there isn't a requirement for control functionality. This network should only be used to transport data from grid edge devices used only for applications such as power quality monitoring and condition monitoring which require high network capacity but do not require high resilience or low latency. Due to the network being less critical to the operation of the electricity network (the data being used more for optimisation or for informing longer-term strategic decisions), networks provided through third-party commercial operators can be leveraged to reduce cost.

In addition, inter-control centre communications will also require development. There will be a need for increased communications between control centres, particularly with regards to availability measurements and control signals which may be autonomously processed or require a control engineer intervention. Inter-control room communications may be between control centres within the same organisation, between the DSO and the ESO and between the DSO-ESO and third parties such as Aggregators.

It is likely that inter-control centre communications will be via an Inter Control Centre Protocol (ICCP) link, similar to that which is currently established between some UK DNOs and the ESO. The ICCP currently used is a subset of the IEC 60870 standard which defines the systems and protocols used for SCADA. SCADA has a large range of protocols to communicate with RTUs and is designed to easily integrate with these numerous protocols, using the same data types and control methods, allowing for direct connection between control centres to facilitate control signals to be passed through one control centre from another. As data transfer requirements increase, the ICCP will be required to be updated with latest versions, ensuring the ICCP database has the capacity to handle an increasing number of data points.

A4.1.3 Cyber security

The transition to a Future World will result in a significant increase in telecommunication links between different internal stakeholders (asset management, SOs, network operators etc.) and external stakeholders (e.g. ESO, operators of distributed generation, Aggregators etc.) to provide DSOs with improved tools and information to monitor and operate the electricity network more effectively. Due to the important role telecommunications will play in future operation of the electricity network, it is essential that cyber security is fully considered and adequate controls have been put into place to mitigate against the risk of future cyber attacks.

As the number of grid edge devices grows and IP network adoption in the operational telecommunications network infrastructure becomes more widespread, the risk in terms of exposure to cyber security attacks grows as there are more opportunities to exploit vulnerabilities in the network. Utility companies are also now required to meet the requirements arising from the Security of Network and Information Systems Directive (NIS Directive), which came into force in May 2018. The NIS Directive Cyber Assessment Framework has recently been published and is being used as guidance for utilities to develop their own cyber security solutions.

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A4.2 IT systems

To identify and manage the impact on the distribution network of DERs operating in the system services markets, network operators will require significant IT advancements. These will include, but are not limited to:

– Determining the ability of DERs to provide system services
– Forecasting DER outputs over various timescales on the distribution network
– Enabling active network management
– Increasing operational efficiency
– Providing congestion management services on the distribution network.

With the requirement for greater visibility and control of the distribution system, the need for a sophisticated Distributed Energy Resource Management System (DERMS) that can handle and fully integrate a wide variety of system tasks will increase.

Whilst it is likely that the DERMS will be centrally located, as field devices become more intelligent many will have the ability to provide autonomous network solutions. DNOs may choose to maintain a central control philosophy or may adopt a local control philosophy enabling control to be enacted at substation or device level.

Enhancements to DNO's Distribution Management System (DMS) may be required to control embedded DERs and facilitate their access to new markets. This may require the mapping of the LV network on the DMS to allow DERs connected to the LV network to be properly managed and controlled. It may also include the need for data with electrical parameters to be mapped to DMS to allow power flow studies to be performed by control engineers in real-time.

In order to facilitate Local Energy Systems and congestion management markets, DNOs may provide stakeholders with access to network data, enabling Customers to balance their local networks. To achieve this, DNOs will need to be able to safely and securely transfer network data between their operational and corporate network and present this to stakeholders in an efficient and user friendly way. Whilst this may be presented in various forms, it is likely to include the development of apps.

A4.2.1 Data storage

As Big Data becomes part of network operation, DNOs require a solution to manage and store the large amounts of data retrieved from the networks. Large data historians will be required to store and interrogate the data. Not only will this be required for network planning and operation, it may also be required for market operation and reporting.

How this data is stored will require consideration: data could be stored in a DNO or third-party data centre. The data could be stored in a "cloud service" which could provide data analysis services to determine what information is required. However, the geographic location of data centres is important to reduce the possibility of cyber security breaches. For example, some countries regulations may allow that country to view data held within the servers that belongs to DSOs which may not be acceptable to DSOs' policies and regulations.

A4.2.2 Smart meters

ENA and its members are working hard to support the roll-out of smart meters, working closely with energy suppliers, Government, BEIS, Ofgem, The Smart Metering Data Communication Company (DCC) and other stakeholders to ensure that the benefits to Customers are maximised. The work includes understanding how information from smart meters can be used to inform efficient network reinforcement decisions and keep these costs to Customers as low as possible. Smart meter information can also improve the level of service provided to Customers who experience network related supply disturbances and interruptions.

A4.3 Network visibility and control

There is currently limited real-time visibility of demand on LV feeders. In the past, when electrical demand was typically characterised by domestic appliances such as incandescent lighting, kettles, electric showers and white goods (e.g. fridges, freezers, washing machines, dishwashers and tumble dryers), the load on the LV networks grew predictably, and therefore there was limited need for LV network monitoring. Traditionally, awareness of increases in peak demand on LV feeders beyond their capacity is achieved through:

– Annual (or bi-annual) manual collection of Maximum Demand Indicator (MDI) readings following site visits and inspections to secondary substations;
– repeated LV switchboard or link box fuse operations due to high load current; and
– Customer-initiated voltage investigations.

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Once capacity issues are identified, the network is typically reinforced in order to provide additional capacity to accommodate the increased load. This is the traditional passive, "fit and forget" approach. The establishment of LV network visibility will enable a more active approach to network management and control. The collection of granular time-series data on LV networks will allow the release of latent network capacity that is currently unavailable due to planning assumptions and estimates that have to be made due to the lack of actual data.

It has been possible in the past to manage LV networks effectively using the reactive approach outlined above, due to the predictability of Customer demand and the relatively slow rate of change on the network. However, the expected rapid increase in LCTs will increase the magnitude and occurrence of network constraints on the LV network, with load patterns and constrained locations becoming less predictable and more volatile.

The deployment of secondary substation monitoring will subsequently enable the deployment of "smart" network control solutions, such as:

– Automated LV Interconnection
– Soft Open Point Interconnection
– Timed LV Connections
– LV Active Network Management (LV ANM), and
– Real-Time Thermal Rating (RTTR) of Distribution Transformers.

The roll-out of visibility and control across LV distribution networks is key to enable Customer adoption of LCTs and deliver decarbonisation at the lowest cost. It is a critical enabling system that will allow the deployment of a range of "smart" LV network control solutions that will ultimately manage constraints across the LV network more effectively and at a lower cost for Customers than traditional network reinforcement. However, these systems need to be installed in advance of the LCT uptakes in order to be able to deploy smart grid solutions effectively.

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